

How Pupil Data From Educational Games can be Presented to Teachers

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Educational games provide new possibilities for teaching and learning. Data from games can be used to inform teachers about their pupils' progressions. By presenting such data in an efficient and useful manner, one might improve assessment and the way feedback is given. There is reason to believe that this would further increase the value of educational games.

In this paper, two pioneering studies explore what kinds of data teachers are interested in extracting from games, and most importantly how this data should be presented. The first study involved teacher interviews, and the second involved teachers testing a prototype. These studies identified a current lack of data presentation and an enthusiasm about the potential use of such presentation. Teachers desire an efficient and easy-to-use overview, but also the possibility of viewing more details about individual pupils, preferably by visualising the data. The positive results open up a wide range of possible future studies, such as how a teacher would use the presented information in a real classroom.

1 Introduction

"If learning were easy, then schooling would be a walkover"
- John Hattie (p 126, 2012)

With the rise of computers come great possibilities for software meant for teaching and learning, so called *educational software*. They can motivate pupils and enhance the learning experience in ways traditional teaching cannot (Jämterud, 2010; Kenny & McDaniel, 2011; Lim, 2008; Suat, 2012). Examples of such advantages are: cooperation encouragement, facilitation of individualised learning, concrete problem-solving in virtual environments, unlimited task repetitions and direct interaction and feedback (Gulz, 2013; Jämterud, 2010). However, to harness these potentials we need to have software capable of providing them. One kind is computer games.

Computer games in general have become very popular and can enable people to learn while playing (Kenny & McDaniel, 2011; Schwartz & Arena, 2013; Shute & Ventura, 2013; but learning while playing is also criticised, see Linderoth, 2012). Much research has been performed on how to include games in education, on the benefits and drawbacks of educational games and on how to create them. Consensus seems to be that there is a place for games in educational environments (Gulz, 2013; Lim, 2008; Prensky, 2008; Schwartz & Arena, 2013; Shute & Ventura, 2013). Yet, in practice it is rare to see educational games that utilise the power of the medium (Gulz, 2013). The benefit of merely translating existing material to a digital variant is debatable; one does not make use of the potential of computers by

reading a book on a screen (Schwartz & Arena, 2013). A well-made educational game makes it possible for pupils to explore on their own. The choices and advancements can be logged and analysed to investigate how the pupil acts in different situations and in the game as a whole (Schwartz & Arena, 2013).

Educational games will very likely be used more in the future. However, in this paper it will not be discussed how to create well-made educational games, but it is important to know about their potential and that they can be made. Instead, the focus will be on how to show what a pupil is learning when playing; how logged data from game sessions can be presented to the teachers. Research about assessment in games investigate the boundaries of what can be measured, and how (such as in Bellotti et al. 2013; Ifenthaler, Eseryel, & Ge, 2012; Shute & Ventura, 2013). The aim is foremost to improve the measuring of pupils' skills to provide feedback and change the game to fit the pupil. But almost no research relates directly to how the *teachers* can use this assessment and how it can be presented.

Kotler (2011) suggest that gameplay data may provide a way to assess patterns of pupils' understanding, supplying information about where and what kind of errors that are made. She also noted that a majority of parents were interested in getting information about their children's achievements in games. Husain (2011) mentions a teacher console, or reporting tool, that the teacher can use to get data about the pupils, mostly for planning coming lessons, and interactive features, such as chatting. Gulz (2013) talk about a teacher module or evaluation tool and emphasises helping teachers evaluate performances and doing formative assessment, which is discussed later. But she also goes into detail about what kind of data that could be available for the teacher, such as: where difficulties arise, what problem-solving methods are used, how different feedback is handled and pupil initiative and responsibility (Gulz, 2013). These papers, although they picture what might be done, lack a concrete approach about what actually can and should be done and what teachers are interested in.

Two pioneering studies on this subject are presented in this paper. The software, aimed to be used by the teachers, will henceforth be called *game analysis tool* (GAT). This can be considered a more descriptive and specific term than those previously proposed. The first study consists of interviews with teachers about assessment and if and what they want to use a GAT for. It intends to give information about what to think about when building a GAT. In the second study a GAT is built based on the results from the interviews. This GAT is tested and evaluated by its intended users, the teachers themselves, who interact with it and give further opinions

about usage, presentation and the GAT in general. Together these studies are meant to give insight about how teachers can maximise the benefits of using educational games.

This paper takes the first steps concerning teachers' usage of a GAT and aims to answer many questions developers and researchers might have. In the next part we will introduce different kinds of educational assessments, how teachers use computers in education and the design of a GAT. After this the two studies are presented and discussed separately. At the end there is a final general discussion.

2 Background

Assessment in Education

Educational environments distinguishes between summative and formative assessment. The first is a systematic testing at the end of a learning period to record the status of the pupil, often for the purpose of certification (Sadler, 1989). The latter is recognising and discussing a pupil's achievements and planning for future learning (Harlen & James, 1997). Another way to put it is that, by nature, summative assessment is retrospective, while formative is in the present or prospective (Gulz 2013).

The general trend in many educational systems is an increasing focus on summative assessment (Black & Wiliam, 1998; Gulz, 2013; Lim, 2008). Basing the grade on one final test can often be stressful for the pupil (Gulz, 2013), which can have a negative impact on success (Beilock, 2008). Concern is raised that the learning process itself is in a black box, that is to say unknown (Black & Wiliam, 1998). It is also claimed that summative assessment limits the range of a pupil's skills (Gulz, 2013; Schwartz & Arena, 2013; Shute & Ventura, 2013). According to Gulz (2013), unless these assessments are made repeatedly and with flexibility they fail to address such things as: the pupil's choice of problem-solving, pupil initiative and responsibility and motivation for ones own learning. Another issue is that pupils learn to do tests, rather than learning the content in them (Shute & Ventura, 2013). Yet, it is important to point out the role of measuring the overall progress that summative assessment has, and also the role in producing comparable results between pupils (Harlen & James, 1997). In this way it can be seen as quantitative and inter-pupil.

Formative assessment can be considered qualitative and intra-pupil. Sadler (1989) argues that there are three elements crucial when trying to learn something: (1) recognition of the desired goal, (2) evidence about present position and (3) some understanding of a way to close the gap between the two. All of these three elements are the essence of what formative assessment aims at. The teacher adapts the teaching to the individual's needs and plans appropriate next steps. This requires an understanding about the inner workings of the pupil and emphasises the learning process itself (Black & Wiliam, 1998; Harlen & James, 1997).

Summative and formative assessment are not contradictory, rather they together paint a comprehensive picture of the pupil's achievement and knowledge. While formative assessment is considered to be the most important for learning (Black & Wiliam, 1998; Gulz, 2013; Harlen & James, 1997), summative assessment plays a role as a recorder of overall achievement milestones and comparable

data. A good example of how they can interact is the way the State of Oregon administers state-tests digitally. They can be taken several times and the results are shown immediately to both pupil and teacher. From this they choose what to continue working with (Gulz, 2013). This becomes an iterative learning process and reduces the pressure of achieving on a single test.

Feedback is an integral part of closing the gap between the present and the goal. According to Hattie (chapter 7, 2012), feedback is one of the most influential parameters regarding successful teaching and learning. He claims that it has the greatest impact when it is: "just in time", "just for me", "just for where I am in my learning process" and "just what I need to help me forward". Black and Wiliam (1998) suggest that the benefits of feedback is maximised when it relates to how the pupil can improve without being compared to others. Feedback can also benefit metacognition and self regulation, which in this context relates to thinking about, and taking control of, one's own learning and how one learns (Hattie, 2012). These mechanisms have been shown to have very positive results on learning (Gulz, 2013; Hattie, 2012). Gulz (2013) claims that to reach maximum potential concerning metacognition, one needs to be concrete and detailed. But today it is more common that the pupils have "reflection assignments" of an abstract and general character.

Using a GAT could aid both kinds of assessment, and produce observables that can be used to give feedback with great impact. By tracking the progression and results from the pupils in the game, it is possible to both summarise the outcomes and supply information on improvements. A GAT can present both the results at the end of a learning period, as well as how the pupils got there. For example, it would be possible to identify weak and strong pupils by comparing them to each other, and also supply constructive comments about how to improve, or what to praise, for a specific individual. This information is available immediately when the pupils have played, therefore it can assist teachers when it comes to giving timely and relevant feedback. A GAT could give teachers a powerful tool to better adapt their teaching to the pupils.

Another aspect of a GAT is that it would grant an objective appraisal. Free from opinions about the pupil or their previous accomplishments outside the game. It would treat all pupils alike. From an assessing point of view, this would, at least from the start of the game, make every pupil equal to one another and all achievements appraised in the same way. Even though a teacher strives for objectivity, it is unavoidable that subjective opinions matter to some degree (Hattie, chapter 3, 2012). A GAT might grant new insights about the skills of the pupils, skills that might otherwise be unobserved. It also gives the teacher a way to confirm, or refute, their own thoughts about a pupil.

