EMERGENT LEARNING
Peer collaboration and learning in user driven environments

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I hereby certify that all material in this dissertation which is not my own work has been identified and that no work is included for which a degree has already been conferred on me.

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Abstract

The purpose of this project is to examine how collaboration in groups of children change from a face-to-face emergent environment to a computer mediated emergent environment. To examine this, a methodology was devised in order to track individual group members’ contributions to exercises performed by the group. Groups of five children built structures out of LEGO's and in the game Minecraft, and through the devised tracking method, data from the different exercises were juxtaposed with each other and compared in order to determine how the collaborative patterns within the groups varied depending on what exercise they were partaking in. The results of this research is that the computer based emergent system was experienced as more engaging and immersive, and that it fostered continuous discovery and problem solving throughout the game session, which wasn’t the case in the LEGO exercise.

Key words: Emergent games, Minecraft, peer collaboration, serious games
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1 Introduction

Using Serious Games for educational purposes is a fairly well established, and also increasingly prevalent, enterprise and they are currently frequently being employed during training of military and rescue service personnel, in corporate staff education and also in many different school subjects (Klopfer, Osterweil, Groff, & Haas, 2009). With its growing popularity and hype as learning tools, serious games have spawned a plethora of research opportunities that need to be seized in order for the phenomenon to evolve further. Much research focusing on evaluating Serious games’ effectiveness as learning tools so far has been scrutinizing linear edutainment software portending to educate its users in very specific areas (for example mathematics, physics, reading or linguistics) (Bente, & Breuer, 2009).

The purpose of the research presented in this thesis is to investigate the usefulness of emergent game systems and shared virtual worlds as educational tools. This work was mainly prompted by two observations concerning the changing environments that educational Serious Games need to adapt to; one being that emergent games consist of elements which has intrinsic potential to solve many of the issues which traditional educational games are limited by, and the other being that recent changes in the Swedish school curriculum indicate that more emphasis is being put on the development of soft skills, such as creativity, reciprocity and collaboration; a change which emergent games might be able to accommodate for.

The reason why emergent games’ properties as learning tools are an interesting subject of study is the idiosyncrasies that distinguish them from more traditional games. Emergent games are fundamentally separate from these games due to their large focus on player agency; in a game which is predominantly emergent, players incentivize and shape the game’s narrative through their actions, instead of being led by it as is the case in traditional, or linear games. Shortly summarized, emergent games can be seen as handing the players a set of brushes, colors and a blank canvas to use them on, whereas traditional games hand them a similar set of brushes and colors but a canvas imprinted with a paint-by-numbers schemata that the players need to follow. This analogy, simplified and broad-brush as it may be, exemplifies the differences in player agency between the two types of games, and it’s the facilitation of wider creative expression in emergent games which make them interesting.

In order to investigate the usefulness of emergent games in educational situations, an experiment was carried out on middle-school children, ages 6-9, where they collaborated on different tasks designed to specifically test whether or not emergent games can provide a better forum for creative expression, cooperation and reciprocal action than traditional forms of collaboration.

To better be able to articulate the framework for the research and the performed experiment, the vocabulary surrounding serious games, emergence and the psychological mechanics that make collaboration possible need to be investigated. The elements that the research aim to scrutinize need to be firmly defined in order for the results of the experiment to be discussed in a meaningful and coherent manner, and the background chapter of this paper will thus cover theories regarding technology-mediated collaboration, emergent behaviors and systems, and of course previous research which have inspired this paper.

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1 Traditional games, as used here, pertains to games with a more or less strict linear narrative determined by the games’ developers,
2 Background

2.1 Serious Games in education

Video games with purposes other than pure entertainment are becoming more and more common within many different types of educational facilities (Lopes, 2010). As the effectiveness and utility of serious games become clearer, their areas of use seem to expand. They are currently frequently employed in staff education within corporations (The Business Game, PixeLearning 2009), training of rescue and military personnel (FlameSIM, FlameSIM LLC 2008) and for teaching school students of different ages (History of Biology, Spongelab Interactive 2010). These games are often created, and implemented into educational curriculums, with the purpose of teaching its users a very specific skill. Their effectiveness can also relatively easily be made apparent through comparing the users’ competencies within the area the game under evaluation is intended to teach before and after they’ve been exposed to it. Research within the field of serious games is as a result inclined to focus on these types of educational titles. Although the quality of these sorts of games have increased and their usefulness made more apparent (Kickmeier-Rust, Pierce, Conlan, Schwarz, Verpoorten, & Albert, 2007), they are still lacking in certain areas; they can’t compete with commercial video games when it comes to production values and they are often predictable and impersonal as a result to developers being limited by stereotypical training scenarios established through traditional forms of education (Bellotti, Berta, & De Gloria, 2009; Lopes, 2010).

2.1.1 Common issues with Serious Games

The reason impersonal and predictable content is a real concern when it comes to the quality of serious games, is that it can pose severe threats to player enjoyment and thus limit the time a student or trainee is prepared to spend in the game. In many traditional educational games, all users are often treated as a single entity and the game’s difficulty setting is determined on the level of acuity and skill the game’s developer believes this target entity to have (Chen, 2006). Of course, all individuals within the target audience of a serious game aren’t identical, and start out at different levels of skill, be it actual gaming prowess, literacy, or knowledge within the subject area the game is meant to teach. This can explain why serious games are considered by many to be un-engaging; for many individuals, the game’s challenges will either be too trivial or too difficult for them to be able to derive any real enjoyment from it (Chen, 2006).

