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From chaos towards sense: A Learner-centric Narrative Virtual Learning Space

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Abstract: Throughout educational settings there are a range of open-focused learning activities along with those that are much more closed and structured. The plethora of opportunities creates a confusing melee of opportunities for teachers as they attempt to create activities that will engage and motivate learners. In this chapter, we demonstrate a learner-centric narrative virtual learning space, where the unrestricted exploration is combined with mechanisms to monitor the student and provide indirect guidance through elements in the learning space. The instructional designer defines the scope of the story in which the teacher and learner create narratives (a sequence of actions and milestones to complete a given task), which can be compared, assessed, and awarded with badges and scores. The model is described using an example from Logistics; where incoming orders have to be fulfilled by finding the good and delivering it to a given location in a warehouse. Preliminary studies showed that the model is able to engage the learner, create an intrinsic motivation and therewith curiosity to drive the self-paced learning.

Keywords: storytelling, narratives, virtual worlds, gamification, automated assessment

INTRODUCTION

Stories are one of the oldest means of passing on information and experiences to others. Storytellers combine words with gestures and expressions, creating illusions, using intonation to build up suspense to finally reach full immersion in the narrative. Storytelling is art; the canvas being the mind and the words the crayons to draw the picture. Storytelling is connective; it requires an audience with whom we can share. Storytelling is creative; we hear words and sounds, see gestures and expressions, but we also combine these shared impressions with our personal experience, understanding, and knowledge to our very individual story. Storytelling is an effective mean to convey "information in a compelling and memorable way" (Neal, 2001) and the "original form of teaching" (Pederson, 1995). "It's our desire to still employ the mood and storytelling tools inherited from film and theatre" (Björke, 2003). Similar to the film industry, instructional designers have to adopt and use the technology in the way it is designed; not enforcing old beliefs and thoughts and methods on it. The narrative has to be sculpted and designed specifically to express the narrative in its environment.

Yet we have to ask ourselves if story telling is teaching? Are teachers story tellers? With all due respect to the numerous teachers worldwide and their never-ending effort to transform the classroom into a learning space full of stories and adventures, we can see that they are often not. The classroom is just a space, the story "provides relevance and meaning to the experience. It provides context" (Kapp, 2012; p.41). Instead, the system that these teachers work within is seemingly more concerned with the continuous equalisation of courses world-wide; predefining years ahead what has to be taught, which text book is to be used, and how the learners have to

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demonstrate the *successful* transfer to their heads; being assessed in uniform tests at times most convenient for the institutions; at least if we assume to be trapped on the lower levels of Blooms taxonomy (Bloom, 1956). While stories are still told by engaged teachers, the systems that they work within have forgotten to include the audience of the stories. We expect that all canvases show the same picture, not guiding the audience through the story but dictating what is important and how to interpret it. With no intention for discussion; we shall emphasise the governmental and administrative drag towards programs like "No Child Left Behind" or strict uniformity and comparability in undergraduate and master programs to simplify the transfer process between educational institutions and smoothen the transition to the working place (Noddings, 2007). Teaching and learning is not about the laziest way, but the best way to engage the learner in understanding and critical thinking (Friedman, 2005); one of the primary concerns for educators to achieve (Boyle-Baise & Goodman, 2009).

The endemic passivity within classrooms is disturbed by giving the listener the power of influencing the storyline by being asked to make decisions at key points. An example is the role playing game 'Dungeons & Dragons', in which a group of characters (each controlled by one player) undergo an adventure in a fantasy context. A storyteller (Dungeon Master) is responsible to pursue the story, play different roles in the story, and challenge the players with tasks like fighting, entering dungeons, or seeking treasures. The dungeon master is capable of controlling the story in any direction; being both the master of the scope and the given objectives. The lecturer can do the same in a classroom; can allow learners to explore the learning space without restrictions, yet having selected activities to provide a scope to keep learners on track. The supervisor or manager in an industrial context can monitor employees' activities to achieve the objectives, and just gently (or with a brusque attitude!) provides them with guidance to ensure that activities are finished on time; so that employees' efforts are not wasted.

The storytelling becomes more complex if we extract the storyteller; the component with the most direct influence on the learner (Bauman & Briggs, 1990). Learners may not attend a classroom session but engage in a self-paced learning process; e.g., learning in a distance educational environment (Gregory et al., in press; Moore & Anderson, 2012). The basic but often used model is to merely provide (or 'dump') all materials within a learning management system with some general instructions to proceed and succeed in assessments and examinations. The environment, in this case a rather unattractive and limited one, becomes the story teller, with the learner doing the journeying as an influencing participant in the story (Danilicheva et al., 2009). A different kind of environment can be found in games, where the focus is on storytelling and the learning process is woven into the story itself. Compared to the first generation of computer games, modern games embed massive stories to feed the player with background information for an extended immersion (Kapp, 2012). An interesting example is the open world that the company RockStar created with the critically acclaimed GTA-series (Grand Theft Auto¹). The environment is designed to be fully explored by the player, while the main storyline is blended into the normal *life* within the city; e.g., characters walk on the street unsuspectingly interacting with other non-player characters (NPC). The player is reminded in different ways, however, that there is a main task to accomplish. This can be as subtle as a reminder message from a NPC up to a more immediate 'drag' towards the original story and main objectives. In other games, such impetus can be provided through the inclusion of timers, or changes within the landscape and environment that progressively restrict the range of actions that the player is able to take, forcing them by default to complete the required tasks as there is nothing else to do!

