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WPI – HER MAJESTY'S TOWER OF LONDON IQP
EDUCATIONAL MATERIALS FOR CHILDREN UNDER 5

An Interactive Qualifying Project Report

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This report reflects the work of WPI students. It does not necessarily reflect the opinions or work of employees of Royal Armouries at Her Majesty's Tower of London.

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ABSTRACT

This project involved the development of portable soft-play educational materials intended to introduce children under five years of age to the history of Her Majesty's (HM) Tower of London. Design of these materials was guided by the results of research on HM Tower of London history, how children learn, and by observation of children at play. Royal Armouries staff offered guidance, as well. The educational objects we designed were a walk-in castle, a Velcro knight, and alterations for existing costumes. Each design was thoroughly tested, finalized, and presented to the Royal Armouries staff at HM Tower of London to be used for outreach programmes.

EXECUTIVE SUMMARY

In the scope of this project, materials for under 5s consist of educational materials intended to introduce children under five years of age to basic concepts related to the history of Her Majesty's (HM) Tower of London. During the course of our project with the Royal Armouries staff at HM Tower of London Education Centre, we fully developed four educational objects into portable deliverable products. Our project included information collection, brainstorming, design, production, testing and suggestions for future development.

Currently, the Royal Armouries has educational programmes focusing on the history of HM Tower of London. These include field trips to HM Tower of London for primary school and above. Approximately once a month, a small organized group of nursery school aged children will visit the Education Centre at HM Tower of London with their parents. The Royal Armouries staff adapts props and lesson plans from primary school programmes to lessons for nursery school aged children.

The Royal Armouries staff feels outreach programmes to nursery school aged children would be very valuable. Families from underprivileged boroughs near HM Tower of London would participate in these outreach programmes. To supplement the programmes, there is a need for educational materials designed for children under five years of age to learn via play.

The purpose of our project was to develop portable educational objects intended to introduce children under five years of age to the history of HM Tower of London. This required the collection of information about the expected audience so as to provide a basis for developing ideas and producing deliverable products. The objective of this project was to produce two or three portable educational objects for the Royal Armouries staff.

We gathered information to spark our creativity by visiting nursery schools. We observed children at the schools to learn about their interaction with other children and what resources were available. We then interviewed their teachers to find what worked best when teaching this age group. Using our findings as a guide, we exercised our brainstorming skills.

We held formalized brainstorming sessions about potential educational objects involving the historical characters of HM Tower of London. During the first two weeks of our project, we held brainstorming sessions one or two times a day for at least a half hour per session. All ideas stated were recorded as we decided that no idea was a bad idea.

It was not within the scope of our project to produce every idea from the brainstorming efforts so we needed to choose ideas to pursue. We took the promising ideas from our original list and scored each in a decision matrix. Criteria that contributed to the final score of each potential material included portability, safety, time and money, what the Royal Armouries staff wanted, what teachers wanted, what teachers felt was effective, what children liked to play with based on our observations, historical relevance and effectiveness, and the availability of specific materials in stores and catalogues. Each potential educational object was scored based on how well it fulfilled each criterion, was multiplied by the weight of importance of the corresponding criterion, and added together for a final weighted score.

From the decision matrix, we chose the top ten potential educational objects. After we developed this list, we discussed which objects were most desirable to the Royal Armouries staff. We eliminated the potential objects related to the same characters the Royal Armouries staff requested from our top ten ideas. Additionally, we eliminated potential educational objects that were better activities than lessons. This left us with the three candidates we pursued to develop into deliverable products: a walk-in castle, a Velcro knight of armour, and alterations to dress-up clothes.

To have deliverable products, we developed, produced and tested these educational objects. This consisted of prototyping each educational object, adding dimensions for design, and producing the objects with either existing resources at the Royal Armouries or with supplies purchased from stores. During development, we focused on ensuring that the educational objects would be easily portable for the outreach programmes. Once the educational objects were produced, we tested them for durability, effectiveness, and ease of use on children under five years of age, Royal Armouries staff and IQP peers.

The most elaborate educational object we delivered was a walk-in castle. We purchased a portable kids garden gazebo and added shock cord to keep the individual parts together to make assembly of the castle easier. The walk-in castle included a drawbridge, a portcullis, and a roof for staff to observe the children inside. It can also be used in conjunction with the other two educational objects we produced.

Inside the walk-in castle, children will be able to participate in role-play by using dress-up clothes as props. Existing costumes made for children over five years of age were altered to fit younger children. We modified one dress by adding Velcro to the neck and waist area to make the respective areas small enough for a child under five years of age to wear without having it fall off. We also added Velcro to the bottom of the dress to have the ablility to shorten it to the child's height.