Computer Usage in Education

Among teachers there seem to be an interest in the potentials of computers in education. Ljung-Djårf (2008) report that how teachers use computers vary to a large degree. Some see them as threats, others as an available activity option to choose from, yet another as an essential activity to learn from. The main issues with games are the uncertainty of when to use them and the fear of failure. Lim (2008) points out that there are teachers who are afraid that they will lose

control in the classroom when introducing educational games. Kenny and McDaniel (2011) argue that teachers need to believe that the medium grants something valuable in order to invest in it. The educational value of games needs to be expressed to the teachers for them to be properly implemented in the curriculum and positively approached. In other words, games need to be useful in both what they teach and how you work with them.

A GAT could improve how teachers use games and lower the threshold for using them. One part of it could inform the teacher about how to use the accompanying game, attempting to reduce the uncertainties stated above. Since it keeps track of all pupils simultaneously, it can also give more control over what is happening in the classroom.

The advent of the iPad in 2010 (Tablet computer, n.d.) introduced new user-friendly ways to incorporate educational games in teaching. It is safe to say that computers, of all kinds, will be part of our future and it is essential that a pupil learns how to use them. But, the computer is not a stand-in for a teacher and his or her knowledge about a pupil. Rather, it should be used as an additional tool that the pupil and teacher can work with. It should also be mentioned that educational games are not meant to be played without a teacher (Kol, 2012), yet pupils often play without supervision (Ljung-Djårf, 2008). Like other learning activities a pupil can be in need of guidance. The teacher can also register factors that the game cannot or does not, such as engendering motivation to learn or enjoyment.

Designing a Game Analysis Tool

“What is to be sought in designs for the display of information is the clear portrayal of complexity. Not the complication of the simple; rather the task of the designer is to give visual access to the subtle and the difficult – that is, the revelation of the complex” - Edward Tufte (Epilogue, 1983). As a designer one creates meaning and order in a complex world. To structure, organise, categorise and in other ways transform the complex into something manageable (Löwgren & Stolterman, 2002).

Presenting a pupil’s data from an educational game in an efficient and useful manner will heavily depend on

highlighting relevant data. Such highlighting can be created in various ways, such as using colours, white space and layout (Tufte, 1990). It is also strongly related to what data is to be presented and how much, hence it is of importance to know as much as possible about what is important for the teacher to create a design that is efficient and to the point.

Examples of what can be presented are: number of tries, correct tries, time spent at different parts, level of activity and if anyone got stuck. There are also more intricate examples of what could be extracted from the game data such as: pupil’s response to certain situations and feedback, methods for solutions and learning progression (Gulz, 2013). This would mean concrete, discussable data accessible to the teacher. To comprehend the data, it is crucial that it is presented in a manner that is easy to read and use. There is also a prerequisite that to understand the GAT one must know what the game is about and what it practises (see understanding of the subject, Harlen & James, 1997). One way to achieve this is for the teacher to actually play the game, another is for the GAT to describe the game and the learning goals, or a combination of the two.

Game Analysis Tool Examples

Almost all games track the progression of the pupil in some way. One of the most common is to give awards or score for certain achievements. However, this is not particularly meant for the teacher, rather it is for the pupil playing the game. There are some games that have a GAT and two different ones will be reviewed here. Note that no research about any of these GATs is available, neither of the idea behind them nor their use.

Qnoddarnas Värld (n.d.) is a Swedish game which claims to be comprehensive in Swedish and maths and meant for grade 1-3. The GAT is here called “teacher client” and is said to give reports of how the pupils are doing and what areas they need to practise more on. It further says that it shows the pupils’ strengths and weaknesses and facilitates creating curricula custom made for the pupil. In the actual GAT, the teacher can see the results from a specific pupil for all game levels (Fig. 1), or the results for all pupils on a specific level. Levels can be locked or unlocked, as well as highlighted,

Övning	A	B	C	D	E	F	G	H	I	J	Godkänd
MA - Blåbär 1:1 <i>Talen 0-5</i>				2/2 100%	4/4 100%	4/4 100%					<input type="checkbox"/>
MA - Blåbär 1:2 <i>Talen 0-5</i>			4/5 80%	4/5 80%	5/5 100%						<input type="checkbox"/>
MA - Blåbär 1:3 <i>Talen 0-5</i>				4/4 100%	4/4 100%	5/6 83%					<input type="checkbox"/>
MA - Blåbär 2:1 <i>Talen 0-10</i>											<input type="checkbox"/>
MA - Blåbär 2:2 <i>Talen 0-10</i>											<input type="checkbox"/>
MA - Blåbär 2:3 <i>Talen 0-10</i>											<input type="checkbox"/>

Figure 1. Qnoddarnas Värld’s GAT (in Swedish). It shows the results from all game levels of a specific pupil.

from the GAT. This must be done manually by the teacher and the pupil cannot unlock levels themselves. One feature lets the pupil ask for help using the game and the teacher sees this in their GAT. Lastly there is a section for teacher guidance with in-depth information about the game.

There are interesting aspects of this GAT, such as the control of and information about the game. The game itself covers a wide area of skills and it could be relevant to see general progress of all pupils or where they are in the game. This kind of overview does not exist, in fact there is no way to be sure what the pupils have just been playing. To see how all pupils have done in the game one needs to search through the levels, or all pupils, manually and make a mental note. The information about a pupil is limited to the amount of correct tries and their percentage of all tries, per level. There might be a need for more details about a pupil's results and when they have played. Hence, the GAT is probably easier to use for summative purposes.

Provia (n.d.) is another Swedish software meant to evaluate a pupil's linguistic competence. The GAT is called "result analysis" and is divided into three parts (Fig. 2). All parts relate only to a single pupil. One part (top left in Fig. 2) consists of a written, computer-generated verdict about the evaluated skills. The two other parts goes into more detail about the answers, there is a summary based on skill area (bottom left in Fig. 2) and a complete list of the pupil's answers (right in Fig. 2).

This GAT gives the teacher much interesting information that can be used to give formative feedback to the pupil. By sorting the detailed results it is possible to see exactly where errors are made, however this is potentially very time consuming. There seems to be no way of tracking progression from one session to another. *Provia* is designed to be used individually and there are no ways to compare pupils.

Purpose

The aim of the studies in this paper is to contribute to further improvement of educational games and the way they are used. From a larger perspective there are two parts of an accomplished educational game package: a high quality game, and a high quality GAT. The former being meant for the pupil and the latter for the teacher. They are deeply interconnected and a prerequisite for any GAT is a well-developed game. The game needs to have the possibility to track pupil data, so that one can analyse it and diagnose its meaning. The analysis process can essentially be split in two:

1. Extracting the raw data from the game and interpreting it into a wider perspective.

2. Presenting the data in a manageable and efficient way.

Depending on the game, the first part can vary greatly. For example, Shute and Ventura (2013) research a way to provide real-time estimates about what the pupil knows, believes, and can do. The focus in this paper is on presentation. What should be shown and how. This part is more general across subjects and games, however it too will vary depending on the game.

Two pioneering studies are presented in this paper, both concerning how to build a GAT with respect to its users: the teachers. The GAT aims at maximising the benefits of using educational games. The approach is exploratory in nature, due to the absence of previous research. These first steps are taken in a specific direction: preschool maths. This is due to this work being part of a larger research programme about math games for preschoolers. The main research question is: How can logged data from a pupil's acting, progression and results in an educational game be presented in a way that makes the information useful and efficient for a teacher?

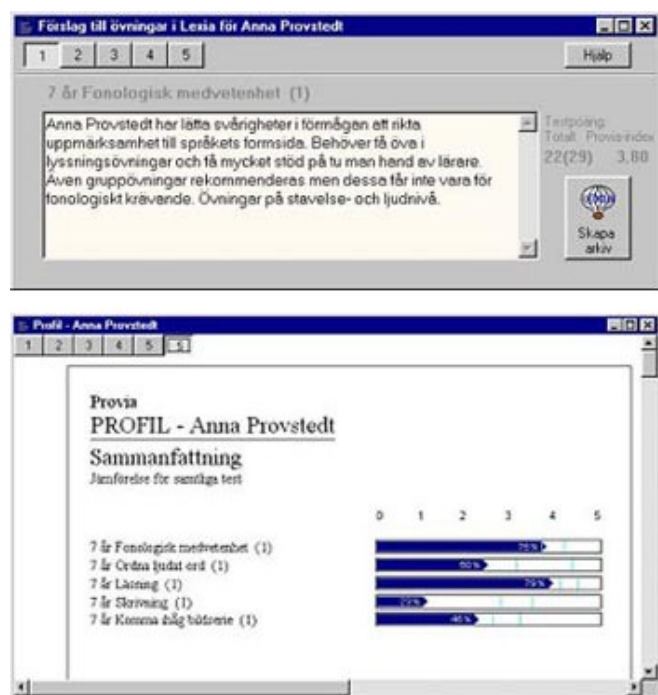


Figure 2. Provia's GAT (in Swedish). Top left is a written verdict based on the pupil's results. Bottom left is a summary of the results divided into different areas. To the right is a result sheet of all answers.