What can educators and instructional designers learn from these game-based examples? Simply this: it is not enough to merely create a narrative; the scope of the narrative must be suitably wide for learners to engage a sense of curiosity and develop intrinsic motivation for learning, while being limited to enable the instructor to ensure completion of learning objectives and course outcomes. It is relevant to track the learner and match its path against the expected narrative as designed by the instructional designer in the role of a game master (Broussard, 2012). It is not required to match the given narrative exactly but 1) the objectives has to be fulfilled; 2) extra actions need to have a (learning) benefit (e.g. sitting on a chair vs. studying the manual of a vehicle to be

¹ <http://www.rockstargames.com/grandtheftauto>

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used); 3) key actions have to be performed (in the right order) (e.g. entering data in the system to keep a protocol); and 4) a score has to be calculated based on the actions done and expected.

In this chapter, we reflect on how the concept of stories and learner-centric narratives can be used to design a learning space in the domain of operations and supply chain management. In the following section, we discuss the terminology regarding narratives and stories as used in the literature and investigate current trends regarding how to increase engagement and motivation of learners within a defined learning space. We continue with a brief description of the processes in a warehouse to fulfil orders. The example is used to explain how an instructional designer can use the story to create potential narratives to guide the learner towards the learning objectives, how the learning process can be analysed, and how gamification elements can trigger the curiosity of the learner. The focus in all chapters is in logistics and supply chain. The chapter is concluded with an outlook on how the learning space will evolve and contribute new ways of immersing the learner in the future.

BACKGROUND

This section depicts the terminology used to describe the stories and narratives; terms that are commonly used in the literature whereas we slightly adjust them with respect to virtual environments and gamification. Figure 1 further visualises the relations between the terms to support a wider understanding. The term *story* as used in the beginning of the chapter sets the overall scope and constraints of what to cover and what to exclude during the story telling (also called a bounded learning (purpose) or action (interactive) space). The story is the *setting* in which the *actors* will *live* their very unique narrative(s); including all required properties and elements. In the above example of the Dungeon & Dragons, the story is the box with all parts to play the game; i.e. the objectives and charts to describe the behaviour of possible enemies on the yet untold/unformed/unmodelled journey. The story is told by *narratives*; unique paths through the story which also enliven the story and "unfold in space" (Nitsche & Thomas, 2003). The story itself is designed by someone in the role of an instructional designer; with narratives being created by the teacher (expert-knowledge-based design of model answer as well as suggestions how to traverse the story; defining *milestones* as a sequence of actions in the scenario, with a high level of continuity between one portion of the scenario and another) and the learner (guided by the teacher's narrative but forming its own perception and awareness around it). This provides structure for a teacher to meet assessable *learning objectives*, but also the flexibility which encourages motivation and volition in learning. From a technical perspective, we consider both narratives (teacher and learner) to be the same; whereas one objective in the learning process might be the alignment of both narratives (see also the final discussion in Section "Story, Scenario, and the Gamified Nudge". Narratives support the process of understanding and building cognitive structures (Riedle & Young, 2003; Bruner, 1990). Interactions in a 3D virtual world already provide an engaging environment to have stories and narratives resulting from the activities and interactions of avatars in this space. Narratives are either pre-scripted (ready to reveal their sequences of milestones and activities over and over again), or use exploration and goal-oriented triggers to multiply the possible narratives that learners can indirectly choose from; e.g. GTA which was mentioned above as an example.

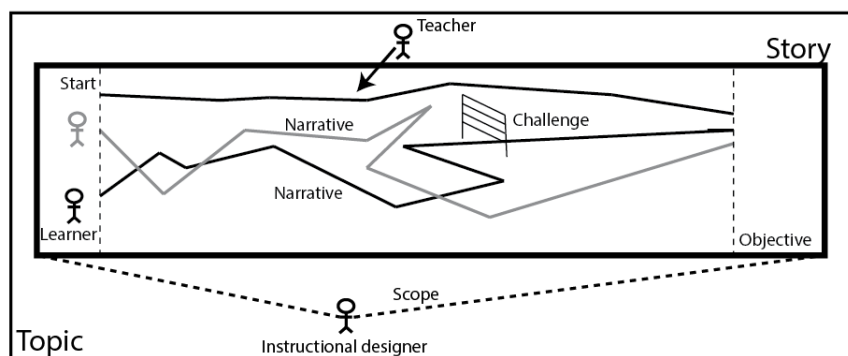


Figure 1: Visualisation of Story and Narrative.

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Danilicheva et al. (2009) distinguish plot-based storytelling (narrative being created by the teacher to be followed by the learner) and character-based storytelling (narrative is dynamically created by the interaction of the learner with the environment and intelligent computer-controlled avatars). Nitsche and Thomas (2003) use the term *Story Map*: the learner explores the virtual environment and maps the space and the story as part of this process. The story is tied to the navigation in the space (Murray, 1997) rather than predefined and orchestrated by the teacher. Recorded actions during the learning process can be seen as dynamic narratives being developed while moving in the (learner-centric) bounded learning space. Having a restricted virtual space using avatars has the benefit of having comprehensive recordings of all actions and situations. These memories can be static and consist of different sequences of actions, images, or statistics; or dynamic by recorded movies; so called Machinima. And all recorded memories are also memories for the learner; remembering and reflecting the past. Kapp (2012) lists four key elements for a vicarious experience, which are implemented in the described environment below. That is characters (actors; i.e. learners), plot (story and narratives), tension (milestones with feedback on achievement), and solutions (assessable learning objectives).