This is one area in which deliberately emergent games should be able to provide some much needed relief. A game rich with clear, deliberately emergent elements can encourage its players to approach the game system with more of an exploratory and play-oriented approach than a game that confines his or her actions and narrative to its rigid design (Rodriguez, 2006). From a purely theoretical perspective, arguing that emergent games contain elements that intrinsically increase enjoyment isn’t a difficult task. Flow theory dictates that in order for the participant of a task to derive any enjoyment in its execution, the task has to present the participant with challenges proportional to his or her skill in that particular field (Csikszentmihalyi, 1990). Linear games seldom have the capacity to regulate their difficulty according to every player’s skill throughout the entire experience; some part of the game can be perceived as enjoyable by some players, while other may find it to be excruciatingly dull or stressful. The players’ enjoyment is completely dictated by the game designer’s
ability to craft a thoroughly well balanced experience, which isn’t easily done; especially not if your ambition with the product is to reach a clientele with varied skill levels. Serious Games are especially fragile in this respect, as they are often aimed at a group of people whose only commonality is their profession or education while their age, gaming literacy, gender, interests and physical capabilities can be tremendously idiosyncratic from one another. Commercial game ventures on the other hand often have the luxury of catering to a very focused market segment, which are defined by their interests, age and gender and whose gaming literacy often can be expected, since they have a deep enough interest in games to purchase one of their own free will. A thoroughly emergent game experience places a lot of onus on the player to set their own goals, build their own narrative and use the basic elements of the game in a way which fits their style of play. Thus, it’s not too much of an assumption to believe that these sorts of games are capable of maintaining its players’ sense of flow for a longer period of time; the game will stay appropriately challenging as the player will create his or her own challenges, based on what they find intriguing.

Emergence has been a large part of several commercial game ventures in the past, and to good effect. Examples of this are SimCity, The Sims, or Grand Theft Auto (Kickmeier-Rust & Albert 2009). And given the limitations that have plagued traditional Edutainment games in the past, applying the same sorts of mechanics to Serious Games can hopefully progress their usefulness as pedagogical aids and engage their users to a greater extent.

2.2 Emergence in education

Recent changes in the Swedish national school curriculum further intensify the need to evaluate the pedagogical tools currently in use in middle-school education. The curriculum puts strong emphasis on the development of students’ soft skills, such as creativity, entrepreneurial drive and collaborative ability (these qualities certainly haven’t been ignored in earlier curriculums, but they have a stronger presence in the most recent iteration) (www.skolverket.se, 2011). Traditional educational games and technical education platforms often don’t accommodate for broad expressions of player creativity, given their relatively rigid nature.

While some may consider the ambition to improve upon educational games, or educational traditions in general, a field that’s best left to researches with a stronger background within didactic research, approaching the subject from a new perspective can still provide interesting new insights and unexpected realizations about the field (Thomas, 2011). Serious Games products often suffer from being too heavily influenced and anchored in traditional means of education, thus not utilizing the full potential that games and play have when it comes to increasing student engagement. These sorts of games have traditionally been produced as a result of a person with a didactic background having the ambition to “gameify” something within their field of expertise in order to make it more attractive and approachable to others (Thomas, 2011). Approaching the area of technical didactical tools from the perspective of a game developer, by for instance inserting a commercial game title into the context of traditional education, can reveal games’ potential as educational tools in unforeseen ways (Thomas, 2011).

The importance of play in children’s development is well established at this point in time, but it’s often neglected in formal education as play and games are incompatible with educational traditions which are heavily based on the ability to measure and grade individual skill acquisition in a structured way. In order for these idiosyncratic
fields to overlap, a greater understanding of play, and the effects that free play have on children’s development, is needed; as is a method for making the patterns in play sessions more easily observable by teachers. (Klopfer et al., 2009)

2.3 Collaborative patterns

There has been a lot of previous work done portending to study collaborative learning among children and adolescents, both with and without mediating games or other software (Blumberg, & Ismailer, 2009). In 2001, a group of Swedish researchers studied collaborative learning through use of word editing and gaming software (Alexandersson, Linderoth, & Lindö, 2001). Their research touched on many aspects of the field pedagogic software with a strong focus towards how younger children perceive and interact with each other when working together in computer environments. One of the things they discuss is of particular interest for this research project, and that is their summarization of Jehng’s different forms of collaborative learning, set in the context of using digital apparatuses. This summarization and adaptation may be of great relevance when it comes to the analysis of the interactions between the students inside the game world. In 1997, Jehng established the basic frameworks for identifying and categorizing different types of group dynamics during collaborative learning experiences. The established categories are peer tutoring, peer collaboration and collaborative learning. These categories were utilized to facilitate a thorough dialogue about the different group hierarchies and patterns that became apparent during their studies (Alexandersson, Linderoth, & Lindö, 2001). During this research, these categories will be utilized in a similar fashion.

Peer tutoring is a collaborative pattern in which one or a select few members of the cooperating constellation has superior previous experience and knowledge within the area that the group is working. This often leads to a collaborative situation where the more capable individual(s) of the group mentor the other group members, and acts as a tutor for getting other members up to speed with the tools and procedures that’s unfamiliar to them (Jehng, 1997).

Peer collaboration occurs when all of the group members are equally capable within the field in which they are working. This most often entails that the group members are all unfamiliar with their working circumstances and that they have to work together in order to figure out how to solve a problem or complete a task. Thus, they collaboratively seek and acquire knowledge of the field in question (Jehng, 1997). This collaborative pattern is often considered to be the most effective when it comes to stimulating learning and inspiring camaraderie in students since the participants experience the sensation of discovery through collaborative experimentation and trial-and-error (Damon & Phelps, 1989; Alexandersson, Linderoth, & Lindö, 2001).

Cooperative learning manifests as participants with a variety of different competencies work in a structured group environment where they utilize each other’s unique skillsets to solve a problem or complete an assignment. In this collaborative pattern, tasks are often delegated to different members of the group so that they get to work in a field where their expertise is put to use (Jehng, 1997).

2.4 Minecraft

The technological platform for the experiment conducted in this research project is the game Minecraft (Mojang, 2009). Minecraft has received much critical acclaim because of its innovative concept and player-driven narrative (i.e. emergent nature),
but there are several other reasons behind the choice to have Minecraft represent emergent games for the purpose of this research.