3 Study 1 – Teacher Interviews

Interviews were conducted to gain a picture of how teachers work and to understand if and how they would like to use a game analysis tool (GAT). These interviews were targeted at experienced teachers with different skills and backgrounds in an attempt to understand the variety of needs for different teachers.

Method

Participants

In total six teachers participated in this study. The sample was selected nonrandomly using a purposive sampling. The teachers were chosen to fit the study, in terms of their use and knowledge of educational games. This was to ensure previous experience and presumably more relevant opinions. Their professions were also considered, opting for preschool teachers and special needs teachers for preschoolers (the latter are summoned when a pupil needs additional support).

Three of the teachers were special needs teachers and one was a preschool teacher. One was a former teacher for middle school (age 10-12), but now an information and communications technology (ICT) teacher (mainly teaching others about the use of computers in education), this person also reviews educational games. One participant was a former teacher who has conducted research about educational games and has experience of designing them. Two teachers participated in a joint interview to stimulate discussions about the questions.

Material

Sketches were developed based on the work made by Gulz (2013) and Husain (2011). In short, examples from these works include, among other: statistics both for the group as a whole and the individual, different time spans and pinpointing strong and weak skills. The sketches were made using a prototyping tool called Balsamiq.

The sketches can be seen in Fig. 3. The top left sketch is a *general overview*. This is meant to show how the group is doing as a whole. The pupils are sorted and colour coded based on how much they struggle. A similar sketch is the *pupil summary* in the bottom left, but this puts more emphasis on showing how the individual is doing by presenting achievement using a progress bar. The top right sketch shows the *last session*. Here all pupils are placed underneath the different levels they have played, which will give the teacher an update on what has happened in the game. The last sketch, in the bottom right, represents an *individual's progression*. A diagram is used to visualise this. Throughout the sketches there are statements about what the group/individual is least and most struggling with. There are also ways to get more details by hovering over specific parts. For example, hovering over a pupil would show the name and short information of how that pupil is doing.

Process

Semi-structured interviews were conducted to find out (1) how teachers use games today, (2) what teachers are paying attention to when teaching, (3) what information they want in a GAT and (4) how this information should be presented. Inspired by *Qnoddarnas Värld*, they were also asked if they wanted to control the game from a GAT. Part of the interview consisted of the teachers being shown sketches of how a

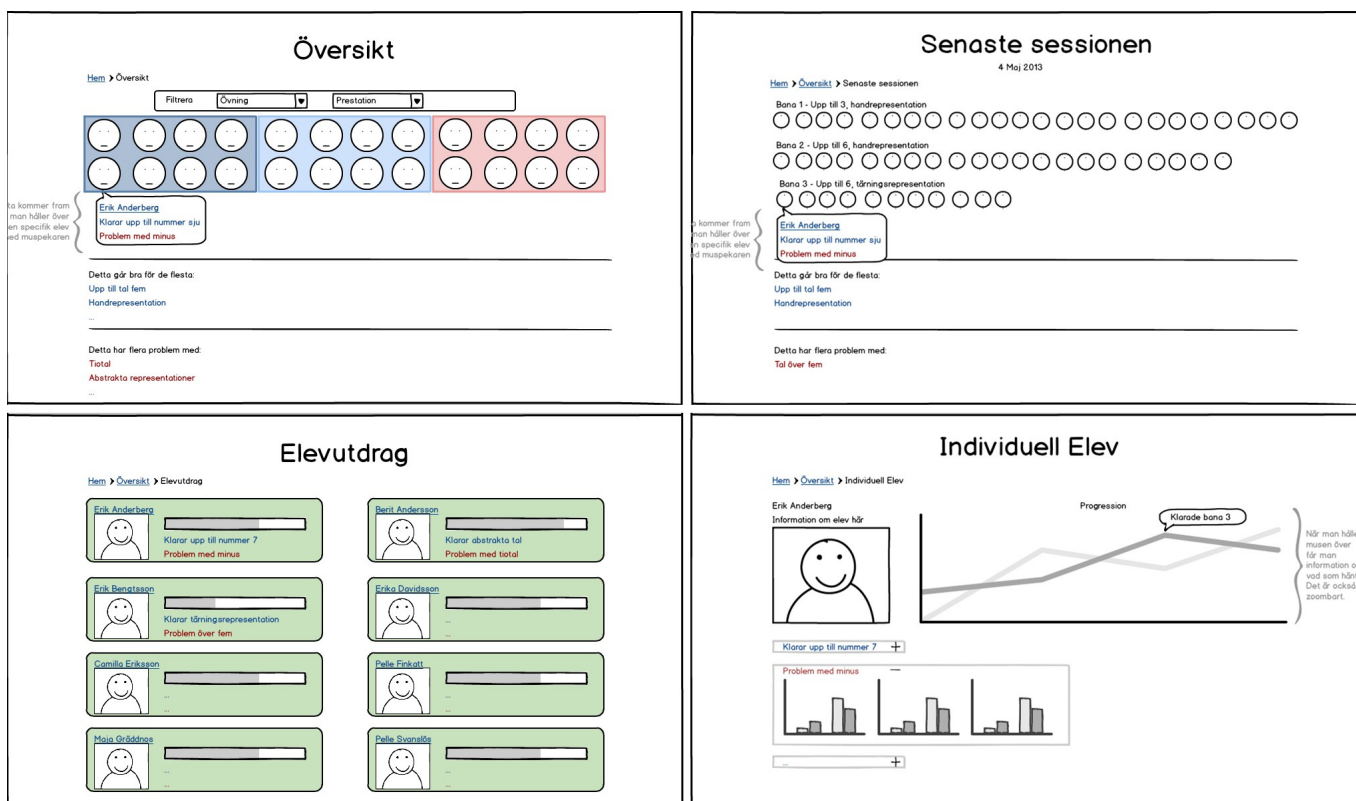


Figure 3. Sketches made for the interviews (in Swedish, see Appendix 3 for more details).

Top left: A general overview. Top right: The last session. Bottom left: A pupil summary. Bottom right: An individual's progression.

GAT might look and work. Since these kinds of features are missing in most games today, it was thought that this would spark ideas of what and how the pupil data can be used. Due to shortage of time the two teachers in the joint interview were not shown the pupil summary (bottom left in Fig. 3). The reason for holding the interviews in a semi-structured way was to be able to explore the teachers' point of views more freely.

The manuscript (in Swedish) for the interviews can be seen in Appendix 1. All teachers were told that they could abort at any time. The interviews were audio recorded and notes were taken. The interview lasted about an hour per person.

Results

All of the teachers, who were still actively teaching, used educational games in their daily work. Almost exclusively tablet computer games were discussed. A majority of the discussed games focused on training one specific skill, such as learning the number line. Everyone was embracing and positive about the use of games, pointing out how efficient they are at grabbing the attention of the pupils, as well as motivating them. There was also a consensus that games are a good way for the pupils to learn and that they enjoy learning using games. Games were used mostly for their educational content, but also as rewards where the pupils could play what they wanted. All schools had several tablet computers and it was pointed out that some schools concentrate on a one-to-one ratio, that is one computer for every pupil.

The Need for a Game Analysis Tool

Almost every game the teachers used lacked any kind of information about how the pupil progressed. Those select few that did only showed right or wrong, only gave information about the use of the game or only had a built-in reward system meant for the pupil. The idea of a GAT was well received, one teacher expressed that: "I am always interested in things that facilitate, teaching is very fun, but it is very, very burdensome." Another said: "Everything that is time saving and can show something in a larger perspective, that is an accumulated way, is very good." Comments also emphasised that a GAT would be most useful in classes with many pupils, even more when they all do the same thing at the same time. One teacher said: "I doubt if I had gone in and checked. I don't know. Maybe if there was someone I wanted to check if they have done it or if I am unsure."

One teacher expressed that analysing and evaluating is what you do the most as a teacher, any way you are aided in this is appreciated. Another teacher said: "This is an observation, though by technical means", and went on by saying that you can double-check your own observations with it, getting a second opinion. Yet another stated that the earlier you identify a struggling pupil the more impact it will make on future learning. But there were also worry from another teacher that one might "be blinded by achievement" and use the GAT too extensively, going on to say that it is dangerous in preschool to focus on progression. On the other hand, the same teacher pointed out that if we use it in higher grades it could be used by the pupils themselves. This could increase the pupils' responsibility over their own learning. It was also pointed out that the pupils have a tendency to forget

what they did the day before.

