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Knowledge Sharing and Collaborative Learning in Second Life: A Classification of Virtual 3D Group Interaction Scripts

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Abstract: In this paper we propose a classification and systematic description structure based on the pattern paradigm for interaction scripts in Second Life that aim at facilitating on the one side knowledge sharing and knowledge integration in groups, and on the other side knowledge creation in formal and informal ways. We present 13 examples of interaction patterns, a description structure to formalize them, and classify them into four classes according to their design effort and added value. Based on this classification we distinguish among sophisticated 3D collaboration patterns, seamless patterns, decorative patterns, and pseudo patterns.

Keywords: collaboration patterns, online collaboration, knowledge sharing, virtual worlds, MUVE, Second Life
Categories: H.4.3, H.5.3, J.5, L.3.0, M.0

1 Introduction

Modern organizations have realized that information and knowledge is essential for their success. The increasing use of electronic information systems in work processes is the foundation of the development of the concept of organization memory and the driving motor in the research field of knowledge management.

Tomek states that the information capturing part of a knowledge management system should include a Collaborative Virtual Environment (CVE) [Tomek, 01]. He defines a CVE as a software environment that creates a configurable universe which emulates a number of serviceable aspects of physical reality, such as the concept of space, movable objects, navigation, and communication between (representations of) humans. The most relevant of the several reasons Tomek gives for his claim are:

- the emulation of physical topology as a natural metaphor, a prerequisite for successful groupware
- CVE allow for organizing both people and information spatially
- awareness of co-workers, usage policies for tools and objects is enhanced
- allocated space can be separated to allow privacy and group restrictions

- computer-mediated communication between disjoint places provides a good basis for recording in context (as all communication can be logged instantly)

Collaborative Virtual Environments can thus enhance sharing and integration of knowledge. We agree in this point and further believe that the use of a three-dimensional CVE can upgrade current knowledge management even more substantially, also in situations that go beyond visualizing data or reviewing spatial models in applications like architecture and design. Our systematic description and classification of group interaction scripts in 3D collaborative environments aims to help facilitate and enhance team collaboration and knowledge management by providing reusable patterns that leverage the ample possibilities only three-dimensional virtual environments offer.

So far it is unclear what enhancements are needed to make a CVE a really good environment for serious distributed collaborations [Bainbridge, 07]. Among other benefits, a classification like the one we propose in this paper could form a first step in the process of formalizing collaboration in virtual environments by providing an overview of so far implemented patterns, could help in the research regarding theories that underlie 3D interaction for collaboration, and could initiate a collection of reusable best practice patterns and templates.

The remainder of this paper starts with giving reasons why 3D collaborative environments in general and the online virtual world Second Life in particular can improve collaboration, knowledge sharing and learning. In chapter 3 we then first discuss previous work that relates to our proposal of a formalization of 3D collaboration patterns. In succession to that we introduce our systematic description structure, show it applied on four example key patterns, and propose our classification. Section 4 presents some decision criteria for the use of Second Life and first guidelines to follow when creating a 3D collaboration or learning experience. Section 5 concludes the paper, suggests implications of the presented work, and outlines some directions of our future work.

2 Why Second Life?

The vague definition of CVE in a general sense comprises systems spanning from text-based environments [Hayes, 98] through environments with simple two-dimensional graphical representations [Vitero, 08] to systems based on Virtual Reality (VR). As mentioned in stating our motivation, our research focuses on the latter, regarding solely three-dimensional graphical CVE that are rich in representation and support embodied avatars and 3D objects in spatial relation to each other. Some major advantages in comparison to the former types of CVE are given in the following section. After that, characteristics of Second Life that distinguish this online virtual world from other 3D collaborative virtual environments are presented.

