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## Real-time computer graphics simulation of blockplay in early childhood

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### ABSTRACT

Observation of young children is commonplace in educational settings. For trainee practitioners however, gaining access at convenient times can be difficult. Even then, small snapshots of observable activity can only ever be captured. We describe the design and development of a cross-platform software application which can be used to support observations made by pedagogical practitioners. Our application Observation combines game-oriented technology: 3D graphics, animation, physics and classical game artificial intelligence. Simple, data-driven scripting capabilities, requiring no programming experience are also included, enabling the user to customise scenes of characters engaging in learning activities. The well-documented stages of blockplay have been used to represent the physical activity of characters, which is the focus of this paper. Positive feedback was received at a collaborating university in a pilot evaluation of early childhood lecturers and students, paving the way for further development and studies. Our prototype system is available for download and evaluation.

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## 1. Introduction

### 1.1. Observation in early childhood

Observations of young children are used to plan and assess activities based on their individual development and needs. Skillful use of these observations enables practitioners to ensure that provision in early childhood environments optimises children's learning.

Examples of observational schemes are: the Practice Guidance for the Early Years Foundation Stage (Department for Children, Schools and Families, 2008), which covers the six areas of learning and development (in the United Kingdom); and the process-oriented child monitoring system (Laevers, Vandenbussche, Kog, & Depondt, 2002). Both approaches present a schedule of observable behaviour. The former places the emphasis upon a stage-related development continuum, whereas the latter identifies stage-independent core behaviour. Observation schedules used for professional development are often accompanied by textual case studies, sometimes with supporting images and/or video.

An observer should ideally aim to be an onlooker, not directly involved in the learning episode. However, children often expect adults present to be a resource to which they can turn. This makes simultaneous supervising/helping and observing difficult; children's needs may not be met, plus there may be health and safety risks. The presence of an observer writing notes, shooting a video, or taking a photograph, can also affect the way children play and behave. To minimise the impact of the observer, a distance should be kept away from the children's activity (Bruce & Meggitt, 2006).

Video recording has its own challenges. Fixed cameras are limited to activity demonstrated within an area and may require editing during periods of inactivity. In addition, an edited recording is no longer a true representation of events. Hand-held cameras provide more flexibility but are more intrusive. If the observer is filming, they may miss something interesting; it is also quite difficult to walk and film at the same time (Bruce & Meggitt, 2006).

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## 1.2. Blockplay

Blocks are typically made from hardwood and fit together in neat, geometric patterns. For example, a unit block from [Community Playthings \(2010\)](#) has the following dimensions: width 140 mm; height 70 mm; and depth 35 mm. A half unit block is half the width of a unit block. Double and quadruple unit blocks are two and four times the width of a unit block respectively.

The benefits of blockplay are well-understood and a detailed description is beyond the scope of this paper. However, one of their main appeals is that they are unstructured toys which require children to use their imagination, facilitating the exploration of many aspects of learning including: science; mathematics; physical development; social studies; social-emotional; art; and language ([Hirsch, 1984](#)). Indeed, blockplay can be considered as a symbol system and very powerful nonverbal language ([Gura & Froebel Blockplay Research Group, 1992](#)).

Early childhood research has shown that a child passes through several stages in blockplay, regardless of age, with older children passing through the stages usually at a faster rate ([Wellhausen & Kieff, 2000](#)). The stages are:

1. Carrying - carry blocks, explore with senses, hit blocks together or against other objects - no building takes place;
2. Stacking - stack the blocks either vertically (towers) or horizontally (rows);
3. Bridging - bridge the space between two upright blocks with a third block;
4. Enclosures - purposefully place blocks to enclose a space;
5. Patterns and symmetry - build structure with balance, symmetry, and decorative elements;
6. Early representational - incorporate building techniques from stages 1–5, begin naming structure during or after construction;
7. Later representational - announce name of structure before building begins, build familiar settings, use structure and related accessories for dramatic play.

Due to both its importance and structure, the stages of blockplay construction have therefore been chosen to be representative of young children's observable activity.

## 1.3. Related work

There has been limited work simulating educational environments for young children.

[Falender, Jordan-Marsh, and Murar \(1979\)](#) present a paper-based role-playing simulation for administrators, in which participants adopt roles of persons in the early childhood decision-making process, using in-box materials.

[Ferry et al., \(2004\)](#) describe a largely text-based web application, for pre-service primary school teachers, which promotes decision-making based upon scenarios, and provides access to a knowledge-base of expert pedagogical advice, against which to compare their own teaching and classroom management decisions.