The future of the school was discussed by one teacher, saying that today more and more effort is put on formative assessment. "You cannot start working on something and then have the test three weeks later to see what you've learned", there is no time for that. It was said that: "A great success factor for learning is to perform systematic checks: Are everyone involved? Who isn't? Why not? What do we need to work more with?"

What Pupil Data to Present, and how

To find out what data is interesting in the GAT, the interviews contained questions about how one can tell if a pupil has learned something. This is a grand topic in itself, but still the brief discussions did produce some valuable information. In preschool and lower grades much of the time is used for skill learning and automation. Hence, the time a task takes is a major factor. For example: if you count on your fingers when you do addition it will be very time consuming compared to the automated case. Another way to know about skill level is by testing the same thing in different ways. One teacher made it clear that it is important to know what went wrong to know what to work with. "It's always useful to get the why", another teacher said. Other mentioned data points were: if and what has been played, how many times, for how long, when and where success were made as well as how far off faulty answers were.

All interviewees particularly stated the need for having a simple, efficient GAT. If it is not easy to work with it will not be used. A quote made by one teacher sums it up: "It's supposed to be as easy as [the iPad] to use, one push and you're there, like you said, in ten seconds. Then you see [the data]; "Fine" that's what I wanted to know, then I turn it off. That is great. Then you can use it [...] then you can put all effort on the other thinking." Some concrete ways to work efficiently included: filtering on skill, grouping on progression, visualisation of the data, not too much details where they are unnecessary and that it should be easy and fast to set up.

Control of the Game

From the teachers' point of view there were no need for strict control, where the pupils only can play what the teachers want. Rather, as suggested by two teachers, by completing levels the pupil should unlock new ones. Following that, some kind of unlocking is appropriate when the pupil already know parts of the game. Another suggestion was that, at least in preschool, the pupil should be able to explore in any way he or she wants; in this age the important thing is that it is fun. A comment that highlights this says: "You never say "play with this one and then with that one" when you play with toys.", and the same should apply to games. It was pointed out that different levels of control have different benefits and drawbacks. Some fit certain teaching strategies better than others. Some are applicable to one type of game, but not to another.

A related topic concerns goals in the game. Two teachers considered goals a necessity, without them there would be no use for the game. These goals should be tightly coupled with the teaching plan (in Sweden, see Skolverket, 2010). Others considered the choice of game itself to be the choice of the goal, that is to say, the game is chosen to fit the goal one has.

Some interviews touched upon the topic of information about the game. According to these it is relevant to add the thought behind the game and the intended use or examples of use. One teacher expressed that you appreciate when you are given examples of how to play games, continuing to ponder that a GAT could aid you in choosing what level to play to get better at a certain skill. It was also pointed out that a teacher often does not have the time to play through the games and if it was possible to read or see a video about it that would be appreciated.

Sketch Comments

The teachers were shown various sketches (Fig. 3). In general, all teachers thought representing the pupils with pictures were a good idea, but there were some worries of how pictures should be taken. The hover functionality, for getting some more information about the pupil, were also considered useful.

The last session (top right in Fig. 3) was shown first and since the sketches have similar elements, such as the statements about how the pupils are doing, this one received most comments. The sketch was much appreciated by all teachers, two claimed that it was terrific and that it had everything one needed to plan for the next lecture. The two teachers in the joint interview worked with their pupils using a weekly schedule and a one-day summary would not be usable, having a way to change time frame for the summary was proposed. Every teacher thought that the statements about the group would be very useful. But they should be improved by stating which pupils they related to. They should also use correct teaching language, such as “subtraction” instead of “minus” and avoid using the word “problem”.

The general overview (top left in Fig. 3) was not given a lot of additional comments. The colour coding was appreciated and proposed to be applied in other areas as well. Considering the colours, it was suggested to use traffic light (green, yellow, red) instead, since that is already used in other software and quickly understood. It was also suggested to use one colour instead of several, where a strong variation would mean a strong pupil and vice versa with a weak variation. One comment expressed that showing the whole group was good, it is important to both help the ones struggling and letting the ones who are doing good move forward.

The pupil summary (bottom left in Fig. 3) was hardly commented upon at all and it was not as appreciated as the other overview example. One teacher said that it might be good for “less informed” people, those that do not use the GAT regularly, thinking that it was easier to understand at a quick glance. Another found the bar to be useful.

The sketch of an individual’s progression (bottom right in Fig. 3) was approached with some reservation. The special needs teachers found some relevance in it, but one of them pointed out that you usually sit with the pupil when he or she plays, hence reducing the need for using it at all. Another teacher were hesitant to whether or not it would be used, lack of time would not make it possible to go through all pupils. The teacher, who earlier talked about how the pupil could use the GAT themselves, followed up with the importance of visualising the information and how efficient graphics can be in comparison with text; to present progress in a diagram is a

way to motivate the pupil. One teacher expressed a great interest in the diagram.

Discussion

The interviews revealed a lack of pupil data presentation in current games. The teachers' comments suggest that a GAT could improve assessment and feedback. Following is a summary of the key aspects, relevant to the teachers, of a GAT:

- Quickly knowing how each individual is doing and the group as a whole.
- Identify weak and strong skills and show what might be relevant to teach the whole group, or a subgroup.
- Showing what pupils played and how they did during a given time period.
- Presenting more details about individuals, such as a progression and in-depth about the strengths and weaknesses. In short, showing why the results of the pupil were reached.

Other appreciated elements include:

- Visualising the data to improve understanding and efficiency.
- Pictures or avatars as a representation of the pupils.
- Colour coding of how the pupil is doing.
- Grouping of the pupils based on achievements.
- Information filtering, for example on skill.

What Pupil Data to Present, and how

It was stated that it was vital to present why the results of a pupil were reached. For example: “Why is the pupil struggling with this level?”, rather than: “How many correct tries did the pupil achieve on this level?”. This kind of information is difficult to specify to a single concrete variable, rather it depends on the pupil and the game. For example, the reason why someone is struggling might not be the lack of skill, it could be that the task is misunderstood. Other than the “why”, the data variables talked about included only those that are easily extracted from the game. Visualising the data is important to get a quick and efficient overview, presenting it as text takes more time to read and creates problems of how to translate the data to understandable text.

Control of the Game

Fundamentally, control is heavily dependent on the game itself. If the game has an escalating difficulty it is appropriate to unlock levels based on progression, but if it is a collection of different games, testing different skills, this approach is less relevant. In that case it is probably more relevant with a fully unlocked game, free for the pupil to explore, or a way to unlock specific games. However, by including a way for teachers to unlock levels they can use it as they see fit.

The same goes for setting goals. There is reason to believe that in a game that practises multiple skills it is more relevant to set goals, since that would focus the way the pupils play. There are different needs depending on how you teach. Websites (such as Swedish skolappar.nu) help teachers with choosing games relevant to their teaching. Another aspect is the age. For preschoolers there are no goals in the manner that older children have and it might therefore be

irrelevant to have them in the game. It should be pointed out that the term “goal” can mean different things and the teachers seemed to interpret the question in different ways. A goal for some meaning learning goal, while others thought about goals as reaching a certain part of the game.

4 Study 2 – Game Analysis Tool Test

The interviews were the foundation for developing a game analysis tool (GAT) prototype. In this study, the GAT was tested by its intended users, teachers, investigating the usefulness of its components. The study also gives further information about usage, presentation and GATs in general.

Two aspects of the GAT stand apart: (1) the presentation of the data and (2) the control of the game. The first shows what has been, while the latter manipulates what is to come.

Hence, these should be separated from each other in the GAT. To know how to present the data we draw inspiration from the summary in the previous study.

Due to the heavy emphasis on efficiency and getting a quick overview of the group, an applicable design choice is details-on-demand (Ahlberg & Wistrand, 1995). Instead of showing all data at once the teacher is shown a selection of them. Details can then be expanded by requesting them. For example: A statement about the group, such as “4 out of 10 are struggling with subtraction”, can be expanded to show which pupils it applies to. Details-on-demand makes it possible to both show a summary of the progression for the group and, on demand, the specifics of an individual’s progression.

The content in the GAT was a reflection of the games the teachers talked most about, small games that train one



Figure 4. The main page of the game analysis tool (in Swedish). Number 1, 2 and 3 is the different filter parts. 4 and 5 is the data presentation.