The virtual storytelling requires an interface between the learner and the learning space (Spierling, 2002). As mentioned above, we decided to have the story being embedded in the environment without a real-life storyteller or human-controlled avatar. 3D virtual environments are able to immerse the learner by projecting the learning material in a learning space that is as close to the real world as possible, as all interactions are mapped "as natural as personal contact" (Danilicheva et al., 2009) with the environment; minus the real-world risks and safety concerns. The current deficit lies in the control through keyboard and mouse and is a major concern for the realism; yet current and future technology is changing the human-computer-interaction dramatically; see for example Oculus Rift², Google Glass³, and the upcoming Kinect⁴ or Leap Motion⁵. Another technology is so called bots or virtual (intelligent actors): computer-controlled avatars with different stages of artificial intelligence regarding interactivity or capability to become a completely autonomous storyteller. Bots can be used to increase the authenticity, the reality; providing interactive elements in the story and guiding the learner through dialogues or hints. The challenge is to make the learner believe that the virtual actor is real and not just an animated script. That is, providing an illusion of realism (Perlin, 2003). As the scope of the chapter is on narratives, we refer to Reiners et al. (2013) and Wood & Reiners (2013) for further discussions and examples.

Figure 2 shows a story. The setting is a small warehouse with just three shelves to stock different goods on pallets or in barrels. Through the door, the learner can see a straddle carrier moving a container to a container bridge; implying that the warehouse is located on a container terminal. Right outside is a ute vehicle. In addition, there are three forklifts that look very similar and also an improvised table with a notebook. The audio is consisting of general noises; e.g. engines outside of the warehouse, beeping to indicate vehicles going in reverse and voices giving some orders to others. The learner is placed in the warehouse near the computer.

² <http://www.oculusvr.com>

³ <http://www.google.com/glass/start>

⁴ <http://www.xbox.com/kinect>

⁵ <https://www.leapmotion.com>

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Figure 2: 3D visualisation of the story "Warehouse".

The designer of the story decides on the degree of freedom given to the learner. Passive story telling implies that the teacher is defining a narrative that has to be followed step by step. The learner becomes an observer, not being able to influence the path, speed, stop, or detours to other areas of interest. The other extreme is an open world, with no limitation how to continue the narrative; allowing the learner to get lost in irrelevant parts of the story. In the example shown in Figure 1, the passive story telling implies that each step to do to fulfil the orders is pre-orchestrated and just presented to the learner. This learning approach has the disadvantage that it is not about understanding but following instructions step by step. The other extreme is that the learner is just getting the orders in a random order and has to fulfil them without any further help. This requires the students to understand the story and how elements can be used to achieve the learning outcome. There is no support besides a final (formative) feedback when the outcome is achieved. An intermediate approach is about the learner starting its own narrative to progress through the story, but being tight to a **narrative rubber-band** to define a maximum range for explorative action (e.g. time or distance) before we nudge the learner back to an intended goal-oriented narrative. Suitable feedback mechanisms create learning opportunities through reflection. Motivation of the student is enhanced with 'open' elements that are constrained/ bounded by the story design. Completing a narrative with required skill means completion to a required level of mastery (e.g., with a suitably low level of mistakes), on time (e.g., within a suitable length of time). Many academics can recall particular PhD students who suffered from 'globalitis' or the desire to address a large range of materials in their dissertation. However, most supervisors at this point try to gently guide the students to restrict their scope. This is to ensure that the project is workable, can be completed within a defined time period, and is largely achievable given the student's capabilities and resources. In much the same way, any student or actor in a system can have their activities gently guided back on track, ensuring that their progress is ultimately moving them in one direction, towards what it is that they define as success. Here, we should focus on the soft and gentle hints to motivate them. This can be completed with fewer hints near the conclusion (on higher levels); these hints can also be adaptive and used to drag them back on track.

Learning should not be about memorising; it should be about engaging, being immersed, in the learning process. The first question a teacher must answer is how to ignite the intrinsic motivation, build up tension and make the learners curious to explore the learning space; yet to provide an environment with a safety net and support to handle every possible situation. Detaching the real learner from the environment is a very first step as all risk is projected to the avatar. The next step is about embedding elements to invoke fun and passion for the learner (Reiners & Wood, 2013) and to trigger curiosity in exploring the learning space in a self-paced learning process. In our research, we focus on *curiosity*, *gamification*, and *guidance*; among other objectives like authenticity and technology (Reiners et al., 2012).

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Curiosity is driven by freedom to move around. The "virtual door" to move to the next scenario opens only when the learner has achieved the learning objectives for the present scenario (i.e., completed the sequence of actions in order). Learners should be provided with scaffolding for learning but also with the opportunity to engage in other, related, activities as long as these support the attainment of the predefined learning objectives. (Note: there are ways of modelling this and determining whether a learner's activities are within scope of the narrative or outside the scope; however, this is not the focus of the chapter.)