Although the state of the game is in constant flux due to it still being in development (new updates and versions of the game are frequently released) the main concepts of the game, the ones that make Minecraft an interesting game and an adequate standard bearer for emergent games, remain the same. The game is void of any traditional video game goals (i.e. accumulate points, complete the level, etc.) for the players to achieve, and it really places a lot of onus on its player to create their own personal goals. During single player sessions, players are simply thrown into their own procedurally generated Minecraft world upon starting the game. The world is populated by cattle, critters and monsters, but the main actor within the game are the blocks, inanimate as they may be. With their pixel-like appearance and characteristics, they constitute the player’s only means of tool creation and construction (be it elaborate or simple). In short, the player can “harvest” blocks that constitute the universe the player was spawned into in order to collect and subsequently manipulate them in different ways. The blocks, which are of different colors and properties, may be combined with other types of blocks to create objects and tools, or they can be manually placed into the game world again. They can thus, when used under careful orchestration, create structures, landscapes, visual compositions or even new game elements within the original game. Minecraft itself doesn’t directly reward the player for this type of behavior; a player can just dig a small hole in a hill and just spend his entire game session within his fortress of solitude without being punished or even, from a strict gameplay perspective, fall “behind” more active players when it comes to game progress (since there are no goals, progression can’t really be measured in the game). Yet, players naturally tend to start using the opportunities for creative outlet that the game supplies them with to plan, devise and create monumental structures, reenactments of famous movie scenes, sculptures and even artwork.

However, during the conduction of the experiment for this research projects, the players will not be able to interact with the world to that extent. Letting the players roam without boundaries in an entire Minecraft world poses some problems. The game has several layers of advancement, which can be troublesome for the subjects to grasp if it’s their first encounter with the game. Having them gathering their own materials and tools would also be quite time consuming, which is troublesome both since it makes analysis of the data a much more arduous endeavor and also distracts the subjects from their normal every-day school activities to an unacceptable extent (while Minecraft may be proven to have potential as a didactic tool, occupying an entire day for a group of children with it is hard to justify at this juncture). To alleviate these concerns, the subjects will be given access to an unlimited supply of building blocks, without them having to gather a supply on their own, and also any tools which they may wish for. Providing “cheats” in this way doesn’t affect the integrity of the game’s emergence in a too damaging way since the researcher is merely providing shortcuts to the players in order to make some of the emergent elements of the game more readily accessible.

The mechanical similarity between the blocks in Minecraft and LEGO-pieces is also a reason for the game’s involvement in this research. The experiment needed to be able to provide indicators regarding the subjects’ collaborative behavior that could easily be compared between face-to-face collaboration and technology-mediated collaboration. Comparing groups’ collaborative patterns and behaviors between a
LEGO-based task and a Minecraft task provides an excellent base for such comparisons.

Minecraft also has several basic benefits that doesn’t relate to the improving the integrity of this research or its results. From a technical perspective, the game is DRM-free\(^2\), thus easily distributable. Furthermore it doesn’t require top-tier hardware to run and offers easily set up and maintained multiplayer servers with built in monitoring in the form of server logs. The latter of these is of grave importance when conveying the game’s viability as a space for their children to collaborate and be creative to teachers and parents of the research subjects. Virtual bullying is certainly a concern amongst parents and educators alike, and if many students are to congregate within a virtual space there needs to be some sort of surveillance in place to make sure that things aren’t getting out of hand. Lastly, the game has a very easy-to-learn user interface, which should be familiar to the majority of middle school students according to recent data about children’s gaming habits (Durkin, 2006).

\(^2\) Free from restrictions imposed by Digital Rights Management-software, which are often designed to regulate the mobility of consumer software products by imposing several safety measures and archaic installation procedures.
3 Methodology

Measuring changes in collaborative patterns isn’t something that’s easily done in a replicable and reliable way. Previous research in the field has often relied solely on observations made by the researcher, and his interpretation of his or hers research subjects’ interactions with one another (Alexandersson et al., 2001). These results are thus influenced by the researcher’s preconceived notion of how collaboration manifests itself in an observable way, which is difficult in situations where several individuals work together and communicate on many different levels. In an attempt to alleviate some of these concerns, mainly the ones derived from the limitations of pure observation, an experiment has been carried out where “invisible” color coding and rudimentary statistical analysis of the group members’ communication between one another has been applied to specifically map out the individual contribution of individuals in collaborative situations. The hypothesis being that combining these more specific and quantitative ways of collaboration analysis will result in a more reliable and perspicacious insights concerning how collaborative situations in a variety of different mediums may differ from one another and how they affect collaborative patterns for a cooperating group of individuals.

3.1 Experiment design

In order to successfully track changes in collaborative patterns, it’s important to establish a clear operationalization of how these patterns manifest themselves through several different variables. As previously stated, the main variables that will be studied during this research’s experiments are communication (general loquaciousness and authoritative semantics), individual physical contribution and proximity and/or overlap of group different members’ contribution. Important to note is that the research isn’t as much focused on identifying which exact collaborative pattern is in use during different exercises, the purpose is to track how elements of the groups’ collaboration might change between them. The theory of collaborative patterns, however, is still a useful framework for variable operationalization and when it comes to describing differences in the participants’ collaboration, which is why it still plays an instrumental role in this research; without the theories of collaborative patterns, deciding what to look for to determine changes in collaboration would be more of a dubious task, and the research would certainly suffer for the lack of formal guidelines.

3.1.1 Participants

The subjects of this research’s experiments are middle-school children, aged 6-9, attending a school in Korsberga (Korsberga skola), Sweden. The amount of subjects included in the experiment is mostly dictated by the research’s time limit, as over one hundred and fifty potential subjects are available while the timespan of the study is relatively narrow. The students were divided into groups of five, and each group took part in a LEGO-building exercise and a Minecraft exercise in a randomized order. During these exercises, the groups’ verbal communication was monitored by audio recording software, while video recording software monitored their activities in the physical (or virtual, in the case of the Minecraft exercise) space. The researcher was also present during each exercise to capture and, if the need would arise, solve unexpected issues and queries that the methodology might not have accounted for.
3.1.2 SICC

A central part of this research’s methodology is the selectively invisible color coding (SICC) applied on the tools which the research subjects use during the experiments. The need for the SICC arose from the need for specific mapping of individual contribution in a collaborative context, without in any way influencing the behavior of these individuals. In situations where a group of individuals collaborate to produce or create complex objects and structures, back-tracking to ascertain which parts were physically constructed by which group member can be very difficult, ergo making it difficult to assert how the group actually collaborated during the object creation. If one is able to apply SICC to the toolset and materials used by research subjects in an experiment, their individual work will leave a residue visible and available to easy and extensive analysis and scrutiny. If the experiment is devised in a way as to conserve the work of the group indefinitely, the collaboration can also be subject to retrospection to a much larger extent than direct observation can, and the researcher isn’t left to rely solely on images and video of the experiment to assert how the group of subjects produced the work in question. In this experiment, SICC was applied to LEGO-pieces and building blocks in the game Minecraft (Mojang 2009). A group of subjects was then asked to construct anything they wanted to with the LEGO-pieces, and then within the virtual Minecraft space.