2.1 3D Collaborative Virtual Environments

Compared to text-based and two-dimensional ‘flat’ graphical CVE, an environment fully based on three dimensions can enhance the functionality in a number of respects. Most importantly, 3D environments provide ways to experience and view information that is *dynamic and interactive* [Krange, 02]. A more accurate *approximation of* *physical reality* can be provided, which can ease first access to the system and improve overall usability. In the same sense, a "feeling of immersion, a perceptual and psychological sense of *being in the digital environment*" is evoked [McLellan, 96]. Also the feeling of *presence* is enhanced, by the sense of orientation and position in space. People and information can be *organized* in a more natural way in three dimensions, also making available more real space instead of small corners on flat screens. McLellan states that three-dimensional CVE are proclaimed to be appropriate for model building and problem solving [McLellan, 96].

Casanueva et al. presented experiment results showing that the *awareness* of collaborators and their actions can be significantly enhanced by more realistic representations of persons [Casanueva, 01]. Furthermore, *usage policies* for tools and objects can be illustrated more clearly and in a more natural way employing the theory of affordances [Norman, 88]. And finally, the level of *privacy* of allocated spaces is continuously adjustable in a natural way (cmp. the office design metaphor: open office vs. combo office vs. private office).

A disadvantage of three-dimensional virtual environments mentioned in the literature describes the opinion that 3D models are more difficult to use than 2D data or text and could thus distract a user from communication. We take this issue into account by regarding the design effort of the particular collaboration patterns in our classification. This is explained in more detail in chapter 4. A differentiation in defining CVE is made concerning the accessibility of 3D virtual environments. Immersive collaborative VR systems are in most cases locally installed, while some desktop-based three-dimensional CVE are online virtual worlds with persistent world states, and are thus accessible virtually around the clock (with regards to system downtime). The fact that all data is being held online is an important distinction to other CVE, yet the acronym MUVE has been established for these *online* Multi-User Virtual Environments.

For the said reasons also we believe that 3D collaborative environments help make sense of complex data, can help develop a common understanding in a collaborative mind set and engage people through appealing and memorable experiences. The latter can lead to an increased involvement, can focus attention of the participants, and provide a good basis for creativity.

2.2 Relevant Characteristics of Second Life

Second Life is an online Multi-User Virtual Environment (MUVE), i.e. a special type of CVE [Second Life, 08]. Using a viewer software, everyone can access this virtual world, from anywhere, at any time. The status of the world is persistent; no data is lost, nor has massive data to be up- or downloaded at login. Users are represented by extremely customizable avatars that have a unique name and can resemble strong own identities. Targeting businesses and entrepreneurs, Second Life is often advertized as "a place where there are no real-world manufacturing or service costs and few barriers to what's possible". Second Life was launched in 2003. After a massive hype in 2007, the statistics of April 2008 state that over 13 million users had registered in total, and about 1 million users had signed in during the preceding 60 days [SL Stats, 08]. Characteristics of SL relevant for knowledge management and collaboration are:

- content is produced by residents of the world; developers provide powerful tools designed to be used by everyone [Ondrejka, 08]

- in-world spaces are thus easily reconfigurable and extendable at any time
- avatars can present valuable identity information solely by appearance
- group and private chat functionality, as well as object sharing provide inherent collaboration possibilities

For education research as well as education practice, Second Life has become a rich and promising new environment. Learners can be addressed in an entirely novel way, and modern education paradigms and learning theories as the following have been implemented successfully:

- situated learning – learners are immersed in the context environment where they learn [Hayes, 06]
- constructivist learning – playing or creating objects and so creating correlations and knowledge from current structures is inherent in Second Life [Antonacci, 05]
- social/collaborative learning – inherent collaboration between avatars
- resource-based learning – a variety of virtual objects and human resources are possible in Second Life
- problem-based learning – solving of problems collaboratively with several avatars is supported in Second Life [PREVIEW, 08]

3 Patterns for Knowledge Sharing and Learning

A pattern is a description of a known solution to a specific type of problem [Gottesdiener, 01]. The theory of patterns, originally developed for architecture [Alexander, 99], but in practice more commonly used in software development [Gamma, 95], can be usefully applied to the domains of collaboration and learning.

Collaboration patterns can be understood in terms of how users act in dialogues and in the usage of artifacts [Krange, 02]. Gottesdiener defines them as techniques, behaviors, and activities for people who share a common goal of working together in a group [Gottesdiener, 01]. For our proposed formalization and classification of different collaboration situations through the use of patterns (cmp. [Zigurs, 08]), we use this definition and extend it by the requirements for the creation of the virtual experience. This is explained in more detail in section 3.2.

