From real-world data to game world experience: Social analysis methods for developing plausible & engaging learning games.

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ABSTRACT

This paper is based on work to develop an interactive learning game called HEALTHSIMNET that is meant for improving practice in a health care network. It considers three selected models for analysis of documentary data acquired during semi-structured interviews with participants of a network of health practitioners in the HIV field. The paper briefly reviews the expansive theory of learning but mainly explains how the three techniques can yield interactive narrative. We end with a description of the game and a discussion of the extent to which games developed using this method can be said to sustain the kind of learning described by activity theory. **Keywords:** activity theory, interactive narrative, game, HIV.

INTRODUCTION

The interactions of actors within any multi-participant activity or situation can undoubtedly be viewed and studied as if they were the interactions of actors (perhaps played by players) within a game. The *game* is a powerful concept, as well a dominant product category, so that when a game creator successfully aligns the manifold variances that define the idea, the result for the player can be profoundly engaging and satisfying. Some researchers – and perhaps more commercially interested commentators – suggest the *entertaining* aspects of gaming could be transported to educational media to create *edutainment* that would capture the inherent interest and fun of game play and (by stealth) lead to painless learning for the user [1].

There is a good deal of valuable evidence for the benefit of games in learning. From

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clues about what motivates players, to the recognition of the cultural functions that anthropologists tell us constitute the role of games in cognitive and social development, the evidence of the importance of games (as typically conceived at least) as vehicles for learning, is highly compelling [2]. Aspects of challenge, curiosity, fantasy and control are widely recognized as engaging characteristics of motivating experiences. Socially, game play offers the cultural function of risk-free imitation and accommodation of practice, an experience that reaches far beyond kindergarten learning in the sandbox. Furthermore, the games we play are also culturally expressive of our values [3] indicating the complexity of the society and its relation to the supernatural.

While our goal is superficially similar to Prensky's above (that is to create games that lead to learning) our approach is to bridge the divide with the use of data structures that can be used to illustrate common aspects of games and learning environments. This approach is far more limited in its claims than the global *edutaining* of the school curriculum. The structures used are common only to a small sub-set of game types and the learning theory we use is neither in widespread use or particularly appropriate to current educational practices. However we think this specificity provides a reasonable possibility that realistic benefit can emerge from the attempt to contribute in this interdisciplinary area.

The intent of the research is to design a new media game that will allow participants to see previously invisible aspects of a network, to be challenged by the perceptions and expectations of others within the network, to explore simulated narratives within this realistic context, to try strategies for improving network performance, and to cross the costly boundaries that separate professional groups from one another. In order to achieve this we have taken an approach that models the causal events and episodes found in interview cases to form working descriptions of stories that are representative of the network. With these we can form chains to simulate a generative narrative that represents experienced stories (and could generate new but plausible ones).

The development of the simulation also helps us to understand the factors that characterize learning in practice networks, particularly within this network (which will provide a contrast with better known formal learning situations), and how to build a new instructional design approach for networks that has potential to provoke critical reflection on any similar practice with a corresponding impact on the methods used to design learning technologies for workplace networks of action.

The HEALTHSIMNET simulation models the interactions of participants within a network of health care professionals and also lay players involved in care and treatment of the HIV disease. This environment is quite like a game in several formal, structural and interactive ways. In other ways, for example its content, pace of interaction, and the seriousness of the outcomes, may make it highly unappealing to the typical marketplace segments in which games are created, and may even violate some of the essential principles that games researchers have invented to try to pin down the defining characteristics of the game experience.

Nevertheless we believe that HEALTHSIMNET may capture a key combination of learning theory and interaction design with a common data structure that can lead to a reproducible practice for the creation of learning games. This new learning design process draws on analyzing data that relates to current practice and is based on a theory of learning that emphasizes the shift in practice as the goal of learning. The mediating

step in the innovation is a process for creating simulation games from analyzed data. The learning theory which best addresses the need is called *learning by expansion* and derives from cultural historical activity theory first developed in Soviet Russia by Vygotsky [4] and others and is now attracting considerable interest and application in workplace learning [5], human computer interaction [6], and school teaching practices [7].