Also inside the walk-in castle, there is space to hang the Velcro knight, a soft-play educational object with which children can learn how knights dress in their armour. The different pieces of armour can be attached to a silhouette of King Henry VIII via Velcro. A more advanced child will also be able to learn the names of different armour pieces.

In addition to deliverable products, we supplied the Royal Armouries staff with recommendations. These included suggestions for how to use the educational objects we

produced. Additionally, we provided basic designs for the potential educational objects we did not develop from the top-ten list.

For a complete copy of the report, please contact Irene Davies at HM Tower of London Education Centre or Professor James Demetry at Worcester Polytechnic Institute.

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1 INTRODUCTION

History can help us understand how we got to where we are today, and how to make improvements for the future. To benefit from understanding history, it helps to begin educating children at an early age. Generally, history is taught beginning in primary school, continuing though secondary school, high school, and college. This means that children do not start learning about the history of their country until they are in primary school. Due to the importance of Her Majesty's (HM) Tower of London to English history, introducing nursery school children to concepts involving HM Tower of London would aid in the understanding of their country's history.

In London, the Royal Armouries staff at HM Tower of London feels it is vital to begin educating children about the history of their country before entering primary school. Educating nursery school children using simple lessons will build their understanding on how things became the way they are today. Introducing information about HM Tower of London will help them to understand and take pride in the country in which they reside. While the notion of time may be difficult to grasp at the nursery school level, concepts involving HM Tower of London, such as castles, armour, crowns, guardsmen, yeoman warders, knights, and ravens, can be easily absorbed if taught correctly.

Currently, the Education Centre at HM Tower of London offers programmes that exist as field trips for primary school, secondary school and higher education. The Royal Armouries staff at HM Tower of London has an interest in expanding their outreach programmes to nurseries in the vicinity of HM Tower of London to begin introducing them to history. These outreach programmes will include the Royal Armouries staff making visits to local nurseries or community centers, or individual nursery schools visiting HM Tower of London as a field trip. Presently, the Royal Armouries staff adapts their existing materials

involving lessons about characters and places designed for primary school children to nursery schools visits.

The purpose of our project was to design, prototype, and construct two or three soft-play educational objects for children three to four years of age by which they may be introduced to the history of HM Tower of London. These include various appropriate soft-play educational objects that will be used in structured play to communicate lessons dealing with HM Tower of London. The following report presents the context for our project, describes our methods, and elaborates on our outcomes.

2 BACKGROUND

This section consists of information about the history of HM Tower of London, existing Royal Armouries educational programmes at HM Tower of London, how children three to four years of age learn, and how to safely design educational materials. This information supplied us with a good foundation on which to base our development of educational objects before we began design and construction.

2.1 History of HM Tower of London

This section will provide basic information regarding important historical characters and structures in the history of HM Tower of London. These characters include castles, knights, armour, crowns, yeoman warders, guardsmen and ravens. As will be explained in Section 2.3, children three to four years of age have difficulty grasping history. The educational objects will introduce basic concepts regarding the historical characters mentioned. An example of this is "Castles have large stone walls. HM Tower of London is a castle." The information presented in this section is what the Royal Armouries staff wishes the children to take away from the educational objects in lessons.

2.1.1 Castles

The White Tower, or "Great Tower," is the largest structure within the walls of what is known as HM Tower of London and a central symbol of English fortitude. It is essential for children to understand its importance and features. Previously, the White Tower has served as a foundation for a residential palace and fortress. HM Tower of London's strong

stonewalls were built up to 15' wide to protect against attack (Hammond, page18). There are no windows in HM Tower of London, only slits to let in minimal air and light while keeping any large openings nonexistent. Entrances are obstructed with unyielding gates, portcullises, and drawbridges to keep unwanted out. Without these characteristics, HM Tower of London would not have been safe or strong.

2.1.2 Knights

Knights are familiar characters to associate with an English castle and should be fun and interesting for children three to four years of age to learn about. Knights were the well-trained lead soldiers of the king or queen. They were also rich because they were well-paid and owned much land outside of the castle. Also, they were given a horse and armour; other soldiers did not receive or could not afford these things. Their bravery to do the kings bidding was a requirement and is second to no other feature (Gravett, page 6).

2.1.3 Armour

There are many aspects of a knight's armour that children should be aware of. Utilizing a model of the different parts and pieces of a full suit would be a valuable instrument for children to learn from. Armour is made of steel to protect against swords and arrows. It moves freely at the body's joints while remaining solid and rigid elsewhere. The weight of the armour is significant but does not immobilize the knights in any way; it allows them to bend and move. Armour is made specifically for each knight who wears it and is not easily interchanged between other knights (Hibbert, page 108).