The reason Minecraft blocks and LEGO-pieces are used for this research is that they are both examples of thoroughly deliberately emergent systems that have the ideal properties for SICC method; they are tools used to create complex structures from very basic elements. Tracking which individual placed which block in the larger structure can give key indicators regarding how the group collaborated; the idea being that frequent and extended color overlap is evidence of close collaboration. This data, coupled with data regarding the group’s communication patterns, should suffice in creating a complete picture regarding their collaborative patterns during both the LEGO-exercise and the Minecraft-exercise, and thus revealing changes between both exercises in an easily visualized and precise manner.

In Minecraft, the color coding was applied by changing the texture packs for each individual subject of the research. The basic texture pack (fig 3.1), was manipulated in a way as to make different blocks appear identical in the eyes of the players. Since players (hopefully unbeknownst to themselves) used different blocks from one another when working on their collaboratively built structure, applying a different texture pack where the blocks appearance signified which player placed them allowed the researcher to enter the game world to examine the exact individual contribution of each subject. Further software was used to also gather specific data about the amount of blocks placed by each player (the blocks can, of course, be counted manually, but applying software to do it automatically both guarantees exact results and speeds up the process). Picture 3.1 shows the color coding in action.

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3 A pilot-study was also conducted in order to prove the stability and viability of the research’s software (Minecraft server client, and a series of third party software that provided video and audio recordings and tracked statistics of individual subject’s activity during the task). The subjects used in this study did not, however, go through the entire experiment process, and the pilot will thus not be presented in this paper.
Fig. 3.1: (left) default Minecraft texture pack, (middle) manipulated texture pack for research subjects disguising several blocks with similar attributes with identical textures, (right) manipulated texture pack for collaboration analysis by coloring blocks used by specific players with distinct colors associated with that player

Picture 3.1: (left), color coded Minecraft world, (right) the same world with manipulated texture pack for the test subjects.

The LEGO-pieces were color coded by using UV-sensitive markers. Blocks were marked with different symbols, and the players were each given a set of LEGO-pieces with symbols representing them at the start of the experiment. After the exercise was finished, the researcher was able to use a black light to inspect the results of the group’s labor and, like in Minecraft, ascertain which piece was placed by which group member.

### 3.1.3 Individual contribution

Being able to track individual contribution has importance outside of the experiment design itself; a large issue that is often attributed to the limited use of play-based learning is the fact that it’s often difficult to discern whether or not the participants has actually been active during the play sessions (Kickmeier-Rust & Albert, 2009). Currently, the only way to be sure of student participation during play sessions is active monitoring, or having the students keep logs or diaries describing their participation. Giving educators the ability to retroactively enter the space of a play session to retrieve indicators regarding individual contribution during the performed exercise can be an important step in making play-based learning a viable didactical tool.

### 3.1.4 Discourse analysis

Just tracking the individuals’ physical contribution to the group’s final creation isn’t sufficient when trying to ascertain the entire complexity of the group’s collaborative patterns. A member can, for example, take on a more administrative role during an
exercise and be responsible for directing other group members’ work. Such a person might not, if one is to only measure his or hers block contribution, seem to be functioning well in collaborative work, when in fact they have been very engaged in the exercise albeit in a different manner than other members. In order to catch cases like these, and to be able to fully discern which collaborative pattern a group is following during the exercises, the communication within the group has to be tracked and analyzed as well. Collecting data regarding group members’ loquaciousness should prove valuable when determining differences in how “at home” or unrestrained the individual might feel in the group context. But, merely measuring the individual’s verbosity doesn’t indicate their level of contribution to the group’s collective thought processes or if they’ve assumed an authoritative role in the exercise, thus basic discourse analysis will be applied to get a better understanding regarding these matters.

The analysis of group discourse will be done by establishing a few categories, each with different criteria, in which verbal statements can be placed. This will result in data regarding what types of semantics are most commonly in use during the groups’ collaborations, and will provide more indicators regarding how their collaborative behavior differ between different exercises. All verbal exchange will be tallied as loquaciousness, but some semantics that are of certain interest for this research will be specifically targeted and subcategorized. To indicate the presence of different collaborative patterns (Jehng, J-C, 1997), loquaciousness will be categorized as described in table 3.1.

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
<th>Examples of signifiers (translated from Swedish)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Governing</td>
<td>The subject influences other participants to perform certain tasks or adapt certain procedures.</td>
<td>Can you/we..., If you/we do..., Let’s..., and similar requests of actions from other participants.</td>
</tr>
<tr>
<td>Task focused</td>
<td>The subject’s dialogue portends to the exercise at hand, and aims to elevate the group’s performance by sharing or asking for information regarding things relevant to the exercise.</td>
<td>How do you/we..., Why do you/we..., Where do I..., Can I do..., How will you/we..., and similar queries about how the task can be carried out.</td>
</tr>
</tbody>
</table>

Table 3.1: categories of loquaciousness and their signifiers

This categorization was in part inspired by the previously mentioned studies performed by Alexandersson et al. in 2001, where the level of immersion in a task was measured in part by how much of the subjects’ dialogue strayed from the task at hand; the tenet being that a task that doesn’t immerse its participants is unable to keep said participants’ dialogue focused on the task (Alexandersson et al., 2001).

3.2 Experiment purpose

Through the devised methodology, how does one discern whether or not the emergent game experience contributes to the didactic process and groups’ collaborative endeavors in a positive way? Claiming that one collaborative pattern is superior to another isn’t really viable, since they contribute to group members’ learning in
different ways. However, through the analysis of groups’ discourse and group members’ individual contribution, plenty can be said regarding in what way the different venues of collaboration differ from each other. This difference is crucial; the point of this research isn’t to discern whether or not collaboration mediated through emergent game spaces are objectively superior to face-to-face collaboration, it’s to determine the differences between the two forms. This is an important distinction, as saying “this research aims to find out if games are better didactical tools for collaborative work” really implies that a difference between children’s behavior during their interactions with emergent games and toys or traditional didactical tools based on emergent systems is already proven to exist, and that the research’s goal is to determine to what extent these differences affect emergent games’ educational potential.