The proprietary *simSchool* ([CurveShift Inc., 2010](#)) is a web application which simulates the interactions between teacher and students, where the teacher can make academic (or behavioural) assertions and observations, or pose questions. When setting up a simulation, students and tasks can be selected randomly or if they are custom-created, students or tasks can be defined in terms of the same dimensions. Visual reporting allows the teacher to see if the student's performance was as expected, above expectations or below expectations. In essence, the teacher can make decisions about whether the tasks they assigned to students were an effective match based upon their individual abilities and personalities.

Both [Ferry et al.'s \(2004\)](#) system and *simSchool* revolve around adult-initiated activities, which is more typical with children after pre-school. *simSchool* has 2D graphics to show students in various states between boredom and engaged, but neither of these systems show any activities actually taking place; it is left to the user's imagination.

## 1.4. Objectives

The motivation for the work presented in this paper arises from both the benefits and limitations of traditional observation. Can the observation of children's play be simulated? If so, observable activity must be represented. However, young children engage in many activities, and we do not wish to include all of them, so we have narrowed our scope to blockplay, which is described in Section 1.2.

Many aspects of children's play have been modelled by researchers in the field of early childhood. There are several reasons (other than prediction) to build models, which support our particular approach: to explain; to discover new questions; to promote a scientific habit of mind; to bound outcomes to plausible ranges; and to train ([Epstein, 2008](#)).

Ultimately, we aim to establish whether a real-time, 3D graphical simulation of young children can enhance the training of early childhood professionals.

## 1.5. Contribution

To give additional support to early childhood practitioners we have developed an application that simulates play activities of young children, drawing upon the research within existing models, providing a sandbox in which to experiment with humanoid characters in a customisable environment.

The benefits of our application are that it: is cross-platform; is aimed at non-programmers; uses free open source third party tools and libraries; uses free assets (models, textures); and provides simple data-driven scripting.

The organisation of the rest of this paper is as follows: Section 2 presents our observational application (Observation), including some of the design decisions, and introduces our research methods and participants; Section 3 discusses the findings of a pilot evaluation at a collaborating university, which includes a staff focus group, and a small-scale survey and focus group with students; Section 4 gives our conclusions and further work.

## 2. Material and methods

### 2.1. Development

Rather than use an existing framework, such as a game engine, we created our own system, thus maintaining more control, and added features incrementally as they were needed. The codebase for Observation was developed using C++, making use of the Standard Template Library (STL).

Tools and resources were chosen that were freely available and/or open source, with permissive licensing. The OpenGL graphics interface standard is used for rendering. 3D modelling was performed using Blender (Blender Foundation, 2010). The biped model used was taken initially from a Blender rig (Cessen, 2008), and was adapted to suit our needs. 3D meshes are loaded using the GLM library (Robins, 2000). Textures are from graphics packages or obtained freely from the Internet. Animations were created using QAvimator (Ree, 2010), except the walk animation which is from Second Life (Linden Research, Inc., 2010). Physics is incorporated by integrating Bullet (Coumans, 2010). For portability and flexibility, the graphical user interface was developed using Qt (Nokia Corporation, 2010). Icons were sourced from the Open Icon Library (Israel, 2011).

#### 2.1.1. Characters

In many games, player-characters can customise their own appearance, often to match their own (Cooper, 2007). Similarly, non-player-characters (NPCs) can be customised. In both cases, there may be options to modify gender, body proportions, clothing and ethnicity. By not providing these options, stereotyping (Isbister, 2006) through outward appearance is therefore completely eliminated and there is no room for cultural or gender bias in any observations. Abstraction of physical appearance not only removes any cultural labelling, but it also simplifies the implementation, since creating variety amongst individuals is a rather complex activity in itself (Albin-Clark & Howard, 2009). For instance, what does a four-year-old girl look like?

The use of an abstract character is not unique in early childhood pedagogy, given the provision of featureless/expressionless dolls in Steiner Waldorf kindergarten, where the young child is encouraged to place their own interpretation onto a universal figure (Nicol, 2007). This is also particularly useful for the Observation platform, when viewing a character as an active embodiment of behaviour and well-being (Merleau-Ponty, 2002), a physical manifestation of engagement in play, rather than focussing on features, such as gender, ethnicity and age.

However, children at different ages do have varying body proportions, so should this be represented? We have taken a straightforward approach to this by globally scaling the skeleton to match the average height for a child of a particular age. For instance, a three to four year old is about one metre tall. This compromise means that all children of that age will necessarily have identical body proportions.

We have used QAvimator to create and edit our skeletal and animation data conforming to the Biovision Hierarchy (BVH) motion capture standard. QAvimator was developed for users of Second Life and supports one unisex skeleton. The slight disadvantage is that there are no digits on the hands.