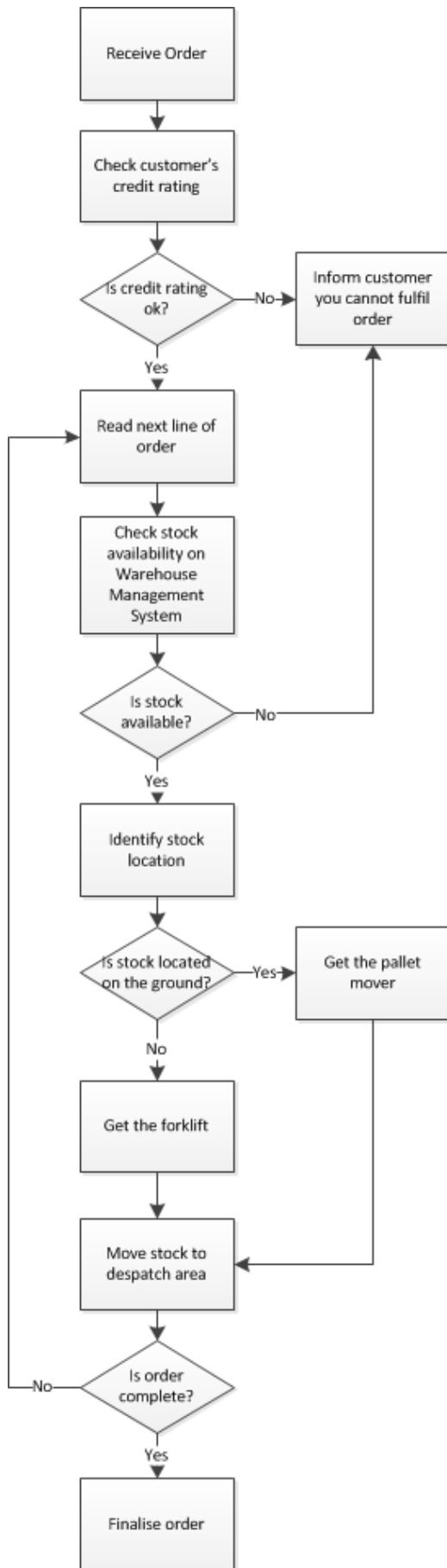
Many of the outcomes of games are desired in a gamified system and this is driven by gamification being "the use of game design elements in non-game contexts" (Deterding, 2011, p. 10) with the explicit intention of creating a fun-filled, playful environment to encourage passionate engagement by users. This is done by taking a page out of the game-designer's handbook and adopting "the *motivational properties* of games and layers them on top of other learning activities, integrating the human desire to communicate and share accomplishment with goal-setting to direct the attention of learners and motivate them to action" (Landers & Callan, 2011, p. 421, emphasis added). This clarifies that an activity is not turned into a game; it retains its core essence as a learning activity. Instead, other motivating game-based elements are 'layered' or scaffolded around the activity. A careful configuration of varying combinations of *building blocks* creates these layers of gamification onto regular processes. These concepts lead to a range of interchangeable terms that are used synonymously, primarily "*behavioral games, funware, applied gaming, productivity games, the game layer of a process, or playful design*" (Deterding, 2011). At present, gamification is the term that appears to be gaining the most traction in the media and publications. Why is gamification and gaming so appealing to learners? In a nutshell: Humans love puzzles and finding solutions to challenges, want to pass obstacles and feel the joy of winning (Hokkanen, 2009). And people may gamify the world every day by making their daily drive to work more enjoyable; imagining the story of other travellers, counting green lights in a row, doing a countdown for the traffic light turning green again, guessing if colleagues are already in, etc.

Gamification includes, for example, multiple recordings, rewinds, point scoring. It differs from the 'regular' gamified system which is extremely linear or 'fixed'; it provides an open yet bounded space for learning. The importance is that a user can deviate somewhat in this open space before the designed boundaries 'nudge' them back on track for completion of learning objectives. As long as the outcome is achieved, the specifics of 'how' this is achieved are less relevant, although in this case it is specified (as it is part of a course or lecture) but the students don't need to do this religiously as though they were actually employed in the job at present. Scores can be completion times (which can be improved in multiple attempts); getting killed or making fatal mistakes removes points or increases the completion time. It is important to emphasise that the combination of virtual environments and gamification provides a further advantage for the learner: failure. In games, failing is encouraged by the designer as the continuous replay of certain parts trains to become better. Players are motivated to repeat situations over and over just to figure out the right solution and try to improve in the score (McGonigal, 2011). Fujimoto (2012) reports, that the failure rate in some games is about 80%; by which the player is even more engaged to invest more energy to master the current task.

Most gamification solutions tend towards a points-, badges-, and leaderboard-based approach; this can easily be added to existing applications. In theory, it can promote a competitive atmosphere, full of rivalry, as users compete to outdo one another. In practice, such an approach can produce stunningly negative dynamics, as unintended consequences spring forth from the thoughtless application. Consider the situation where you recently joined the learning space. You see that there are some well-recognised users, with very competitive scores and a collection of badges that would make a boy scout green with envy. While this inspires some users, it can prove to be a complete turn-off for others. In this chapter, we limit the gamification of the learning space to badges, scores, and a leaderboard; yet elaborate further mechanics in the conclusion as suggested by Reiners and Wood (2013).