Activity theory generates knowledge by overlaying a categorization that describes the components (or a reduced set of parts) of a multiplayer activity. Although CHAT (cultural historical activity theory) is sometimes seen as a research method, in our work we have taken the view that it is complemented by other qualitative approaches that specialize in the reliable construction of theory from real-world data. Grounded Theory is one such method and it comes with its own systemic knowledge representation derived from the idea of a theory or hypothesis. As well as these abstract approaches to turning real data into narrative we have also created a tool that represents some of main features of interactive story generation called TEAMVIEW [8].

In the following sections we show how these systematic approaches to analysis can yield narrative guidelines from interview data.

COLLECTING INTERVIEW DATA

A number of professionals involved in a real network based in the southern part of British Columbia have now been interviewed using semi-structured techniques and diagramming opportunities based on the revealing of network structures. As our participants revealed the stories of their practice we encouraged them to sketch out the others involved and the roles those others played in the story.

We conducted interviews with the centre of excellence in HIV/AIDS in Vancouver, the Fraser Valley health region centre for communicable disease, and members of the BCPLWA[1] organization. Our pilot interviews with network members each revealed intricate and moving accounts of peoples' life struggles whether from the point of view of a person living with the disease or from the perspectives of those with health care roles.

The pilot interview data has been *open* and *axially* coded (using ATLAS.ti) to reveal many interesting phenomena. The first stage of analysis is a modified form of grounded theory [9, 10]. This method is essentially inductive development of explanation (theory) from corpus data. In grounded theory cases are examined for similar outcomes and reviewed for common conditions to find causal factors. Data is *open-coded* in categories, concepts (nouns and verbs) and properties (adjectives and adverbs) and *axial coding* then relates these codes (categories and properties) into causal relationships: the *phenomena*, the *conditions*, the *context*, the *intervening conditions*, the *action strategies* and the *consequences*. Software tools help to organize the data and the process that is the first level of analysis in the development of the simulated narrative.