Separate meshes represent parts of the body, including a featureless head. Using separate, rigid body parts has the advantage that these can be swapped for alternatives but the disadvantage that they are either without clothing or constrained by some representation of clothing using textures or even cruder, colours.

Visualisation options therefore include one or more of the following: bones; joints; and rigid body parts.

When multiple characters are in a scene, how can these be identified? In Massively Multiplayer Online games (MMOs), player-characters and even non-player characters may be given names of some kind, but these are culturally-bound identifiers. We opt for a more abstract representation and give randomly generated colours (a combination of Red, Green and Blue components) to each individual, together with a numerical label. If the colour happens to be similar to another, it can serve as a metaphor for similarity in some unspecified dimension.

The chest area can be optionally used to visualise the well-being of the character. The colour fades from black to white over time as dissatisfaction increases, triggered by events such as not being able to locate certain objects. This well-being is a simplified representation of the Leuven well-being scale (Laevens et al., 2002).

Giving characters perception attempts to reduce the global knowledge of the environment to a more individual experience. A ray is cast from the character, to simulate sight; the length and angle is adjusted each frame, to give a sweeping motion like a searchlight, scanning cells ranging from up close, at intervals, to those at the maximum range. This field of view is used when looking for objects in the environment. They will therefore only see things within this field of view, which means they are unaware of what is behind them, unless they turn and face that direction.

Characters are able to pathfind around obstacles using our implementation of the A\* search algorithm (Bourg & Seemann, 2004). A finite state machine (Ahlquist & Novak, 2007) is used for pathfinding and pathfollowing, which involves following waypoints generated by the pathfinding.

When needing space for an activity, a character is assigned a 1 square metre patch which is: flat (so constructions do not fall over in Bullet physics simulation); and unoccupied by any geometry. The number of patches is therefore only limited by the scene contents (number of characters with patches, objects, and terrain height). The patches are colour-coded, as illustrated in Fig. 1, to match that of the character, and can be toggled on/off. The colour is applied as the geometry is textured. Default behaviour is that characters do not interfere with the patches of others.

The scope is vast for how blocks could be arranged to represent a real-world object. How could the illusion of construction during blockplay be given? Characters are assigned a stage of blockplay and, depending on that stage, select from a handful of construction plans from a file, which are representative of the individual's stage. These are referred to as scripted construction plans since the position and orientation of all elements of a construction are specified in advance. A finite state machine defines the behaviour of the character undertaking scripted construction. Fig. 1 illustrates several characters, each at different stages, engaged in blockplay.

The completion of the building, like in real life, depends upon there being the right resources to hand, i.e. the correct blocks available. An object cannot be instantly 'spawned' by the character if it does not exist already in the environment. However, the observer may drop blocks into the scene.