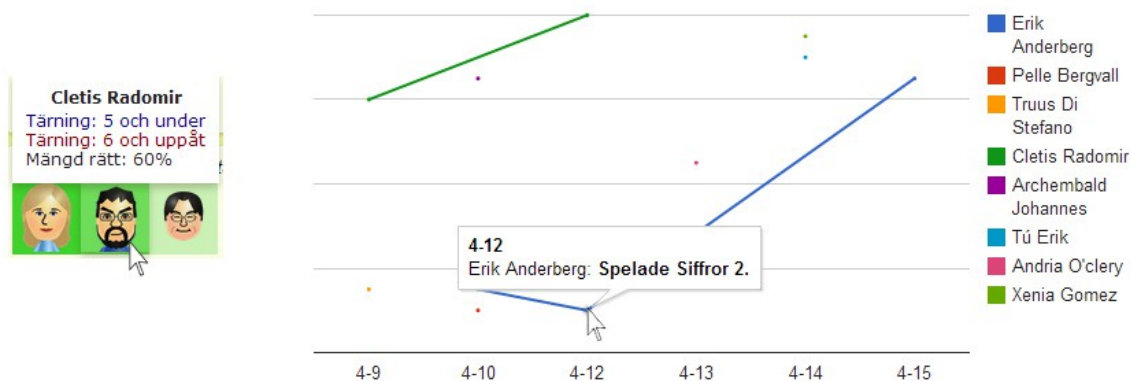


Figure 5. Information displayed when hovering (in Swedish). To the left is when hovering over a pupil. It shows name, least and most struggle and, where applicable, percentage of correct answers. To the right is when hovering over a dot in the diagram. It shows date, name and game achievements.

specific skill. Schwartz and Arena (2013) argues that smaller games have many advantages, such as: a more nimble diagnosis of choices, faster development and different measuring in different games.

The Game Analysis Tool Design

The GAT is heavily influenced by the sketch “last session” (top right in Fig. 3). It was well received by the teachers, with the modification of having a configurable time span (Fig. 4, number 2). A *filter* for choosing particular pupils were added to be able to select an individual or subgroup (number 1). Some teachers considered the goals of the game very important, therefore these were added as a filter as well (number 3). However, in this case, with a game aimed at training one skill, it is difficult to specify different teaching goals according to the national guidelines (Skolverket, 2010), all levels in the game would have the same goals. Instead other goals were fabricated, these should ideally be created by a teacher, but for this study that was deemed irrelevant. The filters have handy shortcuts for selecting: all or none of the pupils, and all time, last month, week or day. All the filter functionality is collected on the left side. This part is fixed on the screen, to provide easy access to the filter without having to scroll.

On the right side the data from the game is presented (Fig. 4). The pupils are sorted from least to most struggling. They are also colour coded; a more intense green means that one is doing better. This seemed appropriate since this GAT is for preschool. The different elements are interactive and hovering over them will give additional information (Fig. 5).

At the top of the right side (Fig. 4, number 4) is a *general overview* of how the pupils are doing and statements about what they are least and most struggling with. The overview is intended to give very quick information about the pupils, those who are struggling will be easily identified. There are also three statements each about the pupils' weak and strong points, designed to benefit the planning of future lectures. They are colour coded, blue means no significant struggle, while red means substantial. The general overview is only filtered on selected pupils, it always shows the entire time span. This design choice was based on the thought that it would not be relevant, and could be confusing, to show this information about the past.

At the bottom (Fig. 4, number 5) is an *analysis* of what the pupils have been playing and how they did, divided into the game's different levels. Each level has a short description of what it is meant to practice. The diagram is an attempt to visualise progression. Its content is a merge of game and skill progression. If a player has played on several dates, it shows a curve, otherwise it shows a dot. The analysis part shows the selected pupils and will only show data from the selected time span. When all time is selected, it is possible to get more detailed game progression than in the overview.

The GAT comes with a separate page for *game information and control* (Fig. 6). This page will inform the teacher about the intention of the game and the learning goals according to the national guidelines (Skolverket, 2010). It could also include different ways the game can be used or examples of game scenarios. This is meant to assist the teacher in how to work with the game. The page also enables locking of levels and picking of a target level for the pupils to reach. Applicable filter on this page is the goal filter, which when chosen will change the list of levels to only show those that match the goal.

Method

Participants

The six teachers from the first study also participated in the second study.

Material

The GAT was developed for use in web browsers and was developed using HTML, CSS, JavaScript and php. Additional JavaScript libraries used includes: jQuery, jQRRangeSlider, qTip2 and Google Chart Tools. The pupil data was created manually and was a simulation of possible interpreted game data from a previously developed game (Axelsson, Anderberg & Haake, in press).

Process

Usability testing was used in mix with qualitative questions. The main aim was to evaluate the different components of the GAT, their usefulness and possibilities, but also to test the actual usability. The teachers were free to navigate in any

Här kan du få reda på mer om de olika delarna av spelet.

Du kan klicka på varje del för att få mer information.

Du kan låsa specifika delar, dessa låses sedan upp i spelet genom att klara delen före.

Du kan sätta ett mål, detta kommer att synas i spelet.

Tanken bakom spelet

Spelet är tänkt att öva den grundläggande taluppfattningen. Det tränar talen och relationen mellan talen.

Inläringen sker genom konceptet "lära genom att undervisa". I spelet finns en karaktär som har rollen som elev, denna följer med spelaren genom spelet.

Inlärningsmålen enligt Ipfö98

Utvecklar självständighet och tillit till sin egen förmåga.

Utvecklar sin förståelse för rum, form, läge och riktning och grundläggande egenskaper hos mängder, antal, ordning och talbegrepp samt för mätning, tid och förändring.

Utvecklar sin förmåga att använda matematik för att undersöka, reflektera över och pröva olika lösningar av egna och andras problemställningar.

Utvecklar sin förmåga att urskilja, uttrycka, undersöka och använda matematiska begrepp och samband mellan begrepp.

Utvecklar sin matematiska förmåga att föra och följa resonemang.

FINGRAR 1

Räkna med fingrar, nummer 1-6.

Fåglarna har ramlat ur sitt bo. Hjälp dem genom att trycka på rätt hissknapp. På knapparna finns fingrar som representerar våningsplan. Det finns sex våningar.

Lära sig enklare räkning



FINGRAR 2

Räkna med fingrar, nummer 1-10.



TÄRNING 1

Räkna med tärningar, nummer 1-6.



TÄRNING 2

Räkna med tärningar, nummer 1-10.



SIFFROR 1

Räkna med tärningar, nummer 1-6.



SIFFROR 2

Räkna med tärningar, nummer 1-10.



Figure 6. The game information and control page (in Swedish). The filter has been cropped out, see Figure 5 for reference.

way they wanted. They were also encouraged to ask questions and think out loud.

The test begun with a short introduction of the GAT, which was inserted after the first teacher due to time constraints. It was a short explanation of the basics: filter to the left, data to the right, how the pupils were sorted and very briefly about the general overview and analysis. After the introduction three scenarios were given one after the other. These were designed to highlight the different parts of the GAT, one for the general overview, one for the analysis and one for the game information and control. It was pointed out that there were no wrong answers in the scenarios. Closing the test were questions focused on finding out what components the teachers thought were most useful and which ones that had the most potential benefit, or if something was missing. They were also asked whether they would like to use a GAT like this one.

The manuscript (in Swedish) for the tests can be seen in Appendix 2. The interviews were audio recorded and notes were taken, however due to unfortunate technical malfunctions the audio recordings were lost. The test lasted about forty minutes per person. Afterwards, without knowing it beforehand, each teacher received two cinema tickets.

Results

In general the teachers enjoyed the GAT and its different parts seemed to work well together. One teacher said: "It is easy to get an overall analysis, when you understand the filter." Several teachers expressed similar opinions. Different teachers appreciated different parts and found their own way of using the GAT. One teacher said that usually they can only give their opinions *after* something has been completely developed and it was obvious that the teachers set out to give much feedback now that there was a chance.

One teacher explained how you constantly need to keep track of what the pupil knows, so that you can make formative feedback to enhance their learning. Continuing by saying, you could use technology to facilitate keeping track. This tool is a form of diagnosis, a clear flagging, and to quote: "Behind the learning materials and books, this is damn good to keep track." Another teacher imagined that if you had used the GAT from the beginning you would have caught those who struggled early and sat down with them. It is a way to screen where you need to be, who you need to help. But, it would fit even better after preschool, where you work with results. Yet another thought that you could use it both in class and as a special needs teacher.

Initially the GAT was approached carefully. Three teachers said that “I am not the kind of person that click around”, but this attitude was relieved by assuring that nothing they could do would do any harm. One teacher considered there to be a steep learning curve in the beginning, which was confirmed by the amount of questions the teachers initially asked. The questions were ranging from how to show a single pupil to what the different wordings meant. Many teachers appreciated the thought of having a tutorial the first time you use it and an added help button.