[1] British Columbia Persons Living With AIDS

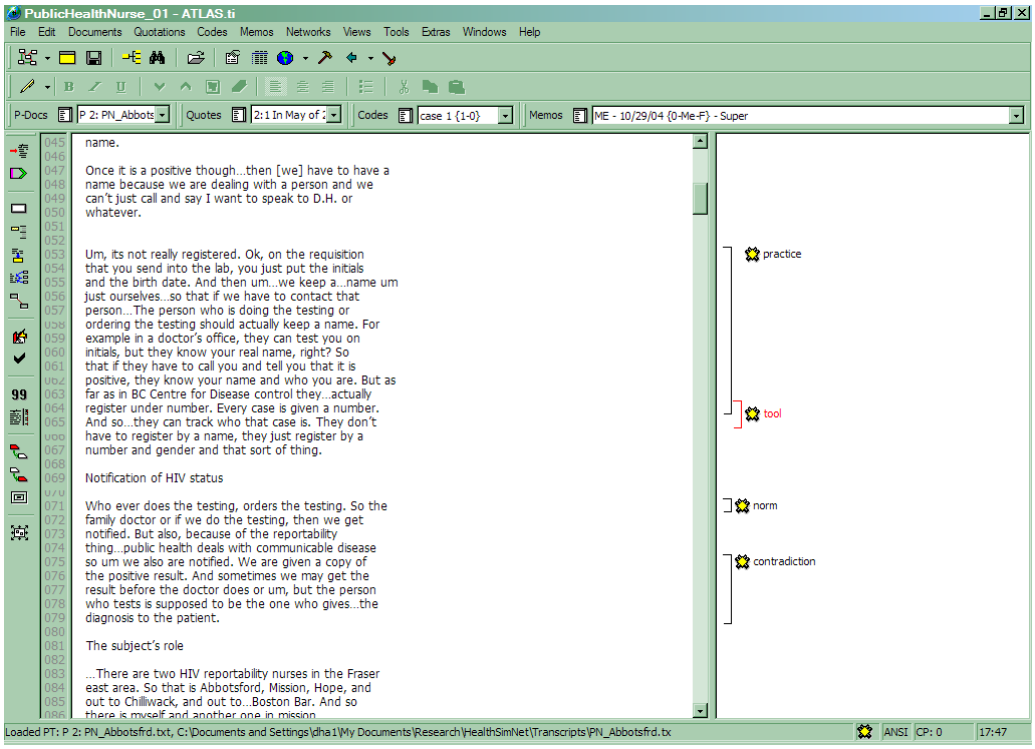

Figure 1. Hypothesis formation in ATLAS.ti

While stories are equally moving they are also diverse in their perspectives. One account detailed the organizational struggle with a legal system clearly intended to protect the interests of minors but that in effect temporarily prevented a public health nurse from taking care measures for a minor who had been sexually involved with a known carrier of the disease. Another account detailed experiences of coming upon HIV patients whose profiles were so unlike the characterizations of those *at risk* that they remained sick and went untreated while in the care system for many years. We heard reports that very large numbers of general family physicians have little knowledge at all about the disease. In rare cases patients had been given medications in error but the more prevalent issue was failure to recognize or diagnosing the disease. And we heard that many cultural groups, for example straight middle class women and men, are not so well taken care of in their emotional and psychological needs as those groups first identified as being at risk. We heard on several occasions of the power and affect of spiritual experiences on patients' wellbeing. In other situations churches were also criticized for taking judgmental attitudes to people with addiction problems who also are living with AIDS. The range and depth of stories collected helped us to realize we could never provide a comprehensive analysis of the network, but at the same time, the depth and complexity of experienced events encouraged us to continue to uncover as much of the activity system as possible.

Data at this point in the analysis can inform our understanding of the nature of interaction within the network. The hypotheses that emerge from the analysis are also crucial to the development of script-based interactive narrative for which there are several methods available to us.

THREE NARRATIVE STRUCTURES

In order to transform the analyzed data (phenomena) derived from interviews into interactive narrative we draw on approaches that offer a way to link causal fragments together. One such learning theory is *expansive learning* found in cultural historical activity theory [5, 11, 12] and can be used to picture the events and cases to illustrate activity [5, 13, 14]. This framework is fairly widely used to support collaborative learning in media development projects often linked by Vygotsky's ideas around the cumulative advantages from communication among individuals with different core skills and a much larger *group* **zone of proximal development** that arises as a consequence of collaborative learning.

Activity theory provides a way to understand how changes can take place in systems through the reciprocal and unified processes of *internalization* and *externalization*. Not unlike the model of tacit and explicit knowledge construction described by [15] Engestrom describes how internal thinking processes can be manifested externally to create new artifacts and social practices. The idea is that what drives change in systems are the contradictions and tensions between individuals and other socio-cultural influences and other activity systems. New systems are created by resolving those tensions creating a spiral process called *learning by expanding* [16].

> The essence of learning activity is production of objectively, societally new activity structures (including new objects, instruments, etc.) out of actions manifesting the inner contradictions of the preceding form of the activity in question. Learning activity is *mastery of expansion from actions to a new activity*. While traditional school going is essentially a subject producing activity and traditional science is essentially an instrument producing activity, learning activity is an *activity-producing activity*.