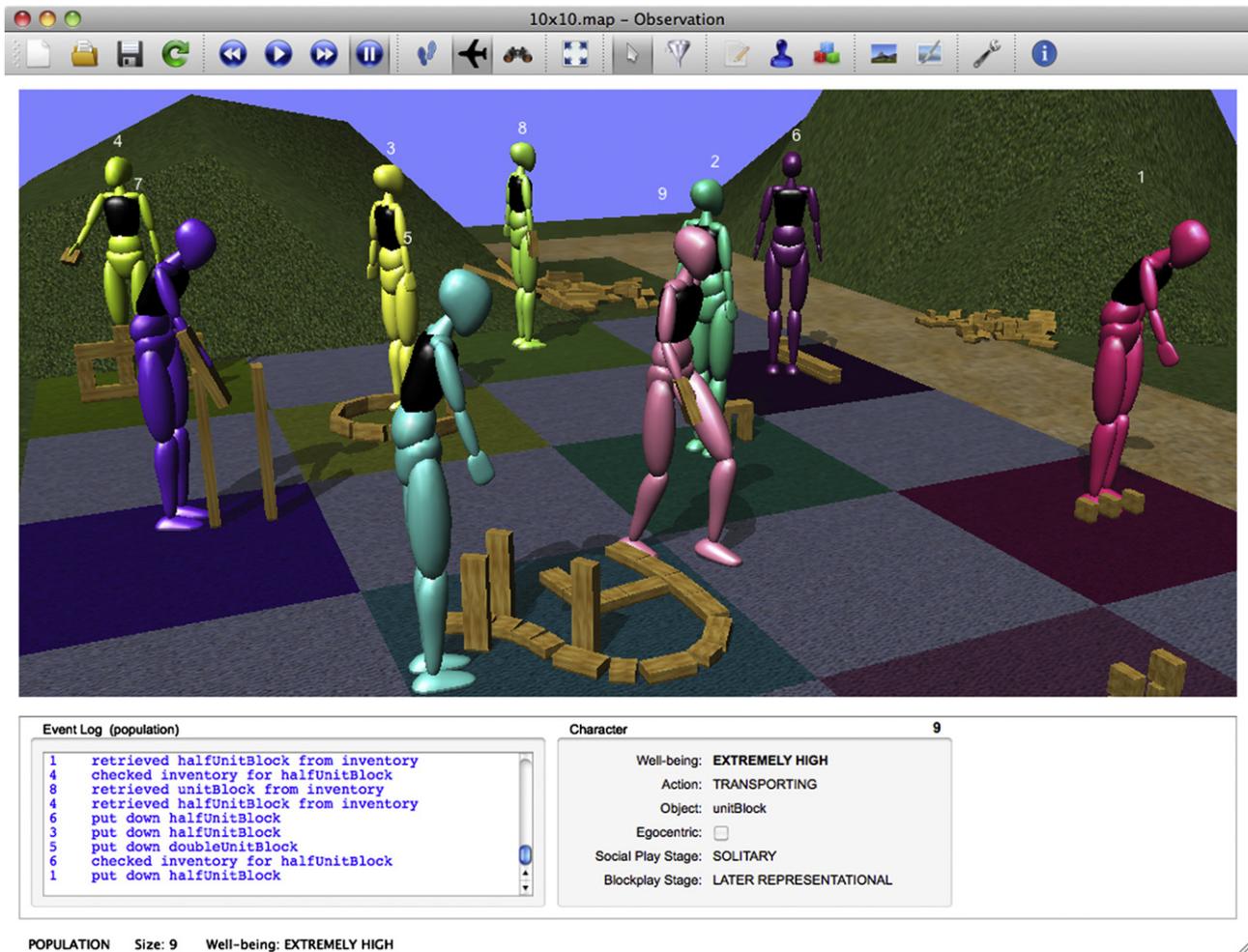


Fig. 1. Characters engaged in blockplay at their colour-coded patch.

### 2.1.2. Environment

Usually, there are zones of activity within a region in an early childhood setting, where certain resources are based. These regions typically have flooring appropriate to those activities and tend to come under two main types: dry and messy. Community Playthings have examples of how to arrange the space (2006), and the blockplay area is situated within the active zone of the dry region. They divide the internal areas into two regions, dry and messy, which have different floor coverings. Each of these is further divided into zones like so: Dry region - active zone, quiet zone; Wet region - messy zone, entry zone. Experiments were conducted to confine blockplay activity within a zone marked as Active. However, this raised several issues. For instance, in the Community Playthings floor layout example, a very small corner of the Active area for blockplay is allocated. If these dimensions are replicated, hardly any characters could be added to the scene if they were constrained to that area. There is also the need to define zones manually and associate activities such as blockplay with those zones. Since Observation is a sandbox application, enabling the user to create their own scenes very quickly, this constraint was relaxed, so that characters can be added anywhere. Textures (and colour materials) can be defined by the user to represent zones within the space, such as a dry region with carpet, where the blocks are, and a messy region with wood flooring. Outdoor zones may have textures such as grass or tiles.

There is no one right way to arrange early years settings. For instance, Reggio Emilia schools in Italy have central piazzas, which are used as a social space and built into the fabric of the building, something not usually seen in the UK. So, rather than having one fixed layout, the ability to configure different layouts is therefore provided.

On the surface, having walls seems sensible, since they constrain movement, delimit areas, and help to define inside and outside, concepts which are relevant in play, as some activities only occur in some areas. For instance, children do not usually run indoors. Some experiments were conducted with a main building, but even having just walls with no roof seemed too restrictive. After all, the whole point is to be able to observe, not have your view obscured by a wall! So there are no walls, and no doors. This raises an interesting problem though because it is difficult to represent a doorway, to be used as a point of entry and exit, without a wall. We decided that there would be no building, no dividing walls and no representations of doorways. Fortunately, this is in line with the practice of free movement between areas in children's centres.

A terrain generator can produce height variations in the scene, which is particularly useful for outdoor areas. Terrain ranges can be defined easily in a map file to give random undulations within limits, or alternatively at constant heights. Terrain vertices can also be manipulated directly to modify the height of the terrain, as illustrated in Fig. 1. Hollow blockplay, which uses larger wooden blocks than

unit blocks, usually occurs outside, so the facility to represent terrain is useful. Using bilinear interpolation based on the underlying geometry which forms a uniform grid, characters will discover the terrain height at their given position and follow the contours of the generated terrain. The observer can choose whether to have their viewpoint rise and fall with the underlying terrain, as they move through the scene.