The education community has long identified three-dimensional CVE and Second Life in particular as a novel environment for education. As stated in the previous section, especially modern learning and teaching paradigms have been successfully implemented. As of now (2008), a number of conferences on education in Second Life have emerged, such as SLEDcc, Metaverse08, the Second Life Education Workshop, at SLCC. Also, there are some very active mailing lists, of which the most popular is SLED [SLED mailing list, 08]. Baggetun et al. composed a good introduction to patterns for collaborative learning, including remarks on pattern mining [Baggetun et al., 2004]. For an explanation of our use and description of learning patterns, see section 3.3. We believe that the pattern concept offers the right type of granularity and reproducibility to capture and *envision* collaboration and learning possibilities in Second Life. This seems feasible as the pattern approach has been applied to similar endeavours such as e-learning [Caeiro et al., 2004, and Retalis et al., 2006], webdesign or programming.

3.1 Related Work

The MG Taylor Corporation developed a modeling language, introducing patterns for collaboration and organization in enterprises [MGTaylor, 96]. Whyte et al. investigate visual practices – practices around visual materials, i.e. artifacts that embody the current status of a design or act as mediating devices to develop understanding [Whyte, 07]. Visual materials play a significant role in knowledge practices within organizations. Krange investigated collaboration patterns for learning in Second Life, but only to a certain extent [Krange, 02]. Since that research strongly focused on learning, i.e. on knowledge construction, the analysis of the interrelations between actors, especially vocal interaction were investigated.

3.2 Description of Collaboration Patterns

In the following we introduce a systematic description structure which we developed as a means to formalize collaboration patterns in 3D virtual environments. We applied this description structure on the various patterns that emerged in our research in Second Life. To exemplify, this chapter presents in detail the descriptions of two key collaboration patterns and two key learning patterns of the 13 patterns we found and classified. Figure 1 shows two screenshots of within Second Life: a virtual meeting (a) and a virtual design studio (b). The latter facilitates the collaborative design and implementation of functionality of a door with a security panel – rapid prototyping at its best: door and panel can be tested already during the creation and design process.

(a) (b)

Figure 1: Screenshots of (a) a Virtual Meeting and (b) a Virtual Design Studio in Second Life

Table 1 shows our description structure, applied on the two shown collaboration patterns. We describe such a pattern among other criteria through its usage situation, i.e. the context in which the virtual environment is used, the aim of the usage, the level of intensity of the participants' interaction as well as common actions of the avatars, what artifacts are required in general, risks or caveats of the pattern and the design effort: the amount of effort required to develop the environment for the collaboration pattern.

Pattern Name	**Virtual Meeting**	**Virtual Design Studio**
Usage Situations	project meeting, team meeting	product development/design, architectural design
Objective	knowledge transfer and decision making	design of a physical (or virtual) object
# Participants	< 15	< 5
Interaction Intensity	low to medium	high
Typical Duration	up to 1 hour	up to 4 hours
Required Artifacts	places to sit, information displays	designing tools, sketching tools, plans
Avatar Actions	chatting, showing	modeling, designing, sketching
Risks	not making use of 3D features	design influenced by limited functionality of design studio
Design Effort	medium: room design and projections	very high: design tools, sketching tools; interaction design

Table 1: Description structure for collaboration patterns in Second Life, applied to two example patterns

3.3 Description of Learning Patterns

Figure 2 shows screenshots of two exemplary learning patterns, a scavenger hunt (a) and a role play (b). In a scavenger hunt, groups of users follow a track comprised of several locations with learning content on their way through a virtual world. Each location of knowledge in the hunt contains one or more hints on how to find the next spot. In a well designed scavenger hunt also the search for the locations itself is informal learning, designed e.g. as riddles that have to be solved by working together as a group. The role play pattern however provides an opportunity to immerse oneself in historic periods of time and play historic characters. Real historic events can be replicated or imaginary get-togethers can be arranged; also political role plays are imaginable, with learners acting as if they were the particular politicians they play. Table 2 shows our description structure applied to these two patterns, whereby here the usage motives are of educational nature.