This conception of social engagement in activity has stimulated a series of investigative attempts to integrate CHAT (cultural historical activity theory) into various design projects. Mwanza [17] for example, created an eight step process for analyzing activity in workplaces based on the component parts of Engestrom's [11] model: subject, object, objective, tools, community of practice, roles and rules, followed by a review of contradictions and thematic tensions. In the K-12 area we find a prescription for designing cooperative (constructivist) learning environments based on activity theory [18]. They add to activity theory the idea *that procedure, routines*, *operation* and *action* are subcategories for activity. In fact, as might be expected from the focus on sequenced competences, their goal is to link activity structure with traditional instructional design and activity theory. In work concerned with the embedding of new medical diagnostic apparatus [19] activity theory is used to show how an innovation can be seen as culturally bound. They show the development of separate, potentially converging networks, during the process of recognizing need and the potential for new medical instrumentation to play a role in better practice. They say, the framework is valuable only when people start to analyze their work practices by using it, relate the abstract model to concrete facts about their everyday activity, give meanings to the elements and their relations and change their work, themselves.

Dobson *et al.* [13] showed case studies that illustrate three methodologically different ways that that CHAT was successfully used in design of learning technologies. We

showed how role descriptions in the target user activity group helped us to design the user trials while creating new software (that was incidentally designed for retrieving learning object data from a repository). We showed how the explicit consideration of roles helped manage operational meetings. And we showed how the discipline of considering activities in a large public space generated improvements both in re-designation of roles but also in the physical layout of installations within a public science centre.

In HEALTHSIMNET we are motivated by a goal shared with Sasha Barab who draws from both CHAT and actor-network theory [7, 20, 21] to build networks of temporal transitions through activities (shown as simple events at the nodes of a network). Their *action-relevant episodes* (ARE) as crucial part of our approach to this project both from analytical point of view, since the analysis grain size approximates to that of naturalistic inquiry [22] and because, as we show below, the ARE can be seen as a basic unit of action in narrative. This is important in producing a generative narrative. Action episodes each have complex antecedent conditions and probable outcomes and can occur only within parameters of regulatory norms or labor divisions and expected temporal patterns of interaction with people and instruments. For example, a family physician rejecting patient with HIV, on the grounds of insufficient expertise, can only do so *after* patient diagnosis). The next section explores how each of these approaches can be more formally described as plans and schema.

STORY TELLING COMPONENTS

The idea of games based on interactive narrative and story schema has noble roots in classical theories from Aristotle's *Poetics* onwards. Nowadays we can rely on detailed theories of narrative plot analysis [23, 24] that provide structures to help us understand the mechanisms and rules that seem to work in good fiction and documentary story telling. In artificial intelligence research the idea of a *script* that is partly controlled by a *plan* [25] is seen as a key component of intelligent human functioning both in simple and in non-recurrent complex situations [26]. These ideas lead to the idea of goal-based scenarios as an approach to designing interactive multimedia for learning [27]. The appearance of our story cases within the simulation is very similar to the goal-based scenario and the main contribution here is in the definition of a methodology for creating story components based on qualitative research methods.

Schema from **activity theory, grounded theory** and the **action-relevant episode** structure belong to a family of categorical structures which differ both, in the means by – and purposes for – which they are created, and, in their core ontologies. The categorizations also differ in the way they suggest state transformations and therefore how they may be linked together in chains to support story generation. In activity theory the basic unit of analysis is the eight-place array below (with relations omitted for space).

Activity Theory-System: {Subject; object; instrument; objective; rules; roles; COP; tensions}

A transition (or expansive learning event) is presented as the resolution of internal inconsistencies or tensions to produce a new different activity system. In the following example a tension arises when a nurse is prevented from achieving her object (to inform a person at risk and reduce epidemiological consequences) because the person is protected

by confidentiality regulation. A new system is invoked that involves two new system players (a social worker who is the legal guardian of the minor and the lawyer who is able to interpret the detail of the confidentially laws). The tensions of the old system are resolved with a modified ruling on confidentiality that forms a part of the new (and more *learned*) replacement system.