As in the first study, the pictures of the pupils, or in this case avatars, were appreciated and considered easy to work with. However, it was said that if a pupil could change their picture, the teacher would probably be confused. One teacher said that there might be those who would like to have lists of names instead of pictures. There were comments, similar to those in the first study, about how pupils themselves can use the GAT. One said that it was a way to become “better than oneself”, another said that older pupils could use it, yet another said that children like to see their own progress.

Last in the test the teachers were specifically asked if they would use a GAT like this one. This generated responses such as: “I can imagine using a tool like this”, “I think this can become something good! It is impressive and looks exciting” or “I would use it”. All teachers who are actively teaching said yes and two teachers asked when it would be released.

The General Overview

The first teacher, who did not get an introduction of the GAT, had initially difficulties with understanding the use of the overview. These were resolved by asking plenty of questions. Due to the introduction the other teachers did not have the same issues. Several comments claimed that it was easy to get a quick insight of how the pupils were doing. One teacher mentioned that the overview can be problematic. If the pupils have played different amount of hours, the sorting of the pupils might give a false impression about who is actually struggling.

The colour coding was said to be quite hard to see; the different colours merged together and were hard to separate. Instead it was advised to group the pupils in a number of different groups based on performance. Not getting the same precision was negligible compared to the benefits. One teacher realised that you could use the group divisions for other purposes, even outside the game. For example, letting the group that progress quickly move forward to another assignment or mixing different group members to generate a conversation between them.

The different statements about least and most struggling were perhaps the least liked element of the GAT. Some teachers said that they did not know how to use them and several were confused about what the wordings meant. One teacher found them to be misrepresenting compared to the sorted pupil overview, saying that the most struggling pupil should be found in these statements. One teacher thought that it was a matter of learning how to use the system.

The Analysis

Overall the level analysis was considered well made, and to have the possibility of choosing time span was very well regarded. A comment about what educational games look

like today said: “We have nowhere to see what [the pupils] have been playing, we just know that they have played.” One comment said that it was clear what it meant and that it seemed very good. But there was also one teacher who found it hard to see exactly who had played what. Going on by saying that, since each level had their own sorting, it was easy to see if someone was missing, but not who it was. Instead it was suggested that the pupils should have their own column, making it very apparent where progression stopped. Other teachers also brought up this issue, but suggested that there could be other types of sorting.

The diagram had one distinct flaw: no one understood the numbers underneath the x-axis. All teachers asked what they meant, to find out that it was the date. Several teachers were interested in the spreading of the curves and investigated them intimately. One teacher said that it was hard to tell how well a pupil had performed using the diagram. Another said that it was easy to imagine how the pupils were doing. But the same teacher, as well as one other, wanted to know exactly what the diagram was showing them, what data it incorporated. The hover effect in the diagram was very appreciated; “It is perfect that you can see what has happened in the dots.” One teacher wanted more diagrams, showing the individual skills that the pupil was learning.

One teacher felt that the GAT was a bit cluttered, that you had to go back and forth a lot. It was suggested to put the two data parts in different tabs.

A grave remark, that four teachers expressed, concerned the detail level. This can be summed up in the comment: “How good is the good and how bad is the bad?” Especially when it came to finding out more about an individual pupil, the teachers considered the GAT to lack details and expressed a distinct need to get more data about the pupil's results. Two teachers said that the statements about what the pupil was least and most struggling with gave some idea, but what did these statements mean? And how about the span in between?

The Filter

The more the teachers used the filter (Fig. 4, numbers 1,2,3), the better they thought of it. Once they started using it they quickly learned how to manipulate the data with it. The time span selector was very appreciated and considered easy to work with, especially with the shortcuts for specific time spans. The goal selector was not used by all the teachers. It was mainly used in the information and control page (Fig. 6). One considered it a bit difficult to understand and suggested to have a level filter instead, or even better: both combined. One teacher wanted to add a filter on skill. There were some issues regarding which part of the filter that applied where. Some teachers were confused about how time span was only relevant to the analysis part.

Almost all of the teachers had comments on the usability of the filter. The most common was that when selecting a pupil it should only show that single pupil, instead that pupil was deselected. One remark mentioned that the pupil filter and the goal filter did not behave in the same way, the first deselecting, while the latter selected only the clicked one.

Game Control

The most common issue with the game control was navigating to it and several suggested that it should be more

obvious that you could push the link. The page itself (Fig. 6) received almost exclusively positive comments. The teachers who talked about learning goals in the first study praised the information part and said that it would be very appreciated by many teachers. It was suggested to add links so that the teacher could play, or watch a video, of a specific level in the game, so you can experience the game without having to play through everything. Everyone found locking of specific levels to be usable, but wondered if it applied to all pupils. The feature to pick target level did not get much attention, other than questions about what the icon meant.

Discussion

You could argue that it is not easy for a person to use a tool that they have never seen and evaluate how well it performs. Even more so when, as in this case, the GAT is supposed to be used several times over an extended time period. Since it was meant for an existing game there were many factors that the teachers would probably know about if they had downloaded the game themselves. For example, descriptions were forced to be explained, such as “Numbers 1”, the name of a levels in the game. From a usability point of view it was unfortunate to make an introduction of the GAT. It was considered necessary to focus the test time on what data was presented and how, but it means that nothing can be said about the initial reaction to the GAT. Even so, the GAT was in general well received. The teachers went from having to handle a brand new tool, to feeling comfortable with it and give constructive criticism and praise, in about half an hour. After getting to know the GAT many of the teachers claimed that the filter-data split was easy to work with and managed to provide a quick overview, as well as possibilities to investigate more in-depth. However, the teachers were able to pose questions about everything they did not understand, hence, if this were to be a commercial product it would be relevant to ship it with a thorough tutorial and help section.

The General Overview

Some concern was raised that the general overview could misrepresent who is actually struggling. Instead of using game achievements, one could use a more advanced algorithm to calculate how much the pupils' struggle. But this sorting could lead to other problems about how far the pupils have progressed in the game. A better way could be to combine struggle and game progression. For example, sorting could still be based on game progression, but colour coding based on how much the pupil struggles.

The teachers had difficulties seeing the colour differences between the pupils, instead some kind of grouping was suggested. The colour gradient could still be visible, but with the pupils divided into clear groups. But what should the grouping be based on? Should the middle group be the pupils who have performed close to the mean? Should it be configurable by the teacher?

The interview in the first study suggested that statements, showing where the pupils are least and most struggling, were appreciated. This study shows the opposite. One problem was that the statements was intended to be used as the pupils progress through the game. By surveying the game with regular interval these comments would probably be of more use. Another issue was the programming of the statements. For example, the level that most pupils are least struggling

with would be the first level, but if the pupils have advanced further into the game it is not valuable for the teacher to get this information.

The Analysis

This part was well received by the teachers, but there is room for improvement. By adding other ways to sort the pupils, the same layout could serve different purposes. For example, alphabetical sorting can make it efficient to find where the pupils have stopped progressing. Another improvement would be to incorporate filtering on the diagram. By doing so you make it possible to show other progression curves, for example how a certain skill improves.

Several teachers wanted more detailed information about the pupils. Mainly this was an issue when only one pupil was chosen. The reason behind this lack of data was that it did not exist. Unfortunately the dummy data used with this prototype did not go into such depth. The idea was that when you view an individual pupil the portraits in the level would be switched to bar graphs of actual data. This could provide the more detail that was requested. That the teachers wanted this detail can be seen as a good thing; the teachers want to know more about how their pupils are doing. Hence, there is a distinct need for including in-depth detail.

The Filter

The general attitude was that you learn how the filter works the more you use it. However, since all teachers misunderstood how to select an individual pupil, it is apparent that it could have been better. By default, the GAT should be showing all pupils and by selecting one the shown data would only relate to that particular one. It could also be easier for the teacher to select the pupil directly in the data part. There might be reason to add more filters, for example different skills that the game is meant to train.

5 General Discussion

Digital games will without a doubt play a part in future education and already do to some extent. But there is much to investigate about educational games and the field is open for improvements (Gulz, 2013; Husain, 2011; Schwartz & Arena, 2013; Shute & Ventura, 2013). The two studies presented in this paper have explored the use of a game analysis tool (GAT), a tool meant for a teacher to use together with a game. They have investigated what kind of pupil information teachers want from a game, and how this could be presented in an efficient and useful manner in a GAT. Six teachers participated in the studies, first by being interviewed about the use of a GAT, then by testing a prototype, developed on the basis of information from the interviews.

From the teachers' comments it seemed very common to use tablet computers and games in school. Compared to the text by Ljung-Djårf (2008) there has been a tremendous development regarding computers. A large market with educational games has grown, but has left a large gap when it comes to support for the teachers. All of the teachers expressed a great interest in games and in the possibilities of a GAT. In the *first* study there was some hesitation about using a GAT, with respect to teaching style and lack of time. In the *second* study however, this hesitation was not

reflected. Instead the teachers wanted more information and they said that they could see themselves using a GAT in their teaching. In other words there are good reasons to develop a GAT.