### 2.1.3. Viewing

Where should an observer be situated? Should they be embodied; in amongst the action, bumping into people and things? If embodied, should they be constrained to walking about the environment at a sensible speed, with a viewpoint determined by the direction of the head? Alternatively, should an observer be a disembodied entity, one that is free to get around quickly, moving through people and objects? Currently we have opted for the latter option, whereby the observer can wander anywhere, with configurable speed parameters. Although a computer simulation can provide opportunities for doing things that would otherwise be impossible in real life, we did not want to provide multiple viewports as this has connotations of surveillance by Closed Circuit Television (CCTV) and is not analogous to an adult observing within a real physical environment. However, as a more meaningful compromise, there is the option to follow a selected character, where the observer's viewpoint is adjusted to look at the now centered character in question from a slightly elevated position. Viewing options include: walking; flying; and following a character.

### 2.1.4. Monitoring

Observation is being developed with the observer in mind, providing a mixture of graphical and textual information, via an intuitive interface, as illustrated in Fig. 1. Characters can be selected to observe their dynamic data such as: their well-being; their action; and the physical object which is currently of interest. Character selection also provides static data such as their blockplay stage. Full screen graphics are available or if world information is required, a timestamped event log can show both archived and real-time events for characters, filtered if needed. The well-being of the population is periodically refreshed and displayed. The simulation can be paused to make monitoring easier.

### 2.1.5. Custom shapes

Taking inspiration from example Virtual Reality Markup Language (VRML) world files (Ames, Nadeau & Moreland, 1996), a configuration file of custom shapes can be defined in terms of other primitives. For instance, a unit block, as described in Section 1.2, can be represented as *cube unitBlock 140 70 35*, where *cube* is already defined within Observation. This means anybody (including the author) can add further custom shapes such as blocks of any dimensions, and refer to them by name when constructing map files.

### 2.1.6. Data-driven scripting

To give flexibility through customisation, data used by Observation is kept in external text files, wherever possible. Alternative maps (scenes) can be made, with a simple, human readable, file format. Within a map, the following can be defined: zones; terrain; and object positions (custom shapes and meshes). Scripted construction plans can also be defined in plan files, which themselves reference custom shapes and models. Other data files include: animations (BVH); models (OBJ); and textures (PPM).

### 2.1.7. Physics

The open source physics library Bullet has been integrated into Observation, to give added realism to objects in motion and at rest, as illustrated in Fig. 1 on the terrain, and in Fig. 2 on the shelves. When objects are added to the scene, a rigid body is created in Bullet based on the object's local coordinate system bounding box. The object's transform (position and orientation) is then used by Bullet to situate the object within the physics environment. If objects move, their transform is obtained from a Bullet motion state and used by Observation firstly to update a uniform grid, which is used for spatial indexing of world objects, and secondly for rendering. With the world being constantly updated, characters are able to see the objects in the new locations, fetch them, and continue about their work.