If differences in collaborative patterns can be identified, it will merely provide a starting point from which IT-based emergent educational tools can be improved and better understood. Furthermore, this research’s purpose also lies in devising a method for evaluating individual participation and progress in shared emergent spaces with minimal infringement upon the participants’ emergent experience. The realization of such a method is also very important in trying to establish emergent systems as didactic tools, as educators need to have the ability to ensure the development of each individual in a collaborating group of students or trainees. Finding ways of providing educators with a toolset to perform evaluations of individual contribution in emergent spaces that doesn’t involve constant monitoring of play sessions or player kept logs should therefore be of high priority in the process of making thoroughly emergent games viable in educational contexts (Kickmeier-Rust & Albert, 2009).

3.3 Hypothesis

Given the results of previous research within the field of technology mediated collaboration with groups of children (Alexandersson et al., 2001; Spiegel & Hoinkes, 2009) some general assumptions concerning what kinds of results this research will produce can be made. The data will probably indicate that the test subjects were more engaged by the computer-based task, as that has been a commonly recurring result in previous research (Alexandersson et al., 2001; Kickmeier-Rust & Albert, 2009). It also stands to reason to expect all participating groups to be of a pretty uniform skill level when it comes to performing the LEGO exercise, as that is a fairly ubiquitous toy that almost all children are familiar with; this will most likely lead to equal collaboration between the group members without much tutoring or mutual learning and thus they should be operating on a high level of peer collaboration. This will most probably differ greatly from the Minecraft exercise, as the level of proficiency between the group members will be more varied, both as a result of gender, age differences and previous encounters with Minecraft and games with similar interfaces. Recent studies have shown that 40% of the European population as a whole have home PCs and that 70% of these own and play games with their PCs (De Prato, Feijóo, Nepelski, Bogdanowicz & Simon, 2010). Studies regarding game preferences in boys and girls of ages also indicate that boys in the ages of 8-13 play electronic games twice as much as girls of the same age, and that they prefer FPS action games to a greater extent than girls (Salisch, Oppl & Kristen, 2006). The chasm between genre preferences between boys and girls widen when the children grow older, for example during Salisch et al.’s study (2006) performed on a large group of children during the period of one year the number of boys’ who preferred to play action games increased from 43% to 62% while the amount of girls’ who preferred the same genre
rose from 24% to 31%. Since action games have similar interface design as the one used in Minecraft, boys in ages 8-9 will probably be most proficient in the Minecraft exercise and perhaps even assume a tutoring role in their group.
4 Study execution

The setup and execution of the experiment went on during two weeks in the month of May, 2011. During this time period, 31 children got the opportunity to play Minecraft; 15 of which, that is to say 3 groups, went through the entire experiment process with the LEGO- and Minecraft exercise. The remaining 16 children only played Minecraft, which served the purpose of providing the research with more extensive data regarding children’s collaborative behavior during technology mediated interaction. The data from the Minecraft-only exercises were mainly collected and analyzed through video recordings; the purpose being to provide general data regarding their behavior in absolute free, emergent play rather than proof of emergent games’ exact impact on their collaboration and comparing it to face-to-face collaboration.

4.1 Experiment results

The results of the experiment sessions provide several indicators as to how the group members collaborated in the different exercises. The groups that participated in the entire experiment described in section 3 in this report had the following age and gender constellations:

Group 1 - A mixture of 6-9 year olds, 1 girl and 1 boy at the age of 9, 1 girl and 2 boys aged 6-7.

Group 2 - 5 girls aged 7-8

Group 3 - 5 boys aged 8-9

4.1.1 Communication

When performing the discourse analysis on the collected data regarding verbal activity within the group, it’s important to note that not all exercises took the exact same amount of time; groups that were finished with their project early was free to leave the experiment area. As a result, some data regarding, for example, instances of loquacious activity, need to be juxtaposed with exercise duration when comparing communicative behavior between exercises exercises. The quantitative data collected for the discourse analysis clearly indicate a few things:

1. There wasn’t any obvious difference in general loquaciousness between the two exercises; the verbal activity was however more task focused during the Minecraft exercise

2. The dialogue during the Minecraft exercise was a lot more task focused and democratic than the dialogue during the LEGO exercise

3. There are generally fewer governing semantics used during the Minecraft exercise than in the LEGO exercise (although they weren’t very frequent in either exercise)

In general, the participants were far more engaged with the Minecraft exercise and the majority of the communication during these were focused on asking questions regarding how to solve problems (either requesting hints on how to navigate through the game world or how to execute a certain piece of a building), describing something that they found in the game world, tutoring other members or trying to administrate other group members’ efforts. This is very different from the communication during the LEGO exercise, which was often void of meaning or actual task information valuable to other group members’ performance in the exercise. The changes in
communicative patterns between the LEGO exercises are shown in diagrams 4.1-through-4.5 and the Minecraft exercises are shown in diagrams 4.6-through-4.10.

Diagrams 4.1 & 4.2: Verbal activity during group 1’s LEGO exercise, note the low level of task engagement and varied loquaciousness. This was the most varied group both in regards to age and gender.

Diagrams 4.3 & 4.4: Verbal activity during group 2’s LEGO exercise. Similarly to group 1, there’s a low level of task engagement and quite varied loquaciousness.

Diagrams 4.5 & 4.6: Verbal activity during group 3’s LEGO exercise, note the low level of task engagement and varied loquaciousness. This was the most varied group both in regards to age and

In the LEGO exercise, group 1 and 3 only collaborated as an entire group to the extent that they established a theme that the members’ creations would follow. In group 1,
the participants split up into a few smaller groups to create things that were of shared interests with another group member but not to others (while still, arguably, following the group theme) and in group 3 all the group members worked on solitary projects. Group 2 had a more calculative collaborative work procedure, as they used the first few minutes of the exercise to brainstorm ideas on what to build and later distributing work duties between the group members. Whether or not these differences are typical of the groups’ gender constellations is hard to say, but previous studies have shown that girls commonly adopt a more democratic and communal approach to collaborative tasks (Alexandersson et al., 2001).