The thought behind a GAT is that it can help a teacher with assessment, especially of a formative kind, and to adapt their teaching to the pupils. A teacher is not able to oversee all pupils at the same time and special needs teachers cannot observe more pupils than they sit with. But if the pupils are playing a computer game, their acting, progression and results can be logged. The logged data can provide information to the teachers about the pupils. The information is available immediately and the pupils can receive concrete and relevant feedback on their performance and necessary guidance for future learning. A GAT would be used mostly to give a quick overview of the pupils. This is facilitated by visualising the data, such as using pictures, colours and diagrams. When requested, the GAT would present more details about an individual.

The way the teachers have talked about a GAT in the studies suggest that they would use it in the above mentioned ways. It has been said that: the GAT could be used to plan coming lessons based on how the pupils are doing. It could be used as a screening to identify struggling pupils who need help, or strong pupils who need more challenge. It could be used as a second opinion of ones thoughts about the pupils' skills.

When it comes to what pupil data that should be presented, the teachers mainly mentioned those that are easy to extract from a computer, such as time and trials. One reason for this could be that because there are extremely few tools today that do this, the most discussed variables are a huge step in the right direction on their own. Another reason is that the teacher can interpret the variables and work out the other information on their own. But as have been stated earlier, the pupil data could be analysed by a computer to find other interesting information as well (Schwartz & Arena, 2013; Shute & Ventura, 2013). This kind of information might have been expressed by the teachers if they had more time to think, or it might be that it is not necessary or interesting for the teacher to know this about preschoolers or pupils in the lower grades of school. There were also discussions about presenting *why* pupils reached their results. This might be answered by providing other data, for example: "The pupil struggled because all subtraction assignments were answered incorrectly". But supplying an answer to why the pupil was incorrect is a much more difficult question. Identifying a difficulty is a first step, from which the teachers could have a dialogue with the pupil about how to overcome it.

Teachers using a GAT are bound to find their own way to work with it and it is likely that they would find new uses of it that was not thought of in this thesis or by a potential future developer. An additional feature for teachers could be automatising paperwork, using the GAT as a documentation tool. By adding more value to educational games and making them easier to use there is hope that teachers will take to using games more in their teaching, and gain their benefits (see Kenny & McDaniel, 2011). The results indicate that the information, control and assessment features of a GAT would greatly add to the benefits that teachers see in games.

In conclusion, the studies in this paper have identified that there is a need and enthusiasm for a game analysis tool

(GAT). Such a tool should be developed to give teachers an efficient and good overview as well as having the ability to go into more detail about individuals when necessary (see more in study 1 discussion). A tool which satisfies these criteria can be developed, which the second study shows. All in all, the studies suggest that a GAT would improve the way teachers use educational games, as well as being beneficial to their teaching as a whole.

Limitations and Further Research

One drawback in the way these studies were performed were how the sketches were used. They were meant to give the teachers an idea of what could be done, but there is a risk that they were leading and that the teachers did not think about other ways to be presented with the information. Hence, it can be concluded that this GAT presented *a* way to show the pupil information and that it was appreciated by the teachers in many ways. But, it is likely that other ways can fulfil this as well. The studies in this paper did not compare with other GAT examples (see Background section), but according to the findings they are lacking in some aspects, such as getting a quick and efficient overview of all pupils. There is also a need to tailor a GAT for the game that it is developed for. Depending on the magnitude of the game, different design choices would have to be chosen.

The studies in this paper cannot tell if a GAT would actually work in practice in the way that it is hoped to. Although the teachers had positive comments about using it, that does not mean that they would. The remark that a teacher could become blinded by achievement, focusing on the pupil doing good in the game instead of learning, should not be taken lightly, especially in preschool. At the same time research shows that it is important to understand the basics of maths to do good in the future (Jordan et al., 2006), ergo, identifying struggling pupils is of the essence. Follow-up studies could investigate: Would a teacher find it beneficial to work with a GAT? Would a GAT make it easier for a teacher to give formative feedback and would they actually do so? Is there a risk that the teachers get blinded by achievement?

The developed GAT was lacking crucial functionality for it to be properly implemented for an actual game, such as how to manage the pupils. This was a deliberate design choice meant to focus the responses of the teachers to the assessment and control functionality. There are also practical issues with software like this: how should it cope with pupils who play together? Or if one pupil plays with another one's profile? On top of it all comes server administration, security and confidentiality.

The GAT need not only be available for the teacher; the pupils could have their own GATs. This would give the pupils direct contact with their progress and might make them more in control of and involved in their own learning. It might also ignite self-assessment and reflection about their learning. Some teachers in the presented studies said that this would be more relevant for older pupils, who can express metacognition. But there were also comments saying that younger pupils enjoy seeing their own progress. A relevant research topic is to investigate how a GAT, used by the pupils themselves, can improve the learning, and also the motivation for learning.

A potential drawback of a GAT might be that the pupils

experience a feeling of being monitored. This could have destructive effects on how the pupils use and learn from the game. For example it could limit the freedom of the pupil and induce stress. However, these are speculations and would be interesting topics for further research.

The results from the studies cannot be generalised to all teachers. The knowledge and usage of computers differs between teachers (Ljung-Djärf, 2008). But, undeniably there are teachers who would like to use a GAT and could potentially benefit from it.

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Appendix 1: Interview manuscript

Inledning: Ok att spela in intervju?

Berätta om att datan är helt anonym, uppmana att inte säga några namn. De har rätt av avbryta när de vill under eller mellan momenten.

Berätta om vad vi gjort tidigare, projektet förra terminen, och vad som är fokus nu, lärarklienten, utveckla hur lärare kan använda lärspelet. (ska man använda ordet lärarklient?)

Varför intervjuas: För att få reda på vad lärare utvärderar när de undersöker elevers färdigheter. För att få reda på hur en lärare vill använda lärarklienten till ett lärspelet - vilken data vill man se och hur.

Hur datan kommer att användas: Som basis för att ta fram lärarklienten. Utvalda citat kan komma att användas i artikeln, utan namn.

Undersök tidigare erfarenheter och kunskaper:

Vad är titeln på arbetet? Ålder?

Utbildning inom digital media. Användning av digital media. Användning av digital media i lärsyfte.

Användning av spel. Användning av lärspelet.

Utbildning inom matematik - som specialpedagog (finns det specialisering i utbildningen?). Undervisar i matematik.

Intervjufrågor (Öppen intervju, semistrukturerad):

Jag ser det som ett samarbete för att komma så nära kärnan av vad man vill åt som möjligt.

Om användning av lärspelet/digital media - vilka (inom matte?), hur? Finns det något som stödjer läraren?

Vad utvärderar man när man undersöker elevers färdigheter? (tex hur bra de är på att räkna) (hur vet man att någon har det svårt?) (när kopplas en specialpedagog in?) (Används formativ utvärdering?)

Hur skulle man vilja använda en lärarklient? För kontroll? Översikt? Annat?

Vad skulle man vilja att ett lärspelet berättar om elevens färdigheter?

Vilken konkret data är intressant? Speltid? Antal försök?

Vill man att den ska gissa hur bra, eller bara ge fakta så att läraren själv får dra slutsatser?

Är det intressant att få tips på vad man ska gå igenom med klassen/eleven?

Visa prototypen.

Ser det användbart ut? Något som saknas? Något som är överflödigt?

Appendix 2: User test manuscript

Syfte: att utvärdera möjligheterna och nyttan med ett analysverktyg, samt att utvärdera användbarheten i de olika delarna.

Innan test: Prototypen är baserad på fågelspelet om de kommer ihåg det från förra gången.

Du får fantisera att dina elever har spelat i 1,5 månad. Du går nu in för att se hur det gått.

OBS! Detta är en prototyp, alla kommentarer är värdefulla! Det går bra att fråga hur mycket man vill.

- Börja med tre scenario -

Uppgift 1: Vilka tre elever har mest behov av hjälp?

Uppgift 2: Vad finns det för skillnader i hur de tre eleverna, med minst svårigheter, spelat under hela perioden?