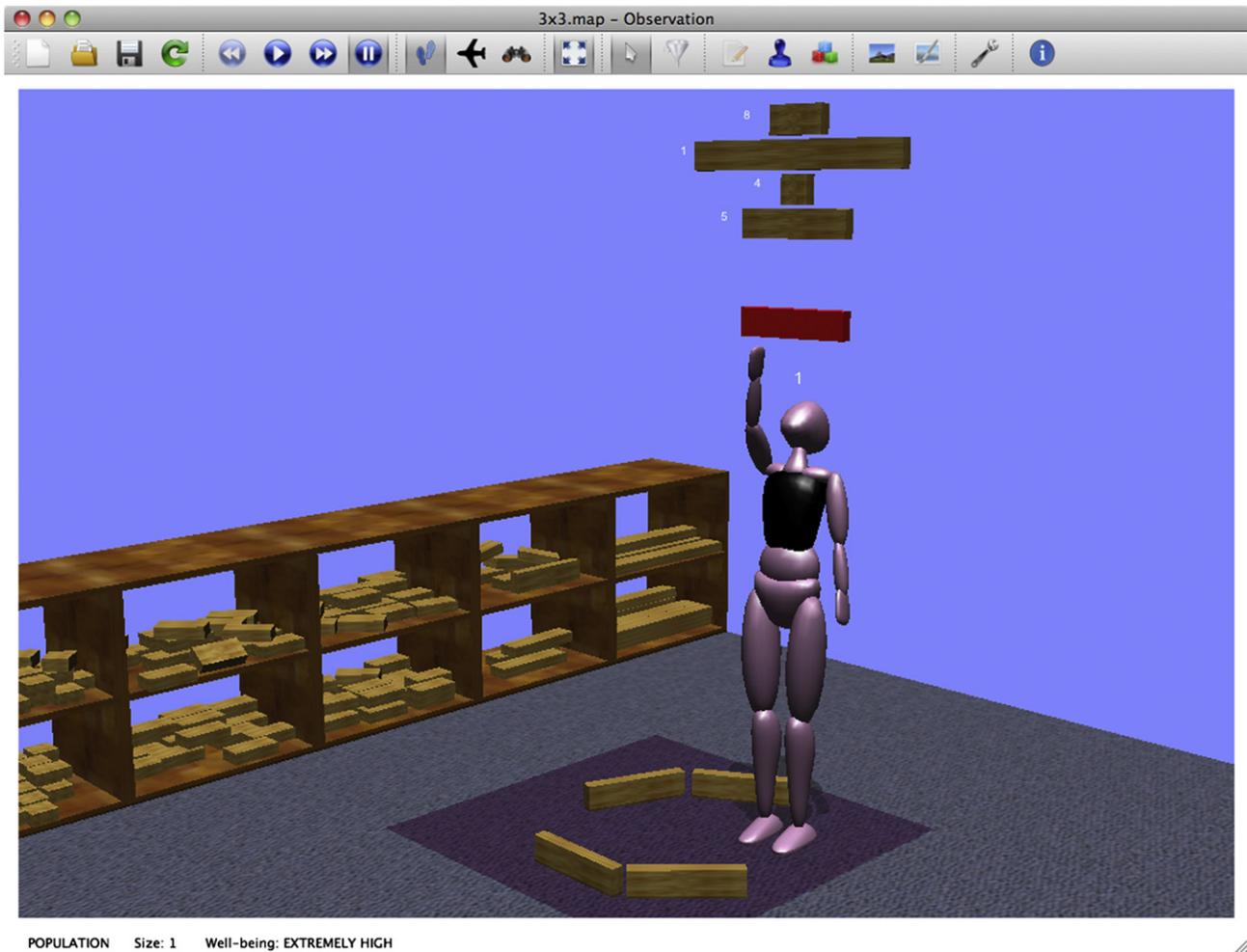
Bullet provides the facility to define an infinite ground plane. We take advantage of this by defining (in addition to a ground plane) four additional vertical planes or walls, by supplying the appropriate surface normal for each plane, to contain the physics objects within the scene.

Bullet has three types of rigid bodies: static; dynamic; and kinematic. Static bodies do not move. These can be used for non-moving furniture in a learning space and also the floor and walls. However, the majority of objects in a setting for young children are meant to be picked up and would not be static. Dynamic bodies are subject to physics; they collide with other objects in a natural looking way. Kinematic bodies are controlled by the programmer but the bodies' interaction is one way only, so they can knock into dynamic objects and cause them to move, but the reverse is not true. A character moving an object around needs control of it but when it is no longer in their hands it needs to be subject to the laws of physics. We do not wish to model a grasping hand using forces, rather like a robot, so we opted for a simpler approach; once an object is picked up, its dynamic rigid body is deleted from Bullet and when the object is placed back down again, a new dynamic rigid body is created to take the place of the original, supplied with an updated transform for the target position and orientation. The limitation of this approach is that it relies upon the target space being unoccupied.

## 2.2. Participants

### 2.2.1. Staff focus group

A focus group meeting was held early in the first semester of the academic year 2010–2011. The venue was a small learning pod at Liverpool Hope University. In attendance were four early childhood lecturers from the university, together with the primary author. A semi-structured walkthrough of Observation was provided for the lecturers, focussing upon its key features. Open discussion took place during the walkthrough. Each participant was given a pen and paper, and everybody jotted down thoughts and suggestions during the meeting, to form a record of events. The results from the staff focus group can be found in Section 3.1.



**Fig. 2.** Personal inventory system. A double unit block is the character's goal object, and is shown above the head and coloured red, signifying that it has not yet been obtained. The character reaches up for the object because it is in the inventory. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

### 2.2.2. Student survey and focus group

In the middle of the second semester of the academic year 2010–2011, a small group of nine volunteers attended a session at Liverpool Hope University in which an introductory presentation to the research was given by the primary author. All of the research subjects were female undergraduates at the university undertaking a programme with an early childhood theme.

Once students had agreed to be research subjects by giving informed consent, they completed a pre-simulation usage survey that asked questions about their early childhood background, including observational experience, and questions about their knowledge of the theoretical material represented within the software. They downloaded Observation (and user manual) within the session for a brief orientation and several days later, completed a directed task which was designed to cover the main features of the simulation software and to give them exposure to the full range of character behaviours. Afterwards, they completed a post-simulation usage survey asking them about their experiences.