In the Minecraft exercise, the communication between the group members differed from the LEGO exercise both semantically and in intensity. As stated previously the dialogue was more focused on how the participants could manipulate and interact with the game, which is to be expected as many of them were new to it and wanted to discuss it during their explorative process. Here, much of the dialogue seamlessly switched from clear task-focus (i.e. “What shall we build and how shall we build it?”) to tool-focused discussions (i.e. “How do we get to the second floor of our building?”) to sometimes just informing group members of their crazy antics in the game world (“I saw a chicken and I hit it with a shovel!”). What was immediately apparent was that the game’s pure girth of possibilities initially distracted the participants, especially the younger ones, from the described goal of their exercise. The younger participants, mainly the 6 and 7-year olds, disregarded the planning the group had done when initializing the exercise and got lost in the game world until older members strongly advised them to return and help out with the task. Thus, the communication and behavior of the group members were very indicative of peer tutoring play, as some members of the group were more proficient with the Minecraft interface than others. However, while the tools were, as indicated by the focus of the verbal activity during the exercises, much more engaging in this exercise than with the LEGOs, the productivity for some members plummeted severely during the Minecraft task due to their inability to effectively contribute to the building process.

Diagrams 4.7 & 4.8: Verbal activity during group 2’s Minecraft exercise, note the high level of task engagement and varied loquaciousness.
4.1.2 Proximity of collaboration and exercise execution

The proximity of collaboration, as shown in appendix A, was for some groups also very varied between the different exercises. Generally speaking, the group members’ building blocks overlapped to a much greater extent during the Minecraft exercise. This indicates that the virtual space is more conveniently designed when it comes to letting several people collaborate on a creation simultaneously. In the physical space, such collaborations are troubled by several obvious factors, such as other people’s hands being in the way and sharing a confined working area such as a table with peers, limiting the space available for material and tools.

The ease of simultaneous work, and how relatively effortless the removal of misplaced pieces are in the virtual space, encouraged the group members to experiment and explore their possibilities together at a much greater extent. A good example of the clear dichotomy between the LEGO and Minecraft exercise’s effects on a group’s collaborative process was witnessed in the first few minutes of group 2’s execution of these exercises. The following discussions are transcribed from video recordings (translated from Swedish):

**Minecraft exercise:**

**G1 (girl 1):** What do we build?

**G3:** I don’t know… a cave?

**G2:** No, a castle!

**G5:** A house?

**G1:** A castle sounds good, this flat place between the trees seem nice, let’s build it here.

**G3:** I’ll start clearing out the trees a bit.

[G1,2,4 and 5 start placing blocks, seemingly at random, on the ground in the area G5 picked out]

**G2:** Oh, this can be the castle wall! [looking at a row of blocks that have emerged from the clutter of blocks]
The girls start helping completing the newly discovered wall, and from there on rooms start to take shape, and in a similar fashion stairs and additional floors are created through, mostly accidental, discoveries

**LEGO exercise:**

G5: Let’s build animals!

G3: Let’s build a house!

G2: A house? That’ll be too large…

G4: A house for the animals!

G1, G3 and G5: Yes!

G4: Alright, me, you and you will build the house, and you two can build the animals. I’ll start with the walls.

G2: I’ll build animals.

G5: Me too.

G3: I’ll help with the walls, I’ll do this side first.

After the work duties have been distributed, the girls start building their house and animals while talking about non task-related things, such as homework and the schedule for the school day

There’s a clear difference in the group’s creative process in the two tasks. The Minecraft exercise was executed in a very exploratory manner, and they changed their plans and vision as they stumbled upon new realizations regarding how they could interact with the game world. This type of collaborative learning process wasn’t apparent in the LEGO exercise, as they were all on an equally high level of proficiency with that toolset.

Another interesting example is group 3’s approach to the exercises. In the LEGO exercise the group members, as previously stated, established a general theme for their creations, but that was almost the full extent of their collaboration. When they entered the Minecraft world, which they were all previously familiar with from game sessions at home and previously in school (they were also familiar with the control scheme and interface from FPS games), they approached it by trying looking around their environment to find an as challenging location to build something as possible and planned on building the legendary city Atlantis in a nearby lake. During their work, however, they discovered the ability to transport water in the game, using buckets. Upon this discovery, their session changed focus drastically to experiment with what they could do with the water and they created slides and vertiginous jumping platforms from which they dove into pools they created. In this case, similarly to group 2, the boys found a new way to approach the game by serendipity and evolved new type of goals in the game and they all competed in trying to create the best jumping platforms to improve their devised game. During this session, a group of comparably very experienced players was able to have a mutual exchange of newly discovered knowledge between one another as a result of the game’s emergent nature. The ability to place water in an of itself isn’t very impressive or interesting, but the group members analyzed the properties of the water and experimented with what it could be used to accomplish in the game and from that devised new ways of experiencing the game and competing and collaborating with each other.
4.1.3 Individual contribution

As opposed to the differences between the exercises when it comes to what type of conversations the participants were most frequently involved in, the individual contribution between the exercises weren’t obvious enough to indicate any specific changes in collaborative patterns, as shown in diagram 4.11-through-4.13. This indicates that the members in each group were at a roughly the same proficiency level as their colleagues; that is to say that very inexperienced Minecraft weren’t paired together with highly skilled players although some minor variation may have been present. This is unfortunate, seeing as having a wide array of proficiency levels during the exercises would probably result in more varied and complex collaborative patterns.

4.2 Free play sessions

During the sessions where 16 children had the opportunity to play Minecraft without explicit instructions to collaborate or perform any specific tasks in the game, several interesting observations were made indicating the effectiveness of shared emergent worlds as didactic tools. Even without the instructions to build something together (they were in fact not explicitly told to build at all), many participants naturally stayed grouped up while discovering the game world, and some even decided to “settle down” in an area they found attractive and thus started to learn how to build their own housing. Here, several cases of mutual learning through peer collaboration emerged; this short dialogue between two participants aged 8 and 9 was observed and transcribed during the “free play” exercise (translated from Swedish);

9yr: Alright, we’ve built a cellar, we need a roof!
8yr: Yeah, how do we build that?
9yr: We need taller walls first.
8yr: How do you build tall walls?
9yr: [after some experimenting, he figures out how to stack blocks on top of one another to create a short wall] You just point on the top of these and place the bricks.
8yr: Ok.