2.1.4 Crowns

Crowns are important artifacts that are very special symbols of authority worn by kings and queens. English crowns are decorated heavily with gems and gold, making them precious and special, and are treated with care at all times. Traditionally, they have been cared for and guarded by yeoman warders in the Jewel House of 1868 (Britain's Heritage and History). A crown represents the degree of importance of the person who wears it, so children may find a pretend crown amusing to play pretend kings and queens (Rose, page 22).

2.1.5 Guardsmen and Yeoman Warders

Guardsmen and yeoman warders are similar in many ways, but differ in some tasks performed. Both are adorned very "smart," or well-dressed, in order to represent their importance to HM Tower of London. Guardsmen are soldiers that have been selected to protect the Queen or King, Buckingham Palace, and HM Tower of London. Yeoman warders are very famous living symbols of English history. They are colorful characters dressed from head-to-toe in a red and gold uniform. Today, they help guard HM Tower of London, look after tourists who visit, and walk in parades (Abbott, page 26).

2.1.6 Ravens

The story of the ravens is an interesting fragment of history involving HM Tower of London. Legend has it that should the ravens ever leave HM Tower of London, the White Tower will crumble and a great disaster shall befall England. For centuries, the ravens have been known by the residents of HM Tower of London to be an essential element and are

protected by royal decree. Although the date at which the ravens became accepted occupants of HM Tower of London is uncertain, certain evidence dates them back to King Charles XI during the seventeen century. Story has it that while Charles was stargazing from the observatory in the northeast turret of the White Tower, he found that bird droppings on the telescope masked his view. Enraged, the King gave orders to immediately destroy all the ravens in HM Tower of London only to be told that without the ravens, HM Tower of London would fall. Since this time followed the English civil war, Charles was not willing to risk further disruption in England. The ravens were spared and the observatory was moved to Greenwich (Britain's Heritage and History). The ravens still reside at HM Tower of London today. Ravens can be seen in Figure 2.1.

Figure 2.1: Ravens at HM Tower of London

This information is very important for children to help them understand and take pride in the country in which they live. While lessons dealing with the characters and places involving HM Tower of London are taught in programmes for children, they are only appropriate for those five years of age and above. The existing programmes are described in the next section.

2.2 Existing Programmes at HM Tower of London

HM Tower of London has interesting programmes for schools to participate in for field trips. These programmes are aimed at infant schools (children four to seven years of age), junior, middle and secondary schools, and freelance-led sessions. Currently, the Royal Armouries staff at HM Tower of London adapts materials used in infant school programmes when nursery school aged children visit HM Tower of London. These programmes focus on object handling, storytelling, famous people, and geography. From HM Tower of London Education Programme Handbook, details of the activities are given as follows:

Object Handling

Top to Toe: Introduces very young children to learning from objects. Ideas for protecting the body from dangerous surroundings are explored and provide the stimulus for new ideas. A full suit of knight's armour forms the center of this session. Present-day sport and work protective outfits are also used.

Storytelling

Charlie the Raven: Storytelling helps introduce young children to HM Tower of London and its characters. Charlie lived in HM Tower of London. One day the raven was seen standing beside one of the guards on duty. Parents are able to bring their children to HM Tower of London to hear the amazing but true story of the raven that stood on guard.

Guy Fawkes: After the failure of the Gunpowder Plot in 1605, the gunpowder was brought from Westminster to HM Tower of London, as was Guy Fawkes who was questioned here. While visiting HM Tower of London, children may experience what it was like by bringing the story to life.

Purpose-Built: Using the story of the *Three Little Pigs* as an introduction, Royal Armouries teaching staff at HM Tower of London Education Centre may bring out a

collection of bricks (miniature and full-size), wood, and stone and explore the building needs of a castle. They consider how HM Tower of London was purpose-built by looking at the windows and doors, entrances and exits, gates and stairs.

Famous People

Queen Elizabeth II: Queen Elizabeth II was crowned on June 2nd 1953. In this Golden Jubilee year, come and hear about the clothes she wore and the crowns that were used in the Coronation. Using HM Tower of London's replica crown jewels and robes, the children will learn about the coronation and monarchy. They will also have the chance to see the real Crown Jewels.

Geography

Barnaby Bear at the Tower: This session will encourage children to think about the concept of travel while using geographical terms and identifying geographical features in HM Tower of London environment. Royal Armouries staff at HM Tower of London Education Centre will use puppets, maps, books and plans to tell the story of Barnaby's trip to HM Tower of London. A worksheet will be available for the children to use after their session while visiting locations throughout HM Tower of London.

2.3 Differences Between 3-4 Year Olds and 5-6 Year Olds

As described in the previous section, there are programmes at HM Tower of London to teach children about its history. These programmes are not appropriate for teaching children three to four years of age because of differences in how children learn at different ages. Children three to four years of age differ in the development of physical, cognitive and social/emotional characteristics as compared to children five to six years of age (Zolten, 1997).