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Ultimately, the overall storyline or sequence of activities takes a participant from the start to the conclusion (objective) of an activity and this sequence can be altered somewhat; however, due to the often sequential or hierarchical nature of activities required to generate an outcome, there is frequently a limit to the amount of flexibility and how these activities are undertaken. Therefore, there must be some observer, or system controller, who is able to monitor and observe the user activities, compare these to what should be undertaken, and then gently nudge so that desired outcomes are attained. The observer does not have to be a human being and does not have to be visible by the players.

STORY: A DAY IN THE WAREHOUSE

A simple business process, fundamental to effective supply chain and business management, is the order fulfilment process. The flow of materials through the supply chain is connected by this process, which shakes materials from one firm and gets them moving to another. It can be completed by a single person with reference to others, or through a computer system providing access to required data. In a given small warehouse, a store person may be required to receive an order, check inventory level, physically collect and assemble constituent parts or materials, and package for despatch. Figure 3 provides an overview of the action-based, complete sequence of actions in the proper order.

1. Receive order. The skills, the specific actions required in order, are: check computer (to see if there is a new order or in response to an audio notification of an order receipt). The main focus here is being aware that orders come in and how to obtain the order. The specific action is to move to the computer and access the 'order receipt' screen.

2. Check credit rating of the customer. If their credit rating is not adequate, inform the customer that you cannot fulfil the order. If their credit rating is good continue to the next step.

3. Read the next line of the order and begin to process the order.

4. Check stock level, ensuring there is suitable stock for the order. If there is inadequate stock, inform that customer that you cannot fulfil the order. If there is adequate stock, continue to process the order.

5. Identify stock location. This may be done from memory after working through the scenario a couple of times or it may be done by visually sighting the stock location. If the stock is located on the ground, it will be necessary to locate and use the pallet mover. If the stock is not located on the ground (i.e., it is higher up on a

Figure 3: The process of order fulfilment

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rack) then a forklift must be located and used. When the moving equipment is in place, continue process.

6. Move stock to the despatch area. When this has been done, check whether the order is complete. If it is not, return to step 3 and check the next line on the order. If it is complete, continue to finalise the order.

Each of these actions must be completed in sequence. A user is not able to complete the work by going to a random location and taking items to the despatch area. The correct items must be located and brought to the correct area (the despatch area). Even with this basic sequence of activities it becomes immediately apparent that there are improvements that can be made. There may be five different items on the order and while the first four are in stock, the final item may be out of stock. In this case, if the user has completed this sequence of actions they will have completed a number of steps before this becomes apparent. A learning lesson here for the student is to consider their activities. In this case, it may be wise to see whether all of the items are available in stock, before wasting time moving around the warehouse for the first time (NB: some warehouses are large!).

Thus, there are limits and boundaries included by the virtual environment place which restrict the learners' movements and actions, while within these structures the learner has freedom to work with certain actions, even while these may be in the wrong order to complete the scenario immediately.

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STORY, SCENARIO, AND THE GAMIFIED NUDGE

The learning space with its boundaries and elements is used in the exploration by the learner. The instructional designer maps the anticipated learning outcomes to real-world objects and their attributes. Regarding the previous example, the boundaries are given by the surrounding warehouse and the assumed constraints of not being able to move objects outside for a certain distance; including the learner. The objects are communication devices (computers), shelves, equipment to move objects, products, and some representation for a delivery region. In the example shown in Figure 2, we use the ute vehicle as the location to deliver the goods to; other options would be a packaging machine, despatch area, or new location in the shelves.

A sequence of scenarios can be created; each scenario having multiple narratives representing an expert solution as specified by the teacher. The first option would be a highly scaffolded approach, where the narratives are constrained and allow for only little flexibility for the learner to achieve the objectives. This would focus on understanding basic tasks for completing the learning objectives. Later narratives are less regulated and consist only of the learning objective. This provides the learner with the opportunity to explore new methods of addressing the problems and exercise their creativity in how to structure some actions to achieve desired outcomes more quickly. In the following example, we use an approach with a maximum flexibility for the learner in the beginning; allowing the exploration of the learning space and experimentation with the given elements. Implemented triggers observe the activities at certain key areas and provide the necessary nudge to ensure that the student stays focused on the learning objectives.

Depending on the granularity of the scenario, the teacher is building a possible sequence of tasks and actions to achieve the learning objectives (narrative of the scenario). Tasks describe an activity on a higher conceptual level than actions and allow the learner to perform in their own chosen way. One possible task is the transport of a pallet of products, which can be done by using a forklift or by carrying each item by itself. Both means of transport come to the same final constellation in the warehouse (pallet is moved), but one is more time consuming and is not taking advantage of previous investment in technology like the forklift. Figure 4 shows a possible narrative for the learning objective "fulfil the next order". The narrative contains of 4 milestones (1: read, interpret, and understand order on computer; 2: chose the best matching forklift or palette mover; 3: by go to the correct shelf and load the right good; and 4: load the good on the ute). The milestones are linked by tasks as an expert would perform them. In addition, triggers are defined to evaluate the correct behaviour (T0: general trigger to check on security equipment and fulfilling the constraints, e.g. driving speed; T1: check on the correct selection of forklift as one of them is too weak and one is too large; T2: check on the right manoeuvre to pass the gate, e.g. slowing down and looking for cross traffic before leaving the warehouse. This narrative is used to evaluate the activities being observed from the learners during the learning process.