1. System[1]:{Subj[Nurse]; Objt[Inform infected patient partner]; Tools[telephone, local knowledge]; Objve[reduce public health risk, make treatment available]; Rules[protect confidentiality]; Roles[*nurse* finds/informs those at risk]; COP[medical system, patients & families]; T[rule of confidentiality vs. object]}

2. System[2] :{Subj[Nurse]; Objt[Inform infected patient partner]; Tools[telephone, local knowledge]; Objve[reduce public health risk, make treatment available]; Rules[protect confidentiality, **protect minors**]; Roles[*nurse:* finds/informs those at risk ***social worker*: guards minor*, medical health officer:* support nurses*, lawyers:* interpret rules**]; COP[medical system, patients & families]; T[tension resolved]}

This systematization can be compared with one that emerges from the research methodology of grounded theory development. As a consequence of analyzing qualitative data [9] tell us that **hypotheses** may be formed that consist of: the **phenomena** (a named experience determined from repeated patterns of events); the **conditions** of the phenomena that are the events or variables that create the situation and partly explain the existence of the phenomena; the **actions/interactions** which are routine responses made to those events; and, **consequences** which are the results of action/interactions or failure to respond to situations. These can be demonstrated in the following generalized schema.

GT-hypothesis: {phenomena; intervening conditions; action strategies; consequences}

This can be instantiated with a grounded theory about the phenomena of *mooted confidentiality* as follows.

1. GT-hypothesis: {**mooted confidentiality**; patients' right to privacy/management of public risk/social & personal stigmatization; CDC anonymity/PHN practices; appeal to higher authority/confidentiality mooted}

This states that while the roles and procedures of family nursing, public disease control and other professionals in HIV care generally assure the privacy of their clients, this confidentiality is mooted (and incomplete) when other principles (such as care or minors) are in conflict with it (which would lead to an appeal to a hierarchically ordered authority who may judge against confidentiality). The structure can generate interactive narrative by manipulating the intervening conditions (is the client a minor/involved with a minor) or the action strategies (the nurse breaks or questions the simple interpretation of practice codes) so as to lead to different outcomes.

This next method develops the action relevant episode and network [7]. This method is a projection of activity theory approaches but simplified to illustrate the actions of single players acting in episodes that are chained in ordinal sequences of single action types. Although derived from activity theory it focuses on the actor, the object and the instrument of action – that together form a node (ARE) – and are strung together to build networks. In our example we could take this following data (that is reconstructed from

interviews) to form a network that could be reused as the framework for a narrative simulation.

The model pays less attention to the resolution of tensions as the trigger force for narrative progress instead attends to the (less causally patterned) idea of ordinal stringing. This presents an easier but perhaps less obviously generative model. Because ARE does not capture the causal factors in behavior we cannot easily alter those variables to create new situations. The most valuable use of this model lies, we think, in monitoring the diffusion of a single practice or small set of practices through an apparently homogeneous group (some classroom experiences may necessarily be also designed around similar assumptions).

Network	*Role*	*Description*	*N*
	Mary PHN	Dr. Eisenstadt. Thanks for taking this call. You will recall Mr. Bolinger who came to us recently from your office. Well, it turns out his HIV test was positive. [*Reticent about the interaction*].	7
	Bob GP	Oh, goodness. Well that's a surprise. He looked pretty good when he was in here last week. [*He is feeling uncertain about not having ordered the test himself, writing on his pad to remind him to investigate with his own nurse receptionist*].	8
	Mary	Yes, but it does explain his health in the last year.	9

Figure 2. Dialog excerpt reconstructed from interview with chains of action relevant episodes

Yet another approach is to model the interactions of network participants using a simple social network analysis tool called TEAMVIEW. The representations of narrative data present several different views of the interactions in a story. They allow us to illustrate as well as create and manipulate several of the core patterns of interaction. The four windows below show (in clockwise direction) the main features of the tool using pieces of a script constructed within the HEALTHSIMNET project. The *message sequence chart* shows communication between participants over time allowing the content of any message to be expanded with the yellow pop-up window. The *sociogram* aggregates all messages within a story file and draws links between communicating participants. Arrowheads show both direction of communication as well as the relative magnitude of messages between each dyad. The reader sees a simple visual appreciation of the centrality of each player and an impression of disconnected dyads. The *meeting plot* draws a line in time between each player in the story and shows the passing of conversational control among the participants. We sometimes call this *the talking stick* representation. The final window is used for creating and recording stories from data. This allows us to create stories directly from a video sequence from data and to amend,

cut and paste the order of events within a story.