In physical development, children three to four years of age are able to copy a circle or a straight line and partake in motor activities that include jumping and throwing a ball. They will try tiptoeing and hopping. Children five to six years of age are able to successfully feed themselves, hop forwards and backwards, and recognizably print numbers, words and their name (Zolten, 1997).

In cognitive development, children three to four years of age are able to understand size differences including "another" and "more," count to three, know what gender they are, expand their vocabulary by making up words and singing silly songs, and (nearing four years of age) begin asking "what if...?" Children five to six years of age begin reading, ask "why" and "how," and understand concepts such as opposite, first, middle, last, same, different (Zolten, 1997).

In social and emotional development, children three to four years of age are able to understand the concepts of "mine" and "yours" making them not want to share until they near four years of age. They also enjoy imaginative play including imitating every day activities. Children three to four years of age cannot understand the difference between fantasy and reality. Children of this age are often egocentric. Children five to six years of age begin to understand the feelings of others, give, receive, share, play fairly, yet still have trouble differentiating between fantasy and reality (Zolten, 1997).

In order to gain a better understanding of how children develop, we observed preschool children in the States (equivalent to nursery school children in London) in the classroom. We were looking to gain insight into what types of toys and educational materials the children were interested in, which were played with the most, which were neglected and what parts of educational materials (e.g. activity books) were not usually used.

We were able to observe both a 2.9 to four year old class and a four to five year old class at First Friends daycare center. From our observations of 2.9 to four year olds, we

found that they were most interested in playing games, building with blocks, modeling with play-dough, and finger painting. We could have adapted these ideas to objects about the history of HM Tower of London including cookie-cutters used with play-dough and castle blocks. While observing the four to five year olds, we found that they were most interested in music, board games, dolls, tinker toys, and crafts. Relating these ideas to HM Tower of London we brainstormed designs including songs about HM Tower of London, paper bag or finger puppets, and dressing-up like a knight or princess.

In developing educational objects for children three to four years of age, it is important to consider what the children are capable of doing. Many times teachers direct what children learn while in the classroom setting and compensate for the abilities, or lack thereof, of the students.

2.4 Educating Nursery School Aged Children

In the classroom, teachers play a very important role in what the children learn. As Copple (1984) states, there are three objectives teachers work toward for teaching nursery-aged children:

- Developing acquaintance with objects and events in the world and awareness of their reaction to them,
- Developing competence in the representational modes, and
- Activating problem-solving processes and increasing problem-solving skills.

When children engage in the play described below, teachers look for ways to incorporate the points stated above when interacting with the children. Teachers may take a small role in the children's play to direct their attention to specific information without taking

control of the play. Teachers do this by asking questions about what the children are doing or making suggestive comments.

We conducted interviews with preschool teachers in the States in order to find out if children have an understanding of time, which in turn would allow them to learn history. We found that 2.9 to four year olds do not understand the concept of "a long time ago." For this age group, "a long time ago" refers to the previous week. For example, they believe dinosaurs are make-believe. They like hands-on activities and creating messes. Alternatively, we found that some four to five year olds are able to comprehend the concept of history. In this class, their history lessons include dinosaurs and holidays, specifically Martin Luther King, George Washington, Groundhog Day, and Black History Month. We found that these findings from our interview questions were supported by our research.

Six Types of Behavior

As Snowman & Biehler (2000) state, children exhibit six different types of social behavior when they are engaged in play:

- *Unoccupied behavior* – Children do not really play at all. They either stand around and look at others or engage in aimless activities.
- *Solitary play* – Children play alone with toys that are different from those used by other children within speaking distance of them. They make no attempt to interact with others.
- *Onlooker behavior* – Children spend most of their time watching others. They may chitchat and make comments about the play of others, but they do not attempt to join in.

- *Parallel play* – Children play beside, but not with, other children. They use the same toys in close proximity to others independently.
- *Associative play* – Children engage in disorganized play with other children. There is no assignment of activities of roles; individuals play in their own ways.
- *Cooperative play* – Children engage in an organized form of play in where leadership and other roles are assigned. The members of the group may cooperate in creating a project, dramatizing a situation, or engaging in a coordinated enterprise.

Cooperative play could include imaginative play where, for example, children are pretending they are in medieval times being kings, queens, knights and guardsmen. By pretending to be these historical characters, they are reinforcing the information they have previously learned. If a teacher observes a child acting as a knight who is not doing knightly things, she may ask a question to give the child a better idea of what a knight really does.

Educational objects and toys can be incorporated into imaginative play as well as used solely in solitary play and parallel play. The next section goes into detail about what needs to be taken into account when attempting to design an effective educational object or toy.