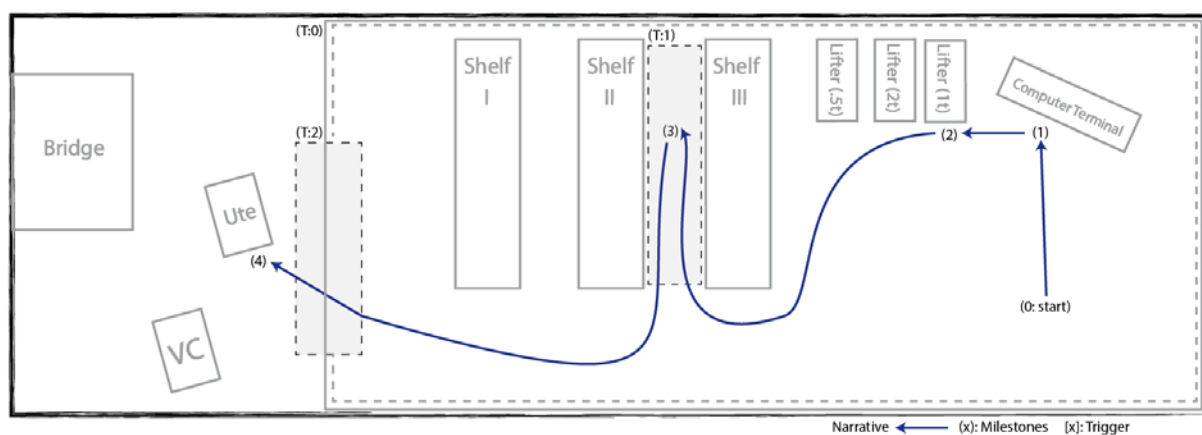


Figure 4: Story and the model narrative of the teacher.

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Note that scaffolded narratives can include further activities or actions (being a short (atomic) activity). For example, instead of just enforcing the usage of a specific forklift, the learner has to do a safety check before operating it. Tasks and actions are associated with competencies and skills; yet we focus in this chapter on the milestones and derived assumptions about what happened in-between; see also Fardinpour et al. (under review) for discussion how to record, analyse, and assess actions using action taxonomies.

Before starting the narrative, the learner is given a general briefing about the story; yet the details of how to proceed may stay unrevealed and need to be explored. The scenario includes objects for which the learner either has the corresponding skills (accessing a computer and receiving the latest order) or can achieve it within the setting of the story (calling the boss to ask about access to the computer). The exploration of the learning space is intended to be unrestricted in the following example; as illustrated Figure 5.

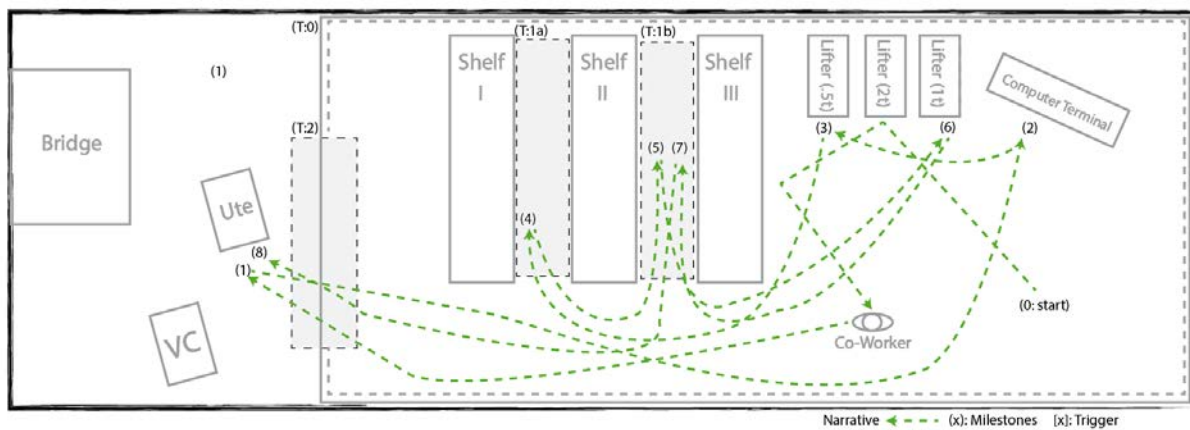


Figure 5: One possible narrative of a learner in the learning space

Figure 5 visualises the narrative of a learner in the learning space. There are several observations that distinguish this narrative from the narrative done by the expert. Note, that the following description includes the reactions from the system based the area and passed trigger:

1. Without any hint about what has to be done, the learner explores the space; i.e. looking at the vehicle and talking to a co-worker. Here, the learner did not ask questions and therefore did not receive any hints. By leaving the warehouse, the learner activated trigger T2; providing the first nudge back towards the learning objective. That is, the driver of the ute is asking about his order and when it is getting ready (the need for the driver to leave adds so-far not known time restrictions to the task). If the learner continues to walk away from the warehouse, the driver can start shouting to underline the importance of getting the order.
Having interactive bots in the scenario can engage curiosity; causing the learner to ask questions about the order; which then results in an answer like "Sorry, I am just the driver, but my boss emailed you today". The answer does not present the final solution but pushes the learner towards the computer in the warehouse. Repetitively questioning could result in the driver calling the boss to get further information about the order; which is then displayed to the learner.
2. Knowing about the order, the learner walks back to the computer to find out more details. Even though the order is displayed, the system is not capable of verifying if all information is read and understood by the learner.
3. The learner picks a forklift; thus seem to have understood that the order cannot be retrieved otherwise. The forklifts are marked with their maximum weight, indicating that the selection has to be based on some criteria.