The following week, six of the nine students that had completed the software evaluation, attended a focus group. The results from the student survey and focus group can be found in Section 3.3.

## 3. Results

### 3.1. Staff feedback

This section provides a summary of the anecdotal feedback received during the focus group described in Section 2.2.1.

The format was considered to be quite intriguing, unlike anything encountered before in this field. To facilitate analysis and discussion, case studies traditionally include any or all of the following: text; images; and video. Compared to this, our approach was perceived as offering more dimensions, as well as being more appealing to this generation of learners.

Due to its exploratory nature, the simulation could be used for problem solving within teams. Areas of investigation might include: negotiation; cooperation; social interactions; and movement. In addition, it was suggested that children themselves might benefit from a tool to design their own models before building them, although this is really beyond the scope of our target audience.

Adaptation, such as making a smaller enclosure, is a facet of play, when resources are constrained. It was observed that characters attempt to complete a predefined construction, by locating the appropriate blocks, but cannot change their plans mid-construction if they do not have the blocks. In such cases, it was suggested that some form of negotiation take place between characters, in order to obtain blocks from each other. It was thought that this would be easier to model if characters maintained a collection of blocks. Collaboration might also be employed to enable a construction to be finished by another character or perhaps several characters.

Characters do not currently take the blocks of others. It was noted that it is quite common for children to do this. Despite many generic dictionary definitions, this is not actually selfishness but egocentrism, a key idea of Piaget, relating to child development. In our context, this can be explained by an example; when a child cannot see the world through the eyes of others, taking blocks from others is not wrong to them, since they merely view the blocks as their own.

The representation of well-being was well received. It was suggested that the scale could be aligned with an existing observation schedule, such as the five-point Leuven scale. In addition, it was postulated that it would be interesting if frustration could be factored into the well-being score.

It was generally felt that the abstract nature of the characters should be preserved, rather than try to replicate real life, on the grounds that such abstraction would encourage more creative analysis of behaviour for students, if there are fewer visual cues such as: no facial expressions; no gender; and no cultural references. People preferred the characters with a body, rather than just seeing the underlying skeleton with or without joints. There was also a comment that the abstract characters were not particularly endearing and that perhaps alternative representations could be made available. It was also noted that the body has adult proportions, despite the youthful gait. It was explained that this is because QAvimator produces animations based upon the adult, unisex Second Life skeleton. It was suggested that movements were kept simple but that perhaps a kneeling animation could be incorporated.

An adult in an educational environment may feel obliged to intervene based on an observation that they have made. However, the freeing up of this responsibility means that observers do not have to intervene, something almost impossible to do in a real situation. It was also thought that multiple observers would have a shared experience by being able to view the simulated world from the same viewpoint and with identical information. The ability to follow a character was considered a useful option as it made it considerably easier to make sense of what was going on when a scene becomes busy with many characters and many objects.

### 3.2. Response to staff feedback

We now discuss one of our responses to the suggestions made by the focus group in Section 3.1.

One of the suggestions was for characters to maintain a collection of blocks. For this, we have introduced a personal inventory system, as illustrated in Fig. 2. There was already the ability to display a character's goal object above their head. We extended this by keeping an internal record of how many of each object a character possesses, similar to a player-character inventory system. The major advantage is that virtual physical objects occupy no world space whilst in inventories, thus keeping the patch solely for displaying constructions. The inventory is the first port of call when a character is seeking a block, so by checking their local supply, represented above their head, they may not need to travel to obtain it. Such a local store will also be useful, in later implementation, when characters exchange blocks. Inventory is (currently) lost when a character is removed from the scene. An alternative method would be to find a place for them to be deposited, such as a central spot. Yet another would be to deposit them on the patch previously occupied by the now removed character. However, in either case, they would need to be added in a controlled way as multiple physics objects understandably react dramatically when they all placed in the same world position.

### 3.3. Student feedback

#### 3.3.1. Survey

This section provides a summary of the data collected in the small-scale survey described in Section 2.2.2.

The pre-simulation usage survey revealed that some students had several years experience working within their field of study. Most were familiar with at least some of the theoretical content within the simulation, collectively showing prior knowledge of 37% of the seven blockplay stages. Everyone had done some observations of young children, either as a learner, or as a learner and as an early childhood professional, collectively showing prior observational experience of 29% of the seven blockplay stages.

In the post-simulation usage survey, some statements, using a five-point Likert-scale, were given to the students, to establish the usefulness of the simulation; Table 1 presents this data combining the Agree and Strongly Agree responses. In the comments section, one subject said, "I believe that the simulation is an excellent way of possibly seeking links between the needs of individuals in the real world." Another said, "The outcome of the observation can be exaggerated."