2.5 Design of Toys

There are many different types of toys. The design of these toys can play an important role in the development of every child. For this reason, many matters need to be taken into consideration: the needs of the intended audience, the materials used, the required safety precautions, and the intended learning experience. Solutions to these matters should all be well thought out before construction begins. Due to different toys being appropriate for different age groups, designing educational toys can be very challenging.

Toys are more effective in play if they coincide with the following ideas (Toy Action Guide):

- More value when they have many different usages,
- Appeal to children at more than just one age,
- Not always linked to video games, TV, or movies,
- Could be used with other toys for new and more complex play,
- Stand the test of time and remain a part of play while children develop new interests and skills,
- Promote respectful, non-stereotyped, non-violent, interactions among children, and
- Help children develop skills important for further learning and sense of mastery.

The toys children play with in their upbringing will affect them into their adult years. Understanding the challenges of conveying the wrong messages is a crucial part in the development of the right toy for a child under five years of age. The design of educational objects is very complex. Our job was to take appropriate toys and relate them to HM Tower of London.

Fisher-Price shows in "All About Play … stages, toys, & tips," many toy ideas that are appropriate for children three to four years of age. These concepts could be adapted to educational objects that relate to HM Tower of London.

The first group of appropriate toys for this age range consists of dollhouses and their accessories. Regarding HM Tower of London, this could be a replica of a tower with the many different characters that go along with the tower. This encourages children to use their imaginations while relating to the real world (Fisher-Price).

The second includes play-sets and action figures. An example of this that relates to HM Tower of London could be yeoman warders, guards, knights, or even ravens. This will get a child's imagination going, encourage cooperation, teamwork, and respect for others, as well as practice problem solving skills with the action figures and imaginative play (Fisher-Price).

The third is role-playing. These types of toys would include dress-up costumed, figures, vehicles, and realistic parts that give the child something to talk about and to play act with using their imagination. Linking this idea to HM Tower of London, all the characters and collections mentioned can give a setting with figures to play with. Additionally, a wardrobe of costumes modeled after guardsmen, yeoman warders, or other medieval characters would allow them to pretend to be a part of the history of HM Tower of London. Children at this age are very interested in taking what they know and putting it into realism as they play (Fisher Price).

Finally, creative activity toys are appropriate for this age group. This includes drawings of the characters associated with HM Tower of London. Molding play-dough into a castle or any of the characters is also imaginative. Creative activity encourages a child to show self-expression and helps refine hand and finger control as well as eye-hand coordination. A few other ideas that fall into these categories may include: hand puppets, props for pretend, wooden and plastic blocks, washable art materials, matching games, board games, intermediate puzzles, picture books and storybooks, tape player, music, and story tape (Fisher Price).

There are many standards and safety precautions that must be followed when designing toys for children three to four years of age. One is avoiding the production of toys with any small parts, which could pose a fatal choking hazard. A good way to avoid this is to use a toilet paper tube as a tester to see if a part is too small. If a toy, or toy part, fits inside

the tube, then a child could choke on it (ToySafety). Small balls, balloons and pieces of broken balloons are also dangerous choking hazards because they can completely block a child's airway. Another precaution would be to avoid strangulation hazards, which could be dangling cords. Also, we have to be aware that children could easily suffocate themselves. We should avoid sharp points or edges as these could cut a young child and is potentially very dangerous. Noise level could also pose a threat to a child. A child's ear is much more sensitive than an adult's making them much easier to be damaged. Flammability is also a hazard when designing toys for young children, especially in our case dealing with dress-up.

2.6 Summary

Based on the information about HM Tower of London, how young children learn, and how educational toys are made, we formulated appropriate methods that helped us develop educational objects. We further gathered information about how children learn and the existing programmes at HM Tower of London Education Centre. We then began to develop educational objects for children three to four years of age related to the historical characters of HM Tower of London.

3 METHODOLOGY

The background information we learned in research, preliminary interviews and observations was not enough to develop educational objects. To effectively complete this task, we visited nursery schools in London and observed the similarities and differences from preschools in the States. We also interviewed teachers to learn if there were different principles for teaching children under five years of age. We had formal brainstorming sessions and deduced which ideas would be most effective based on the interviews with Royal Armouries and nursery staff members. We then prototyped, designed, tested and finalized the educational materials.

3.1 Nursery Schools

The target audience for the educational materials we produced is children of nursery school age. To ensure the effectiveness, helpfulness and usefulness of the educational objects, we visited nursery schools to get input from the users of the products. At the nurseries, we interviewed the teachers, observed the resources available to the students, and observed the student-teacher interaction.