(a) (b)

Figure 2: Screenshots of (a) a Scavenger Hunt and (b) educational Role Play in Second Life

Pattern Name	**Scavenger Hunt (Virtual Quest)**	**Role Play**
Usage Situations	learn spatially distributed content	experience a period of history, while acting as historic characters
Objective	informal learning: creating knowledge by finding learning content	informal learning: experience a historic period, learn about historic or political persons
# Participants	< 5 in group	< 10
Interaction Intensity	low to medium	high
Typical Duration	up to 2 hours	up to 2 hours
Required Artifacts	learning content, hints	scene, costumes, artifacts
Avatar Actions	interacting with environment, navigating	talking (also monologues), moving, gesticulating
Risks	getting lost, neglecting the learning content	not playing the particular historic character right
Design Effort	low to medium: learning content design, hints design and placement	medium: scenography, animations

Table 2: Description structure for learning patterns in Second Life, applied to two example patterns

3.4 A Classification of Collaboration and Learning Patterns

We propose a classification of collaboration and learning patterns in 3D virtual environments by arranging them in two dimensions according to their design effort and their 3D added value. By design effort we mean the amount of work that is necessary to stage the particular collaboration pattern; 3D added value can be seen as a compound measurement comprising the increase in efficiency, cost, and quality of the collaboration and its outcomes or quality of learning and its learning outcomes, for learning patterns. We chose these dimensions to put into relation the effort of designing a virtual 3D experience with the outcome gained from it. The following box gives a more detailed description of the two dimensions we defined.

The Classification Axes: Design Effort and 3D Added Value

The design effort could be gauged in measuring the time and manpower required to prepare the collaboration setting and functionality. In the final setting this is expressed by the array of interaction functions and the quantity of sophisticated interactive objects that were created.

The compound axis of 3D added value, however, is more complex to measure. To position the patterns in the diagram in figure 3 we looked at the added value in terms of how the spatial character can give additional information or hints, e.g. is it possible to remember locations, offices or people and find them even without any names, just by coming back to the place. Other forms of 3D added value would be the obvious benefit of viewing 3D data in three dimensions, the generation of an additional communication layer by moving through the environment with avatars and group building, and the very important characteristic of being immersed in a virtual world. All these interpretations of 3D added value and thus also the compound axis should not be understood as measurable and comparable quantitative values, but as tendencies. Especially in this early stage of research, both measurements are operationalized qualitatively.

Choosing these criteria allows us to distinguish real value adding collaboration and learning patterns from merely cosmetic ones.

The principal research methods used are participant observation in Second Life and subsequent classification and documentation. The classification showing the first 13 emergent patterns is shown in figure 3. Elliptic elements in the figure make clear that there can be different occurrences of one pattern. In fact, most ellipses could span across the whole diagram, but for readability we chose to depict their most common use and thus keep the ellipses within a certain size range. Ellipses with dotted outlines resemble learning patterns, the ones with straight outlines show collaboration patterns.

To exemplify the two axes, the upper extreme in added value would be a collaboration pattern that is time-efficient (e.g. product modeling and reviewing/testing at the same time), saves costs (e.g. in physical prototype production) and can result in a higher quality (by e.g. seeing a product in its designated usage context), like the earlier described *Virtual Design Studio* pattern. The design effort in this case is high, due to the necessary a-priori implementation of design and modeling functionalities and tools. The *Virtual Workplace* pattern describes the mirroring of ongoing work and workplaces in the real world into the CVE, e.g. casting the computer screens of employees while they are working (called 'screencasting') onto walls or other in-world projections. Co-workers can thus get an overview of what everybody is currently working on by wandering through the virtual workplace and can give help in particular cases. Another example pattern of collaborative work is *Knowledge Map Co-Construction*. Collaborators construct and modify a knowledge map in the CVE. The 3D added value here is based around collaborative interaction as well as viewing and editing multiple designs of a knowledge map in context. Obviously, many of the classified patterns share the fact that putting more design effort into the collaboration pattern leads to more added value; this can be seen both by the orientation of some ellipses from the left-lower corner to the right-upper corner and by the concentration of the patterns on the diagonal between said corners in the diagram.