#### 3.3.2. Focus group

This section provides a summary of the discussion which occurred during the focus group described in Section 2.2.2. The comments have been organised according to the themes that emerged.

**Table 1**  
Summary of the simulation's usefulness as perceived by the students.

Agreed	Statement
8/9	It was useful to influence the well-being of the characters.
7/9	It was useful to move among the characters.
6/9	It was useful to change my viewing position.
5/9	It was useful to define the behaviour of the characters.
5/9	This simulation has increased my understanding of blockplay stages.

It was stated that an observer would not automatically witness all possible behaviours in a setting, so being able to choose what is seen is an advantage. One student said, "Observation would be perfect for developing observational skills in childcare courses, for those lacking in confidence to go into settings and just do it."

There was a comment that lots of thought and effort had been put into the theoretical aspects of the simulation to maintain the interest of the observer. Several students had not done many observations and felt that such a simulation could provide a great deal of information, and enable the fine-tuning of observational skills. Several felt that the user needs some understanding of the underlying theory before using the simulation. For instance, blockplay stages had not featured on many of the students' programmes. Some students were not sure why some characters appeared to be just waiting, as they had not familiarised themselves with the behaviour descriptions in the user manual.

The students were impressed with the amount of information that was available for the characters and also that it is possible to filter this specifically for one character. They also appreciated being able to follow a character when the scene became quite busy. The comment was also made that reading the events on the event log was quite difficult when there were a lot of characters in the scene. It was claimed that an observer may have more information available because a child will be known to them; for instance, something may have happened to them the night before. Somebody pointed out that the ability to pause time is a luxury that is not afforded in real-life observations.

Some students had watched a video as part of an assessment, which they said was quite difficult as they had no say in who would be in the video. It was felt that being able to choose the type of children that would appear in an observation gives more control over the observational episode.

There was a consensus of opinion that being able to intervene in a simulation was a good thing. However, the comment was made that it isn't always possible to improve the situation, unlike in Observation, where one of the main vehicles for increasing well-being is the provision of resources.

Some had tried adding random characters and felt that this was more like real-life, where you cannot define people. The process of adding characters within Observation reminded one student of the simulation game RollerCoaster Tycoon. Comments were made that it was very effective when the characters were actively building with blocks. One student felt that the representation of the characters within the environment was a bit clinical.

Some students were quite experimental and enjoyed changing the terrain and applying textures, such as flooring. They found setting the scene to be very useful because this is something that must be done in real life; "A practitioner provides things," said one student. In contrast, another student was surprised to find that scenes are defined by the user; they thought it would be more like loading in a scene already populated with objects and people that you would watch, rather like a video.

### 3.4. Limitations

There are several limitations to the work presented in this paper, which are now discussed.

The feedback provided by the lecturers and students during the pilot evaluation was extremely useful. However, the number of students involved was clearly very small, so the figures should be taken as a guide rather than representative of all early childhood professionals undergoing education at a tertiary level. The pilot evaluation will therefore be used as part of an ongoing process of evaluation and development.

The well-being representation, although respecting the five levels of the Leuven scale, is very much a simplification. For instance, indicators of well-being in children are body posture and facial expression, though neither of these is currently used. The well-being of the characters is influenced directly by the provision of resources by the observer. Whilst the physical environment and resources do play a very important role, it is not our intention to suggest that this is the only way, or main way, of raising the well-being of a child.

The uniform appearance of the characters and their universal animations imply no specific age, although the animations show characters walking. The age of the character can therefore be decided by the observer, although this may be too open-ended when it comes to determining whether the development of the child is appropriate.

The simulation is effectively constraining the play of characters to blockplay because there are no other play activities represented, which is a rather narrow view of physical play in young children. In addition, it is only construction using blocks that is represented, not dramatic play which sometimes follows on from it.

## 4. Conclusions

We have described our prototype application and how it has been designed for the purpose of simulated observations, which at the moment depicts physical activity as the blockplay stages seen in young children. The feedback from the pilot evaluation has been very encouraging and has helped to steer development. Students did report increased understanding in theoretical areas depicted within the simulation. A high proportion of the students agreed that it was useful: to influence the well-being of the characters; to move among the characters; and to change their viewing position. Others expressed an enthusiasm for changing the environment. Even with such a small sample, this may suggest that a real-time 3D graphics simulation has something to offer observers of young children that traditional methods such as text and video do not.

To continue our work, we intend to further develop our sandbox application Observation, and to roll out a large-scale survey to include more early childhood students from Liverpool Hope University, plus widen the audience to include research subjects outside of this institution, and also outside the early childhood field.

Observation is available for download and evaluation from <http://www.cs.man.ac.uk/~aac/observation/>.

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