3.1.1 Arranging Visits

Our correspondent from the Royal Armouries at HM Tower of London Education Centre, Irene Davies, supplied us with a list of five nursery schools the Education Centre has worked with previously. We used The Primary Educational Directory 2002 to look up the addresses, phone numbers and contacts for each nursery. A list of the nurseries and corresponding contact information can be found in Appendix **A**.

Once we obtained the contact information, we sent letters to the nurseries requesting permission to visit. The letter included an introduction to the research team and the project, the reason the visit was needed, the time frame we requested for the visit and when we planned to contact the nursery to set up a visit. The letter of request delivered to the nurseries is in Appendix **B**.

To be proactive in our research efforts, we telephoned each nursery a few days after the letters were sent to arrange visits. In each phone call, we introduced ourselves as a research team from the Royal Armouries at HM Tower of London Education Centre and inquired about whether they received our letter. We then gave a brief explanation of our project and requested their permission to come to their school to observe the children and interview the teachers. We informed them of our availability and asked when a convenient time was for the nursery. Based on the conversations, we arranged visits to the three available nurseries.

3.1.2 Observation

During our visits to nurseries, we collected information. We learned what types of resources are available to the students, how teachers used them to educate the students and how many students were working with different materials or activities. The observation sheet we used for data collection is located in Appendix **C**. In addition to the observation sheet, when permission was granted, we took digital pictures of available resources to reference when analyzing the information.

The information provided us with concepts for effective educational objects and basic ideas to spark our brainstorming sessions. With the information we gathered, we adapted information related to the historical characters of HM Tower of London to basic concepts of

existing educational materials. By doing this, we did not need to come up with brand new concepts for educational objects and used what has already been found to work.

3.1.3 Interviews

After we absorbed the atmosphere of the nursery, we interviewed teachers to gain more insight about teaching children under five years of age. We asked various questions regarding how they felt children learn, types of educational materials and learning activities used, safety, HM Tower of London, and suggestions. Additionally, we presented a list and sketches of some brainstorming ideas and asked for input. The interview questions are in Appendix **D**.

The information we gathered from the teachers helped us in the development of educational objects as the teachers work with the children daily and have a feel for how this age group learns via play. The teachers also have experience in using lessons with educational objects to teach certain concepts.

3.2 Educational Materials

The development of educational objects started before we visited nurseries. We brainstormed for one half hour to one hour each day for one week before our first nursery visit. We continued brainstorming during the time we allocated for visiting nurseries. Based on the information gathered from nurseries presented in Section 4.1 and Royal Armouries staff, we narrowed down the ideas to pursue from our brainstorming efforts. Next, we prototyped, designed, and tested the educational objects before we produced finalized deliverable products.

3.2.1 Brainstorming

Before receiving input from nursery school teachers, we formally brainstormed ideas for implementation. Sessions were organized with a set list of topics to be discussed. The length of each session was not limited but continued until all ideas had been contributed. To maximize the efforts of our brainstorming during the time we allocated, we allowed for a second session within the same day if necessary.

Brainstorming sessions were organized, open discussions of potential educational materials pertaining to the historical characters of HM Tower of London. The sessions consisted of all available group members sitting in a particular work area with one record keeper and one leader. The record keeper recorded any idea that was relevant to the topic and corresponding details to aid in the prototyping phase to follow. Details about each idea were also recorded in order to aid in the prototyping phase that would follow. The leader's task was to establish the current topic, keep all relevant thoughts flowing, and to ensure all ideas were explained. When brainstorming, we followed the philosophy that no idea was a bad idea; therefore no potential concepts were withheld. Often times a former idea could be transformed into a viable option for development with slight modification.

3.2.2 Choosing Concepts & Prototyping

To choose two or three ideas to develop for deliverables, we had multiple stages to eliminate potential ideas. After each topic was visited for brainstorming at least once, we chose a limited number of ideas to develop. We narrowed down the original brainstormed ideas based on feasibility and interviews with preschool teachers in the States while taking resources, such as time, money, and materials, into account. We also removed "bad" ideas

and resources the Education Centre already had from our list. We then brought this condensed list of ideas for educational objects to nurseries for input. Our schedule did not allow for all brainstormed ideas to be modeled, therefore only the top ten ideas were conceptualized on paper or cardboard cutout.