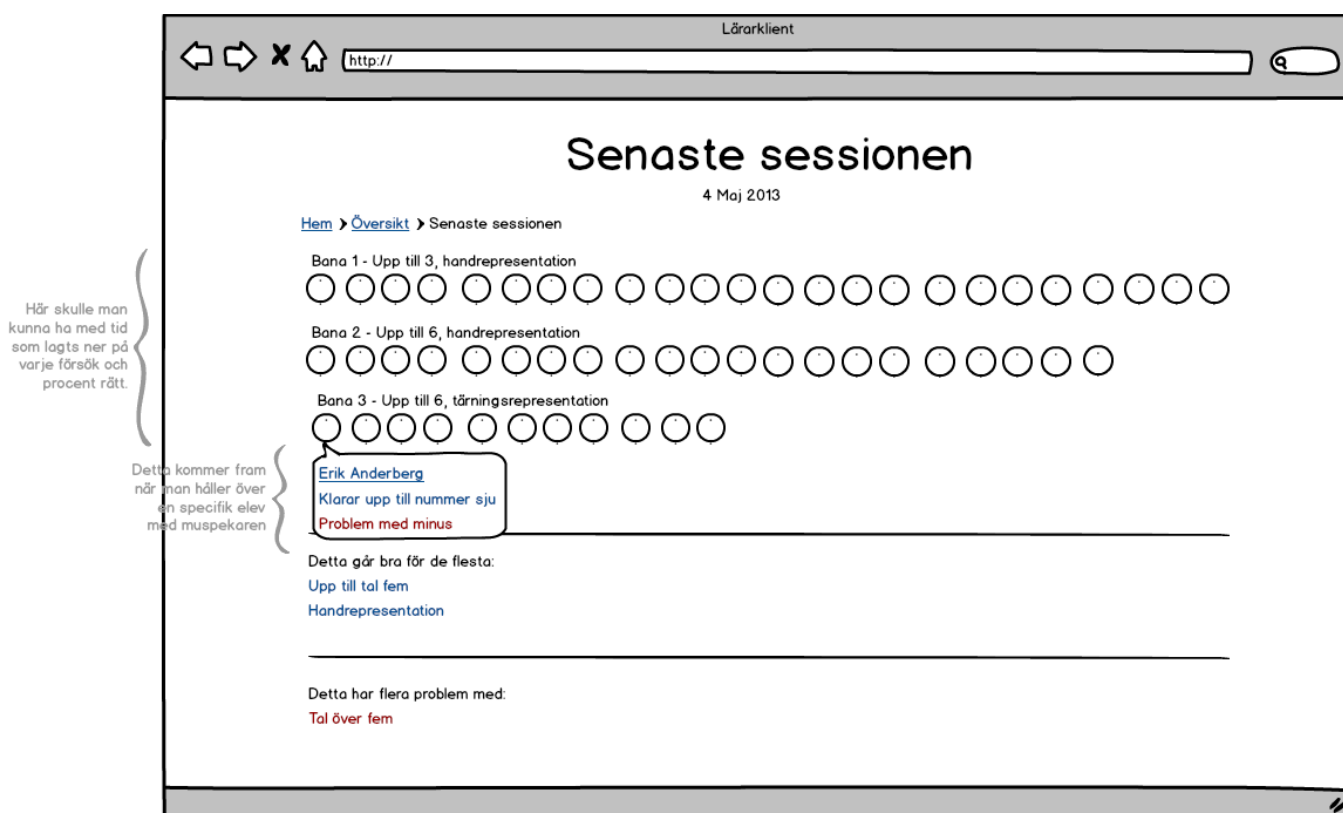
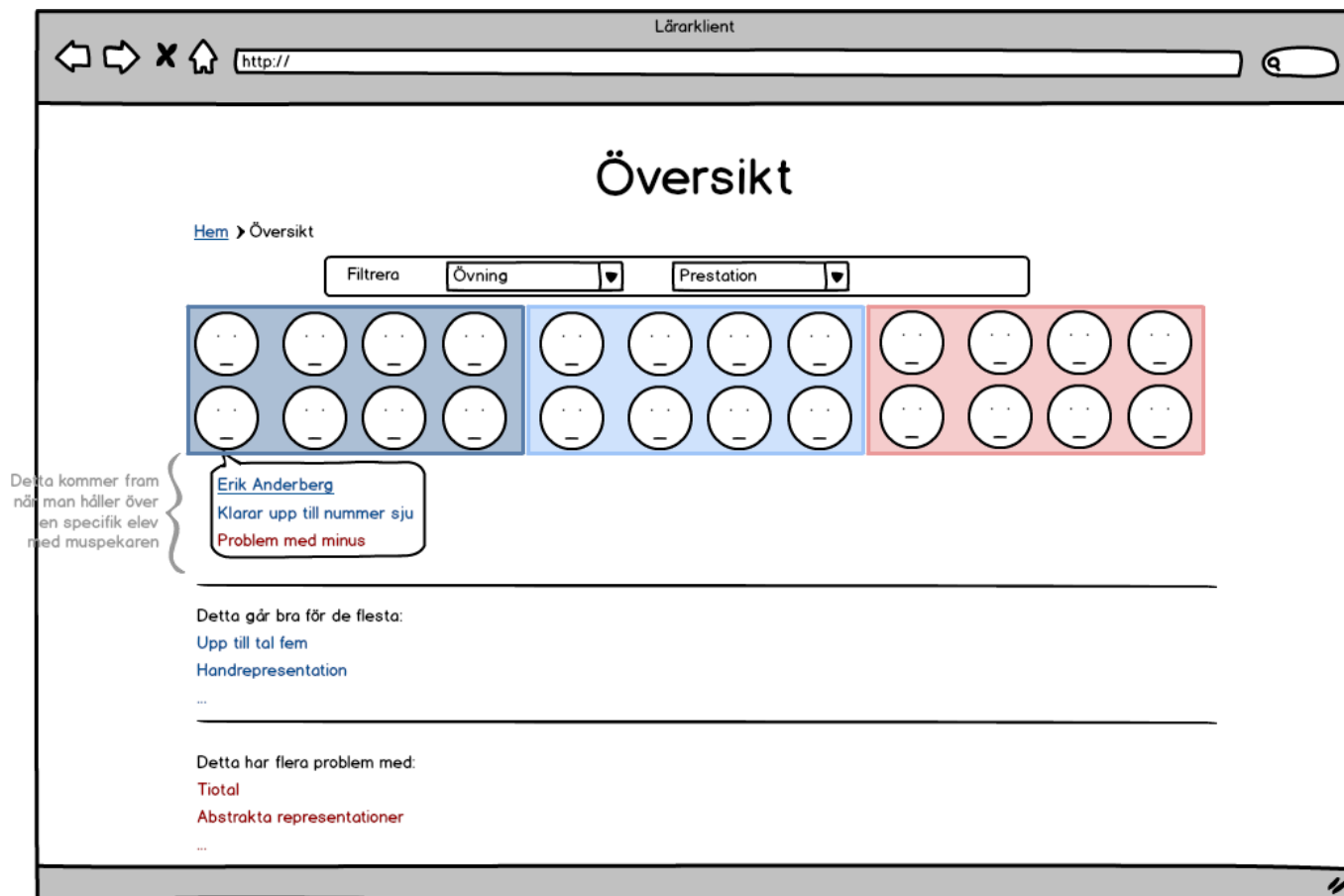
Uppgift 3: Tillåt eleverna bara att spela med abstrakta talrepresentationer.

- Efter detta så kan de leka runt som de själv vill -

Vad är bra? Vad är dåligt? Vad är mest användbart? Vad är minst?

Sist: Skulle du använda det?

Appendix 3: Sketches





http://



Elevutdrag

[Hem](#) > [Översikt](#) > Elevutdrag

Erik Anderberg



Klarar upp till nummer 7
Problem med minus

Berit Andersson



Klarar abstrakta tal
Problem med total

Erik Bengtsson



Klarar tärningsrepresentation
Problem över fem

Erika Davidsson




...

Camilla Eriksson



...

Pelle Finkatt




...

Maia Gräddnos



...

Pelle Svanslös



...



http://

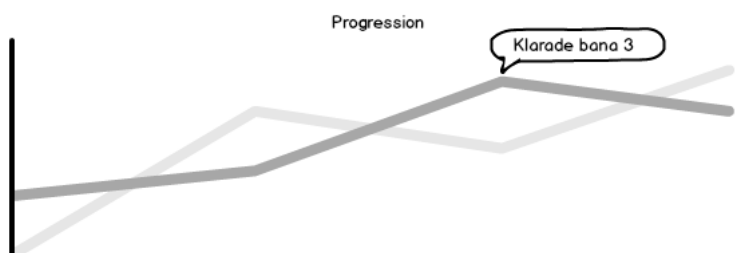


Individuell Elev

[Hem](#) > [Översikt](#) > Individuell Elev

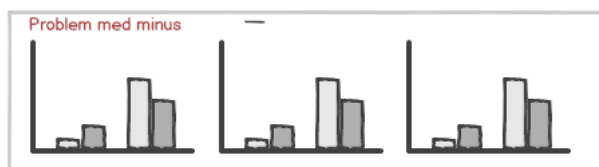
Erik Anderberg

Information om elev här



När man håller musen över får man information om vad som hänt. Det är också zoombart.

Klarar upp till nummer 7 +



... +