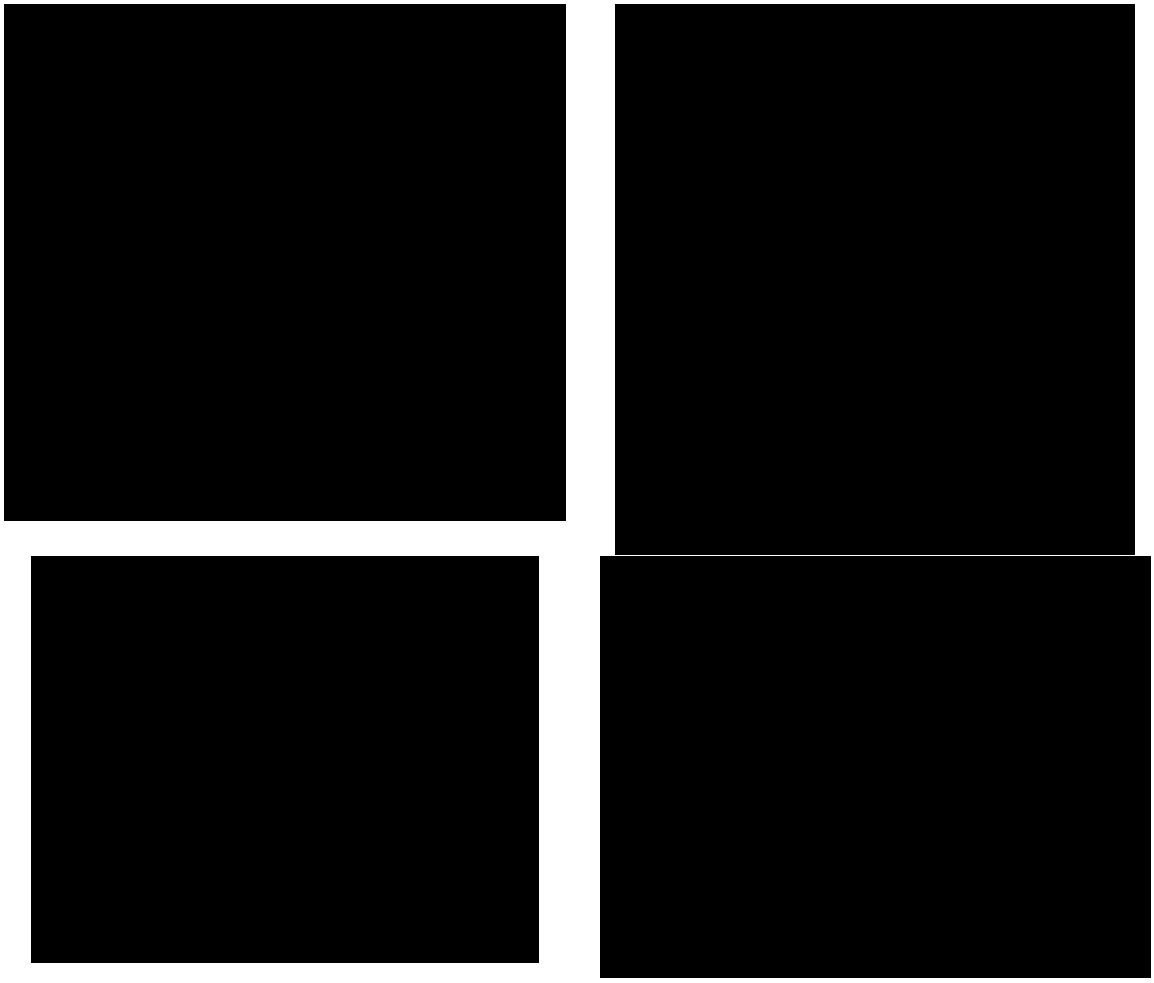

Figure 3. Showing representations of dialog interactions in message passing, sociogram, talking stick and input windows in TEAMVIEW analysis tool.