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4. The learner activates trigger T1a; which verifies if the current order is in the associated aisle. In this example, this is not the case and the system displays the order marking the position in the warehouse, thus showing the learner important features of an order as well as guiding the learner to the correct shelf.
5. The next activated trigger is T1b; verifying the right shelf but the wrong forklift as the order is weighs more than the allowed 0.5t carrying load of the forklift. Again, the system displays the order, indicating the information about the weight. The learner has to drive back and chose another forklift with the correct attributes. Note that there are no triggers for the forklifts as the selection itself is not *wrong* as long as it is not used for a specific task.
6. The next activated trigger is T1b; this time the shelf and the forklift match the order and the order can be loaded on the forklift. Note that this process depends on how the scenario is designed and if the exact operation of the forklift is part of the learning process. Otherwise, the learner is offered an option to automate this part.
7. The final activity is the transport of the order to the ute; successfully finishing this narrative.

Successful is relative and represented by different gamification components; i.e. scores and badges. The score could be time based, thus a small score would indicate a better (more efficient) performance; the badges are received for doing something special like selecting the right vehicle after reading the order or by staying below a certain distance to fulfil the order. Even though this summative feedback is generally motivating in games causing players to repeat the level until the lowest known score is beaten, we target for formative feedback to support the process of understanding the scenario. To do this, we analyse the recorded narrative (milestones) of the users and compare it to the narrative of the expert.

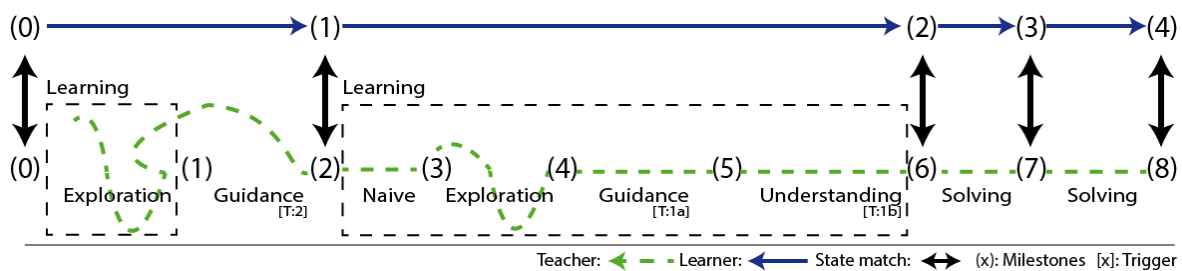


Figure 6: Alignment and matching of two narratives based on their milestones. Note that the distance between the milestones does not reflect the time needed to achieve them.

In Figure 6, both narratives are aligned by their milestones. That is start (0), reading the order at the computer (1), choosing the correct forklift (2), find the shelf that contains the order (3), and delivery to the ute (4). From a technical perspective, milestones are recorded when a trigger is activated (leaving the warehouse), the state of an object changes (communicating with the ute driver, using a forklift), or a specific area is reached. For each milestone, the state of the learning space is recorded; i.e. the position of all avatars and objects to calculate a delta and making assumption of activities; e.g. the learner moved objects, experienced the driving of the vehicles, or talked to other avatars. To reduce the amount of data, we do not keep close records for all objects but of the learners themselves (positions and executes actions). Unfortunately, it is impossible to observe activities in the real world (looking up information in a book) or learn more about the decision-making process rather than analysing the resulting activity. In this example, the system is able to interpret a learner's narrative in the following way:

1. Activity between milestone 0 and 1 [0-1]: The only observed change in the scenario was the position of the learner as well as the walked distance. Furthermore, the activation of trigger T2 conflicts with the teacher's milestone 1, indicating that the learner is not on the expected learning path. The trigger T2 is associated with the ute driver, thus starting the communication including some hints on how to proceed. This activity can be associated with *exploration* and *learning* about the scenario.

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2. [1-2]: The next milestones matches the expectations; thus the hints by the driver worked and the learner was guided back to the expected narrative.
3. [2-3]: The next milestone is created when the learner selects a forklift. Based on the expected selection according to the teacher narrative (using the 1t forklift rather than the 0.5t version), it is feasible to assume that the learner either did not read/understood the order or did not verify the specification of the forklifts (naïve selection).
4. [3-4]: The activation of trigger T1a and the driven distance indicates another *exploration* of the learning space; trying to find the location of the order. It is feasible to assume that the learner did not read/understand the position information on the order or does not know how to identify the shelf number.
5. [4-5]: The activation of trigger T1a (Milestone 4) resulted in some *guidance*; e.g. explaining where to find the correct position. Arriving at the right position (Milestone 5) activates trigger T1b, which verifies the correct position but the wrong forklift; as the 0.5t version would flip over if loaded with the heavier order.
6. [5-6]: As the immediately following milestone matches the expected milestone on the teacher's narrative (after some guidance in the previous activity), including the selection of a new vehicle; we can assume that the learner understood what was wrong and what should be the next step to achieve the learning objectives. Note that the learning objectives were never directly stated but only hinted at the driver or visible by the incoming order on the computer.
7. [6-7][7-8]: The match between the milestones on both narratives indicates that the learner understood the learning objectives and is in the process of solving the learning activities.