Top 10 Concepts

The next stage of eliminating potential ideas was to choose the top ten using a decision matrix. We established a list of criteria, which is explained later in this section, that we found to be important to choosing educational units from our research. Figure 3.1 shows two sample educational objects being evaluated in the decision matrix. All weights and scores were on a scale of 1 to 5, where 5 was high. Each criterion (across the top of the matrix) was given an overall weighting factor that represented how important that criterion was in choosing which educational objects were to be developed. Each educational object was given a raw score based on how well it fulfilled each criterion. The raw scores of each educational object were multiplied by the overall weighting factor of the corresponding criterion to give a weighted score. All the weighted scores for a specific educational object were added together to give a total weighted score. The educational objects with higher total weighted scores were better to develop than those with lower total weighted scores.

where 1 is low and 5 is high & a higher total weighted score is best	Criterion	Portability	Safety	RA Staff	What teachers feel effective	What teachers want	Historical Linkage (effectiveness)	Stores / Catalogues (availability)	What kids want / play with	Time / Money	**Total Weighted Score**
Potential Educational Units	Overall => Weighting Factor =>	5	5	5	4	3	4.5	1	3.5	5	
Dress-up	Raw Score	4	4	5	4	5	5	3.5	4	4	ranked 1
	Weighted Score	20	20	25	16	15	22.5	3.5	14	20	**156**
Food Molds	Raw Score	5	3	1	2	4	2	1.5	4	2	ranked 2
	Weighted Score	25	15	5	8	12	9	1.5	14	10	**99.5**

Figure 3.1: Sample of Decision Matrix

We established nine different criteria important to choosing educational objects to develop. The paragraphs to follow explain each criterion and why we assigned the corresponding overall weighting factors:

Portability was given an overall weighting factor of 5 out of 5. Two members of the Royal Armouries staff will be transporting the educational objects to the outreach programme sites by walking, taking a taxi, or using the tube. The educational objects needed to be light and easy for the staff to carry. Portability was considered one of the most important factors in deciding because if the educational objects are not portable, the staff will not use them. If we were unable to think of ways to make a potential object easily portable, it received a low raw score.

Safety was given an overall weighting factor of 5 out of 5. When using the educational objects we developed, staff and children should not get hurt. This included making the educational objects meet the specification of "soft-play" and not violating the basic safety precautions mentioned in Section 2.5. Also included in this criterion was durability; it is not a safe educational objects if it breaks when a child is using it after it has been used for a while. Safety was considered one of the most important factors because if someone gets hurt using the educational objects, the Royal Armouries could get sued. Any potential educational objects that may have had small parts or strangulation hazards, etc., were given low raw scores while large, soft-play items were given higher raw scores.

What the Royal Armouries staff wants was given an overall weighting factor of 5 out of 5. While children three to four years of age will be the users of our deliverables, the Royal Armouries staff was our customer. It was important to supply the staff with the educational objects they desired since they know what is needed for their educational programmes. Potential objects the Royal Armouries staff were not looking for received low raw scores.

What teachers feel is effective was given an overall weighting factor of 4 out of 5. Teachers work with children three to four years of age on a daily basis and see how these children learn. They use educational materials to teach children about certain topics and know which ones are most effective – both in teaching and attracting the attention of children. If teachers felt a potential object was very effective, it received a high raw score.

What teachers want was given an overall weighting factor of 3 out of 5. While many times the materials teachers want is the same as the materials teachers feel are effective, they are not the same thing. Some ideas would be fun and interesting for the children to use, but would not do well in teaching a lesson about historical characters of HM Tower of London. Low raw scores were given to potential objects teachers did not want.

Historical relevance (effectiveness) was given an overall weighting factor of 4.5 out of 5. This criterion included ensuring the potential educational objects were related to the history of HM Tower of London and that they could be used easily as a supplement to a lesson. If a potential educational object was only slightly related to HM Tower of London or was more of an activity than a lesson, the raw score was lower.

Stores / Catalogues (availability) was given an overall weighting factor of 1 out of 5. This included what educational materials were already available for teachers to use in teaching lessons. If a potential object was easy to purchase at a store or through a catalogue, it got a high raw score.

What kids want / play with was given an overall weighting factor of 3.5 out of 5. This criterion was a combination of what we observed the children playing with in the classroom and the activities teachers found to be most popular. Potential objects similar to the most popular activities received high raw scores.

Time / money was given an overall weighting factor of 5 out of 5. We were given a budget of £500 and a project completion date of 02May03. If we did not have enough time and money to produce the potential educational objects, it received a low raw score.

Best Four Concepts

As requested by our correspondent at the Royal Armouries, the top ten designs were then filtered to the most promising four concepts to be fully developed into deliverable products. This consisted of looking at the results of our decision matrix, found in Section 4.2.2, and deciding which potential educational objects would be easiest to produce and the best to work into a lesson. This included eliminating those that made better activities than lessons, such as crafts. We also eliminated potential educational objects that were related to the same historical character as an object we were seriously considering to pursue. A more detailed explanation regarding how we chose the top four educational objects can be found in results, Section 4.2.2. Once we chose our four educational objects to fully develop, we met with Royal Armouries staff to receive their comments on our ideas.