The results of these four analysis techniques are being used as basis for the design of an interactive narrative drawing on interactive narrative theory [23, 28] and schema theory [25, 26] but by using the story elements defined by the coding system above we will investigate the extent to which plot can be constructed by chaining events arising from tension resolutions in activity systems.

This work will take a simplified view of interactive narrative more concerned with the effect of plausible generated story lines on the user's learning experience than on the complex process of story understanding [29].

THE HEALTHSIMNET PROTOTYPE

The design of the HEALTHSIMNET prototype is then informed directly from the analysis of experiences accumulated during our interviews with network participants. We see this as a middle ground between the first-person narrative and the re-enactment or invented game. First person stories are a vital part of the power behind the development of understanding and episodic memory and may be particularly useful for the development of complex social skills [30]. The authenticity of the reproduced experience can be extremely clear when the full account provided by the author is available to the reader. Unfortunately, however, the possibilities for providing alternative plot constructions within the simulation are lessened as the grain size of the story fragment is increased. If we were to simply reproduce the stories as we recorded them from our first person interviews the outcomes of the simulation would be entirely predictable (although the learning outcomes are never so probable). In other approaches full stories are indexed for their instructional value and retrieved during the execution of a simulated practice environment based on rules that suggest they are relevant to the context of action [31]. In that system the simulation is separated from the story telling (which is used to prompt and advise the player). Case-based reasoning and narrative construction offer several opportunities for the design and implementation of narrative documentary games. In our first prototype of HEALTHSIMNET the stories appear only as reconstructed fragments in play that is constructed using a planning system from the simple schema above.

The situations presented within a scenario are illustrated to the player by means of a three dimensional isomorphic representation. Characters from story fragments are presented as fictitious personalities. The stories are played out by retrieving case structures from a database and applying rules to situations to allow the possible outcomes of player choices. Choices are made generally in dialog and by selecting one interaction over another.

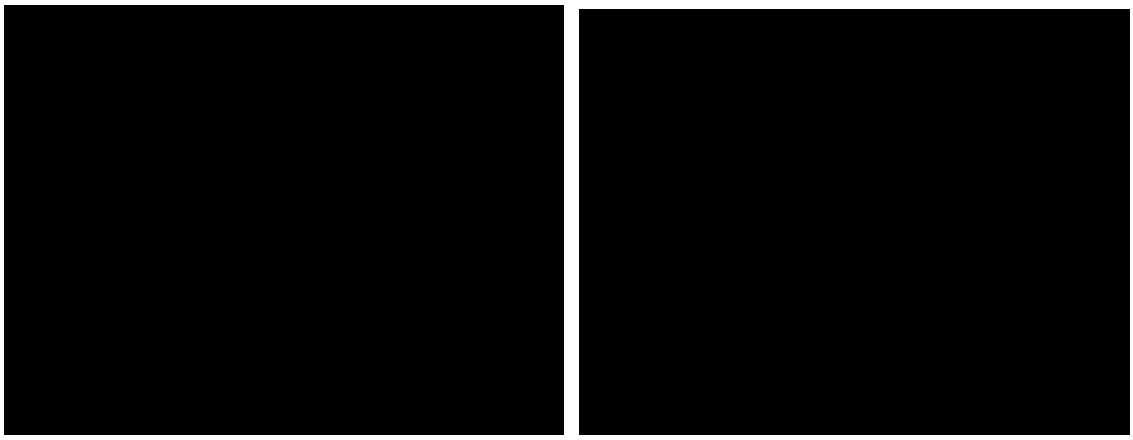

Figure 4. Screen shots from HEALTHSIMNET dialog and context selection.