The desired outcomes of the scenario are those elements that must be accomplished for a 'successful' outcome for the learner. This is often tied to 'learning outcomes' in education. Within this remit there are certain things a student must undertake, while other activities are optional, or the space between doing one activity and another is elastic, so that one activity must not necessarily follow from the other. The described story telling approach and the usage of comparative narratives promotes an authentic learning process.

The described understanding of how narratives can be embedded in a story has several advantages:

- The story is an ideal framework for gamification and can be embedded in multiple places without being immediately visible to the learner. The guidance can be done via virtual actors which respond to different situations. For example, if the learner leaves the warehouse (noticed by triggers), the ute driver asks for the current status of the order but starts to complain when it takes longer and longer to actually deliver the good. Another time-based event could be virtual phone calls by a supervisor asking how the work is coming along (and reacting accordingly to the answer of the learner), announcements through speakers, or colleagues explaining why and how the job has to be done. If all works well, the learner can receive badges (summative feedback) or advices on how to improve the next time (formative feedback). Time itself represents a score which the learner has to maximise to achieve leadership on a score board; e.g. a counter ticking down to represent the time when the ute driver has to leave.
- Milestones represent the states of the learning space. In this model, we are not directly observing every single activity of the learner but allow for a maximum of freedom to make a decision. Preliminary studies showed that the delta of two states is sufficient to deduce an assumption of the major process that was done. The learning space is focused on the achievement of learning goals, not necessarily the tasks themselves. As mentioned before, we consider failure as a critical component of the learning process. The learner is encouraged to find the best solution (most likely the narrative of the teacher) as this will be the one with the highest score as it is using the resources efficiently. Note that the score can also punish usage of extra material (fuel, electricity), damage (forklift is used with too heavy goods), or not finishing milestones (e.g. randomly picking a good and delivering it to the ute; without finding out what the order was).
- There is an opportunity to provide formative assessment according to the milestones; being fulfilled, missed, or not in the expected sequence. Placed triggers in the learning space provide sufficient insight into the learning process; i.e. if the milestones on the learner narrative can be compared to the narrative given by the

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teacher. Rather than feeding the knowledge to learners, the learner is guided from one milestone to the next; having a free choice of how to gain the knowledge. Most important in such learning spaces are methods to identify the need for help; e.g. based on time or "distance" to an expected outcome. Distance could be measured in the number of object states that do not match the expectation; e.g. too many pallets were moved to fulfil the order.

CONCLUSION

Teachers need to focus on the provision of skills and knowledge, yet this requires significant design capability. We present the learner-centric bounded learning space, structuring the approach to create an interactive and layered series of narratives within a story. While the tools are forthcoming to achieve this in a simplified manner, here we present an overview of how these tools work and can be used to create environments that are designed to motivate through developing openness in a way that encourages curiosity and, through gamification, rewards attempts, efforts, and success in achieving the learning objectives. This contributes to literature in the 'authentic learning' space as it allows suitably complex scenarios to be developed, and it contributes to literature in the 'motivational learning' space as the provision of a bounded space enables experimentation and flexibility in activities undertaken towards attaining outcomes. Throughout the chapter, we used teacher as the neutral form of someone passing on knowledge to another person called learner. Even though the described learning space is developed with a university setting in mind, the underlying concept of storytelling and applicability of the learning space is transferable to other educational settings.

Future research is required to define and refine methods to automate the assessment of 'completion' of a sequence of tasks and ensuring that there is some way to measure how closely related learners' actions are to the outcomes that are specified in the learning objectives. This is required to suitably create the 'gamified nudge' to bring the learner 'back on track' in the sequence of tasks and actions. First experiments showed an overall satisfaction of being able to explore rather than follow instruction. Learners reported that they felt immersed in the environment and could identify themselves with the avatar; yet we are interested to increase the level of immersion as well as authenticity. With Second Life, we noticed various problems with respect to the physics (forklift jumps on shelves and boxes can be "pushed" over long distances). Therefore, we look at different game engines like Unity; which include realistic visualisation and behaviour of objects and vehicles.

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KEY TERMS AND DEFINITIONS

1. **Gamification:** The use of game-based mechanics and game-based design elements in non-game settings to engage users and encourage achievement of desired outcomes through motivation of users.
2. **Story:** The story sets the overall scope and constraints of what to cover and what to exclude during the story telling (also called a bounded learning (purpose) or action (interactive) space). The story is the setting in which the actors will *live* their very unique narrative(s); including all required properties and elements
3. **Storytelling:** Storytelling is an effective mean to convey information in a compelling and memorable way.

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4. **Narrative:** Unique paths through the story which also enliven the story and "unfold in space" and support the process of understanding and building cognitive structures. Narratives are either pre-scripted (ready to reveal their sequences of milestones and activities over and over again), or use exploration and goal-oriented triggers to multiply the possible narratives that learners can indirectly choose from.
5. **Virtual agent:** So-called bots are non-player characters, alternatively known as "animated pedagogical agents" that are guided by the compute but behaving, as we would expect, as other humans
6. **Immersion:** The state of consciousness where someone perceives an artificial or virtual space as real; often described as a degree of suspension of disbelief which correlates with the perception of the virtuality being real.
7. **Virtual World:** It is a computer-based, immersive, 3D multi-user virtual environment that imitates real (or imaginary) life, experienced through a graphical representation of the user.