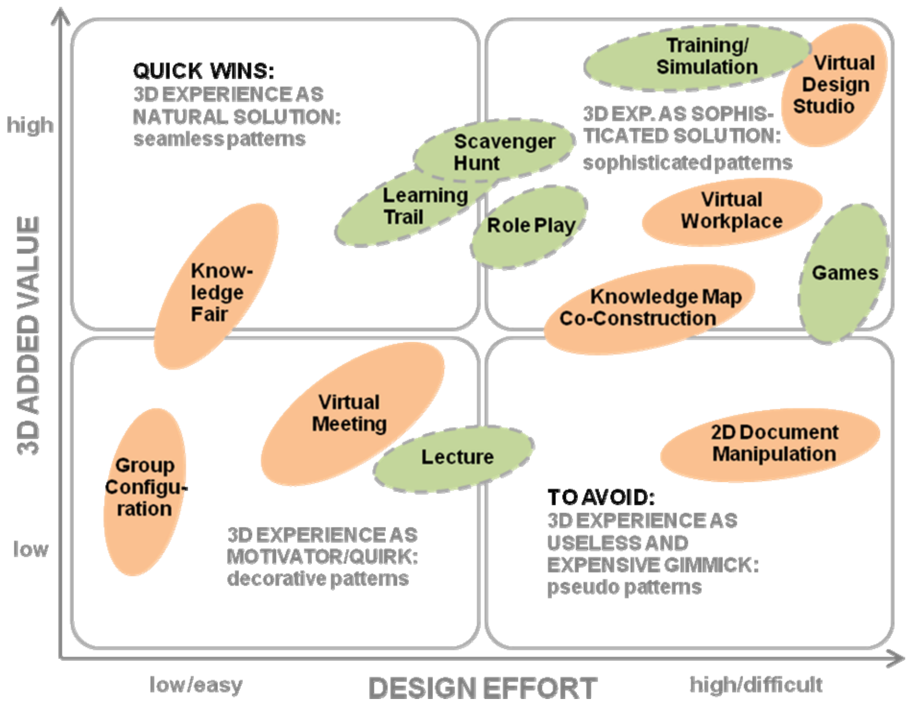

Figure 3: A classification of collaboration patterns and learning patterns by design effort and 3D added value

For the learning patterns, the most sophisticated one is most likely to be *Training/Simulation*, which might also be the most widely used 3D interaction pattern. It is used in a broad range, spanning from the training of employees to operate machines or vehicles (or planes), through architectural simulations, combat training, the simulation of and training for emergency situations, to the treatment of phobias by systematic desensitization, where patients are put into controlled fear situations. The design effort ranges from medium, focusing more on collaboration and avatars to high, if sophisticated virtual objects and interfaces are required. *Games* are more and more used for education, with collaboration often playing a big role. One major argument for using 3D virtual environments and games for education is that today's youth should be addressed by settings familiar to them, rather than only confronted with traditional learning methods and materials. As a special kind of educational game, *Role Playing* can be seen. This earlier described pattern gives the opportunity to immerse in historic or political settings and lets the learners experience circumstances and personated characters. Collaboratively they learn from each other. The also earlier described *Scavenger Hunt* is another form of informal learning, where learners have to find items and thus pick up learning content in a playing way. A *Learning Trail* is a means for providing stepwise knowledge acquisition by positioning objects of any complexity as learning content along a trail in the virtual world. People share and perceive common interests implicitly by meeting in front of the same objects. This concept of premeditated serendipity is also applied in the *Knowledge Fair* pattern, which differs from the learning trail in terms of time scheduling. A knowledge fair is an event while a learning trail is more of a persistent exposition. The two patterns are different also in terms of complexity of the presented objects, as at knowledge fairs mostly simple elements like posters and video/slideshow presentations are on display. We called this class, which comprises 3D experiences as a natural solution to problems, "Quick Wins" to emphasize the great 3D added value compared to a rather low designing effort required.