The simulation is capable of producing behaviors that are both realistic and surprising for many of its users. For typical learners in training programs where protocols are reasonably well understood this kind of simulation presents a way to explore practice and to confront their own perceptions of best practice. We can call this phase of learning *exploratory*. The simulation creates an authentic and realistically complex environment for the typical professional learner.

The simulation can also in some ways be said to support a genuinely *expansive*

learning experience. Practices of course do not change instantly in all locations for all participants or even at a regular or predictable manner. Therefore activity systems that have been resolved in one place may remain unresolved in another for some time. This represents a phase that we could call *transitional* in which this kind of simulation can be useful for players to update their skills in a realistic and interesting way. Another phase we call *creative* exists when the simulation creates situations that have not yet occurred in practice (or have not been reported) but because the rules that generate the situations are realistic, could easily emerge. In this situation the new instrumentation, role reassignments or other ways in which the system may be altered, cannot be fully implemented prior to the simulated experience. In the *creative* phase we plan to use the simulation as the basis for stimulating discussion among representative users perhaps in a group seminar situation.

The framework for interaction is not without several serious design questions that remain to be resolved. The framework, which is based on an accumulation of many interacting rules that can be varied by altering the variables of antecedent conditions, can very quickly lead to an explosive combination of possible outcomes and undoubtedly leads to an unwieldy, if not potentially infinite set of outcomes, most of which are very unreasonable and unlikely. In the equivalent of going out of bounds in a game like SSX-Tricky, the vast majority of such possible outcomes in HEALTHSIMNET, result in a message that indicates the simulation cannot provide interaction in this area. In such events the player is replaced within a reasonable track of play.

Perhaps qualitative researchers will baulk at the methods that under pin our acquisition and development of experience cases. Many qualitative researchers take a rich and complex view of the role of the personal narrative in inquiry [32]. Our approach may not capture the subtlety of the role of story in the development of identity development presented [33]. Life threatening illnesses appear to challenge assumptions about temporal framing of people's lives and often lead to transformations in spirituality and of life priorities. The stories people tell themselves and that are created around them directly impact the possibility of increased self-understanding and insight, or instead, can lead to depression, despair and declining health. The stories in HEALTHSIMNET are deliberate attempts to create valid scripts based on objectively sound story turns. Sociology tells us the narrator of a personal story may take considerable latitude with their own stories, perhaps guided by consistency with factual events and circumstances, and can thereby have enormous affect on the outcome in their lives. This is a very powerful phenomena that is not suggested by the current simulation. Herein lies the possibility for a simulation that may be even more powerful than the expansive learning model shown here.

Such a design for a next generation simulation could explore this development of personal narrative in response to the challenge of life-threatening disease. This may be done both at the individual and social realms. Personal narratives have to negotiate information processed by the teller and also ready processed information offered by others. If a person's response to illness is key to the outcome, then the community in which the response is made is key to what qualifies as a reasonable narrative response. A second-generation simulation could show how choices made at both the cognitive and social realms can lead to different health outcomes.

CONCLUSION

This paper has given an overview of our work in the field of documentary learning games that is focused on the development of a design method which takes first-person interview data and creates from that an interactive learning narrative. We have briefly shown the creation of interactive dialog using four systematic approaches to data collection and analysis, 1) cultural historical activity theory, 2) grounded theory practice, 3) the action-relevent episode, and 4) the TEAMVIEW representations. The paper then describes the design of the HEALTHSIMNET prototype and reviews the extent to which truly *expansive* learning can be supported. The development of the simulation (and the analysis tools) will continue to deepen the reproducible detail for this method. The next phase of the research will investigate the use of the tool within an inter-professional post-graduate course designed around the care of HIV patients.

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