[After the house has a wall consisting of two stacked blocks, they ponder how to keep increasing the wall height, their character only has a vertical leap capable of clearing 1 block, not 2]

9yr: We have to get higher, the roof will be right on our heads…

8yr: [serendipitously manages to create a simple flight of stairs by placing a block next to the wall and jumping on top of it] Look at me, I’m up here!

9yr: How did you do that?!

8yr: [Jumps back down] Like this, just place a block here and then you can jump up [shows the maneuver by jumping up on his previously placed block]

Similar tutoring events occurred if a player stumbled upon another player’s creation and wanted to know how they built it. The self-taught player would then instruct the inquirer in how to mimic their building style, thus passing that knowledge on.
5 Conclusion

Although the study performed is too small to dismiss or validate the use of Minecraft or other technical platforms as didactical tools, it has revealed several conditions that need to be met in order for a shared emergent experience to work well as a collaborative exercise. It has also revealed areas in which technology mediated interactions might actually be detrimental for collaboration as well as indicators regarding which type of user is more or less suitable for these sorts of exercises. As previously stated, it’s important to keep in mind that the purpose of this thesis isn’t to make a value judgement regarding which type of group collaboration is better than the other; it’s merely to determine how, if at all, they differ from one another and by doing so develop our understanding of shared emergent worlds for educational purposes.

5.1 Results

As made apparent by video recordings and analytics performed on communication and activity participation in the different groups, there are clear differences between the groups’ face-to-face and technology mediated emergent collaboration. As previously stated, the differences noted are at most preliminary indicators of children’s collaborative behavior seeing as the study performed was at such a limited scale; but it can still serve as a basis for discussions regarding the effects of technology mediated interaction in collaborative exercises.

When analyzing the results of both exercises, there is a clear lack of intimate collaboration between all the group members in two of the groups (group 1 and 3). During group 1’s LEGO exercise, there’s not much evidence of any sort of communal effort to work together to complete a project; in this case the participants formed their own clusters of the group to pursue their own goals rather than contributing towards a common goal. In group 3 the children established an overarching theme of their structures, as everyone agreed to make a “snowy landscape”; the execution of the vision was however far from uniform and the group members started pursuing their own ambitions without much regard for other group members’ efforts. This was a commonly recurring procedure during the groups’ exercise execution, sometimes apparent in Minecraft and sometimes in the LEGO exercise and it can have several explanations. Analyzing the video recordings revealed five recurring themes which had a close correlation to changes in the group members’ behavior towards one another; tool proficiency, tool constraints, canvas accessibility, artistic differences and personal space. Below is a description of each of the identified factors that seemed to contribute to the groups’ collaborative behavior the most:

**Tool proficiency**: the group members are comfortable enough in the tools provided during the exercise to regard the assistance of, or help from, other group members to be superfluous as they are capable of executing on their goals well on their own.

**Tool constraints**: the number of available materials during the exercises may affect the participants’ willingness to collaborate with their peers, as collaboration means that they have to share their resources on elements of the work that they don’t agree with.

**Canvas accessibility**: the physical hindrance of constructing objects out of LEGO together deters intimate collaboration in smaller scale projects, i.e. the hands of other children are often in the way.
Artistic differences: subjects become too enamored with their own visions for their project and don’t consider the participation of other members to contribute to it may only force compromises of the vision and thus harm the project, or they simply disagree with the group’s initial project idea and “go rogue” to pursue their own goals.

Personal space: collaborating in physical proximity with other children might be uncomfortable if they aren’t very close friends and some participants receded to work in solitude rather than approach, or risk being approached by, other members for collaboration.

Establishing the basic factors that may have contributed in changes in the groups’ collaborative patterns is a helpful to conduct further analysis and discussion regarding the collected data.

5.1.1 LEGO exercise

The most prominent factors that were the most consistent when it came to all groups’ work process during the LEGO exercise were the group members’ uniformly high tool proficiency and concerns for tool constraints and canvas accessibility.

In two of the groups, group 1 and 3, there was almost no conversations about how their visions would be collaboratively executed, and the discussions about what they would build was also very ambiguous and limited within these groups. Group 2, however, were very organized in these manners and they all agreed upon what specific theme their buildings would have and which group member would be responsible for what piece of the final product (see Picture 5.1 and 5.2)

Picture 5.1: the detachable rooftop of a barn housing LEGO animals, created by three participants in group 2. The group members worked together to complete the structure, each building separate pieces of the wall and then joining them together (note the X- and horizontal line-marks on the upper half and vertical line marks on the lower).
That being said, according to Jehng’s model for identifying collaborative patterns there are no variation in the different groups’ cooperation, they all seemed to conform to the peer collaboration pattern seeing as they were all of an equal skill level with the caviat that they didn’t need to explore the tools together as they were already familiar to them; none of the participants made an effort in educating others to get educated themselves, there was simply no need to. Peer collaboration doesn’t necessarily have to mean that the group members approach a task with an equal level of skill deficiency; they can also be of a high level of expertise. The majority of the task-centered communications were focused on either establishing a general theme for the group members’ work, or the participants narrating their own construction process. A fairly large amount of the verbal activity consisted of the children creating fiction around their work and attempts to craft realistic scenarios which would have led to their constructs manifestations if they were real objects (such as their real-world functions and reasons for existing). This can be considered in two ways, either the LEGOs weren’t engaging enough by themselves and the children needed to add this fiction in order to find the task interesting, or the LEGOs were inspiring the children into crafting these narrative machinations. The reality is probably a bit of both; the simplicity of the LEGO pieces and the ability of the participants to set clear goals and achieve them with the tools at hand probably gave them the opportunity to invest their mental faculties in thinking further than merely the execution of the blueprints for their buildings. Picture 5.3 is an example of both highly distributed work that conformed to an agreed upon theme for a group’s building efforts (group 3) and of a constructed narrative.
At several occasions, the constraints of the LEGO, that is to say the finite amount of pieces each participant was given, was directly responsible for what was constructed. Participants frequently stumbled upon blocks of particular color and shape that caught their fancy and these serendipitous finds would often inspire the participant to build something suited to that particular piece and start looking for additional pieces with similar attributes. In this case, scarcity of material both acted as inspiration for creations that the participants hadn’t previously considered (for example, creating flags became a common theme among some members of group 1 upon discovering thin pieces of suitable colors) and as a disruption of the groups’ collaborative work as some members deviated from the agreed upon building themes to create something of the piece they were infatuated with.