Descending the axis of 3D added value, three patterns emerged that use the 3D experience primarily as a means for motivating collaborators to participate and for higher engagement; we called them "decorative patterns". The *Virtual Meeting* pattern in the simplest form merely constitutes the staging of a meeting room where collaborators can chat and talk to each other and hold presentations. Also in this case, as illustrated in figure 3, adding more functionality to get a higher added value comes with an increase in implementation effort. The *Lecture* learning pattern seeks to describe all settings that include a lecturer and an audience. Collaboration is implemented in group discussions and the possible collaborative work on a learning object. The *Group Configuration* pattern comprises all group activities that follow the "voting by feet" principle, i.e. using localization, navigation and other spatial cues as an indication of personal preference. For example, a group of people can divide into disjoint subgroups for voting or to answer a question; the results and tendencies are visualized.

An example of a 3D experience as a useless and expensive gimmick we have come across is the creation and editing of a Powerpoint presentation on a Second Life collaborative design screen. In the classification this is represented by the pseudo pattern *2D Document Manipulation.* The complex user interface of enabling several people to work on a 2D document together could be done easier and more convenient in a 2D collaborative environment, for example in Google Docs [GoogleDocs, 08].

4 Guidelines for the Use and Deployment of Second Life

If you think about creating a collaboration space or learning environment in a 3D virtual environment like Second Life, we believe it is wise to consider our following compilation of reflective questions, in order avoid creating an experience that is not worth the effort (and the money). In the end, we consider a 3D experience worthwhile if it could be positioned on or above the diagonal from the lower left to the upper right corner in our presented classification diagram. If you can answer yes to one or more of the following questions, your plan of creating a 3D space might be worth the effort:

- Does my intended 3D experience harness the spatial character of the 3D environment to help users remember locations in order to find spots again they have been to?
- Does it make use of the additional communication layer that arises by using avatar movement and positioning, or by using gestures?
- Can the immersion in a 3D environment improve the interaction/experience that is intended for the users?
- Do three-dimensional objects play a role in the setting, so viewing or manipulating them in a 3D space brings a clear benefit?
- Is the target group for using my intended 3D space ready for it, i.e. would the users understand how to use it without feeling too intimidated?

The following questions help to reflect on how the 3D experience should be designed and created:

- Do I want to develop the 3D experience internally or should I contract outside specialists for the job (depending on the available time and know-how and the required development effort of the environment)?
- Do I want to I include the users in the design or creation of the 3D experience?
- Should we work in a consortium with partners who have similar needs or do we require an individual solution?
- Can we make sure that our solution is scalable and easily modifiable to meet future training and collaboration needs or changes in the relevant content?

5 Conclusions and Future Work

The presented classification should sensitize designers and users to the fact that not all collaboration and learning scenarios envisioned for use in Second Life may generate the added value that the amount of effort put in might promise. The classification can furthermore be used to empirically test which features lead to high-value patterns and which quadrant patterns are used in which constellations or for which motives. As such the current classification is subject to on-going revisions. It is early work, scientific proof is still to be developed. Nevertheless already its current form can help researchers, designers, and practitioners to assess a 3D collaboration or learning setting in terms of its scope and benefits.

Further steps will include the definition of additional patterns, different classification approaches, and also the development of well-grounded guidelines for the creation of effective experiences for virtual environments. Future work could furthermore include an experimental comparison of collaboration tasks in three-dimensional CVE against corresponding tasks in text-based CVE and real-life collaboration, which could be evaluated by performance. Furthermore, to go deeper into collaboration, investigating the question of which theories help to explain 3D interaction for collaboration and learning would be useful and interesting; for example, the actor-network theory, Gibson's theory of affordances, and the cognitive scaffolding theory might be applied to 3D environments.

Our research has focused on Second Life so far because of its availability, the great opportunity to conduct research due to a huge number of events and participants, and its convenience of use, but we are not excluding other virtual worlds and collaborative online environments.

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