5.1.2 Minecraft exercise

As opposed to the LEGO exercise, the participants weren’t as uniformly proficient with the Minecraft interface and the groups varied from novice to adept when it came to navigating and interacting with the world; group 1 being the least proficient, group 2 being of average proficiency and group 3, in comparison, being highly proficient. This had a clear impact on the groups’ collaborative patterns, and the patterns shown during the groups’ executions of the Minecraft exercise were very diverse. As previously mentioned, there were big differences in how group 2 and 3 approached the different exercises; the LEGO being approached with pre-planning which was followed to the end of the exercise and Minecraft being more of an exploratory exercise in which the groups’ vision changed when new possibilities were discovered in the game. Why this is a positive result concerning emergent games’ viability as educational tools is most evident in group 3’s Minecraft exercise. A group of users experienced with the tools presented to them found a new way to view an element in the game world (in this case, water) and this new realization inspired a whole new approach to the game. In this new player-devised gameplay, the participants were pulled out of their comfort zone and started experimenting with the newly discovered element’s properties and devised ways that it could be used to enhance their experience. In this case, the emergence encouraged the players to interact to a greater extent than just determining how they would use tools they had already mastered; something which could be very valuable in an educational context. This is also beneficial from a game designer’s point of view, seeing as the lifetime of a game can be greatly expanded when players have the opportunity to find new variables within the game which they can combine with their previous knowledge, often leading to many interesting and compelling situations and encouraging creative entrepreneurialship.

5.1.3 Antisocial play

One beneficial factor of technology mediated interaction is also the cause of one of its side effects. In general, not just between children, having a technological filter through which people interact reduces their feelings of empathy and reciprocity towards each other (Workman, 2006). This can have a positive impact on people who feel limited in social situations because of their physical attributes or other types of impediments; there’s a certain sense of security that comes with technology mediated interaction as the only datapoint people have to judge you by is your conduct, your real life appearance of life situation isn’t as relevant and thus not limiting. However, this elimination of the real human component led to some children in the study conducted for this research to engage in antisocial activities, such as destroying other
participants’ creations. This behavior was never apparent during the LEGO exercise, and when the children were told that they were actually destroying someone else’s work, the work of a peer, they quickly regretted doing it and apologized.

This is an important thing to consider when creating emergent games for children, and it places a lot of responsibility on the educator to explain that the things inside the game world isn’t just meaningless bits and pixels, but actually the fruit of someone else’s labor.

5.1.4 Use of emergent games in education

Taking the factors that seemed to change the nature group members’ collaborations the most; that is to say tool proficiency, tool constraints, canvas accessibility, artistic integrity and personal space, we can identify some areas in which emergent games such as Minecraft can excel and which can be developed further if games of this nature are to be used in education. In the area of tool constraints, canvas accessibility and personal space, technology mediated interaction seem to have a clear advantage over traditional forms of collaborative platforms. Materials and access to work areas doesn’t need to be constrained in the same was they naturally are in the real world unless the game’s designer explicitly want to implement those constraints. In Minecraft, for example, gravity doesn’t affect many of the building blocks inside of the game; a fact some of the participants took advantage of to create some farfetched structures they wouldn’t be able to build otherwise. Their infinite amount of resources and their (atleast for some participants) ease of use also encouraged many of the children to experiment wildly and explore the possibilities and limitations of the platform.

That being said, there are several disadvantages intrinsic to emergent games that can’t really be overcome without seriously infringing on the very things that makes the game emergent. The broader verb palette you equip the player with, the more he’s likely to use it in ways that don’t necessarily contribute to the type of learning the educator wishes. In more linear learning games, the educator can be confident that the student is gaining some knowledge within a certain subject by seeing that the game’s narrative is being traversed as mastering the heuristics the game focuses on teaching is necessary for the traversal. Thus, an emergent game places a heavier burden on educators as they need to be involved in what the student is doing in the game world, an issue that the methodology described in this thesis aims to alleviate by, unbeknownst to the student, tracking their contributions to the group’s goals.

5.2 Discussion & Future work

The results of this study were very much in line with the hypotheses established before the experiments were carried out, and the SICC coupled with discourse analysis proved to be an excellent tool for evaluating user participation after the exercises were finished, eliminating the need for a supervisor to be constantly present. This has obvious uses in educational situations in schools or training facilities, as the work loads for teachers and instructors can be made more flexible and less severe by allowing them to access direct data regarding each exercise participants’ contributions to the final product. As described below, however, the process needs to be automated and easier to use in order for the methodology to be a viable means of examining student participation in more loose exercises such as the Minecraft exercise conducted in this research. The current method, especially the analysis of audio recordings, is very high maintenance and seems difficult to mechanize. Finding means of assisting
educators to visualize and contextualize the verbal activity and progression of a group's labour would dramatically increase the usefulness of emergent games as learning tools.

Furthermore, devising means of subtly directing the emergent activity of students without infringing on the emergent nature of the game can also be very useful, as totally unguided emergence seems to distract children. It would also be interesting to study the use of Minecraft, or a similar game, in a stronger educational context than was done during this research; letting a group of children play Minecraft for an hour with very loose and educationally disconnected instructions regarding what they should do in the game doesn’t really give any real information regarding how the game would fare in real educational situations. Given more time to conduct the study, the participants would be given the opportunity to use the game for a longer period of time, which would gradually make the interface less of an obstacle and would also give them the opportunity to plan and carry out a longer term project which can be more motivating than having a very limited time period to create something. Emergent behavior and the utilization of an emergent system is something that slowly ramps up as a user becomes more proficient and secure in the tools and milieu of the system; in that regard, this study didn’t do Minecraft or emergent games in general justice.

Although Minecraft isn’t specifically designed to be an educational game title, it did display didactic potential in several ways during the research. The opportunity for the participants to explore and experiment with the game world in order to reach goals they set for themselves, or to acquire new ones, sparked several creative endeavors and spontaneous collaborative behaviors, even when the participants weren’t instructed to work together. This potential could certainly be harnessed in order to create a very engaging and flexible educational tool.
6 References

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