3.2.3 Designing and Producing Educational Units

Based on the results of choosing our best four ideas, Section 4.2.2, we began developing the following educational objects: a walk-in castle, dress-up, a Velcro knight, and puppets. This included making some basic prototypes and finding resources to produce the educational objects. When designing each educational object, we thought of ways to ensure its portability and durability.

Walk-in Castle

The Royal Armouries staff at HM Tower of London Education Centre informed us that they desired a walk-in castle. It will be used to set the stage of any lessons or stories they tell in outreach programmes and will give young children an area to play in. The walk-in castle needed to be large enough to contain four to seven children and small enough for the staff to observe the children playing from the outside without interrupting play. This educational object also needed to be light in weight and collapsible for easy transportation, and easy for two people to assemble.

When we began thinking about how we would design a walk-in castle, we visited Tower Hamlets to see their Story Tents. The Story Tents were full sized gazebos that were cut down to be approximately 1.5 metres (5ft.) in height. Canvas panels decorated by nurseries about a certain theme were draped over the sides. There was a roof that had two windows made of sheer fabric so outsiders could see inside.

We found their design of the Story Tents very good, but some aspects were not applicable to making a walk-in castle:

- **Shape.** The four corners of the Story Tents were tapered outward, thereby not having a cube shape. We decided we needed to find a scaled down version of a full sized gazebo that did not have tapered legs. This would give us the proper shape for a castle and less design work since we would not need to cut poles down to size.
- **Temperature.** While we were inside the Story Tent, it got very warm quickly. If children were inside role-playing, they would get warm after a short amount of time. We duplicated the design of the roof for a kids garden gazebo and made it out of sheer fabric. This increased the ability of heat being able to exit the walk-in castle and the staff being able to observe the children inside it.

- **Assembly.** We were also informed that the Story Tents took around ten minutes to assemble with two or three people. To reduce the amount of setup time, we added shock cord to the inside of the poles to keep each pole loosely connected to the appropriate poles or joints when being stored. The shock cord pulls the adjacent poles and joints together.

Once the frame and roof of the walk-in castle were designed, castle walls were designed. The walls were to include battlements at the top to drape over the sides of the frame. Included in the walls was a drawbridge that raised and lowered, and a portcullis.

Dress-up

The Royal Armouries staff had previously made dress-up costumes for children over five years of age. The costumes are good props when teaching children over five years of age. In our research, we have found that children three to four years of age enjoy pretending. We altered one dress by adding Velcro to change the size of the dress to fit children three to four years of age. The alterations we made to this dress will be used as a template for altering the other existing dresses.

Adding Velcro altered three areas of the dress: the neck, the waist, and the length. In each place Velcro was added, the soft side of Velcro was added to locations that would potentially contact clothing a child was wearing. Long strips of the soft side of Velcro was added to one side of the inside area of the neck and waist. A small amount of the hook side of Velcro was added to the other side of the outside of the dress in the same areas to vary the size when attached to the soft side of Velcro. Velcro was also added to the inside and bottom of the dress to vary the length.

In addition to adding Velcro, we modified the dress to make it easier for a child to put on. This included cutting the back of the dress all the way down so a child could put it on like a smock. Velcro was added to where the dress was cut in the back in case a child over five years of age was to wear the dress.

Velcro Knight

To teach children about the order in which armour is put on, we developed a Velcro knight the size of a child three to four years of age. Initially, we were going to have a board with a picture of a person that pieces of armour could Velcro to. Near the beginning of designing the Velcro knight, we looked in the storage closet at HM Tower of London Education Centre and found the Bag O' Bones produced by Active Designs, shown in Figure 3.2. We decided to produce this educational unit copying the basic design of the Bag O' Bones.

Figure 3.2: Bag O' Bones by Active Designs

We first decided the Velcro knight would be a metre tall. The person to wear the armour was King Henry VIII. We used a visualizer to enlarge an illustration of King Henry VIII to be 1 meter (3 ft.) tall and traced him on a large piece of paper. We next chose where the armour would be divided and enlarged each piece using a photocopier. Using the copies, we made patterns for the pieces of armour.

Once we had patterns for King Henry VIII and the armour, we bought fabric and wadding. Next, we contacted an embroidery company to have them produce our armour pieces. We supplied them with our patterns and specifications for production. When we received the armour back, we attached the hook side of Velcro to the armour. We made the base of the educational object with the silhouette of King Henry VIII using hook nylon.

3.2.4 Testing Materials

After designing and producing the educational objects, see Section 4.2.3, they were tested. We tested ease of use, effectiveness, durability, and portability. Our test subjects included children three to four years of age, IQP peers, and Royal Armouries staff.

Walk-in Castle

To test the basic setup of the frame of the walk-in castle, we had IQP peers Sarah Doherty and Josevan Vallejo attempt to set it up. We gave them the bag containing the frame with shock cord and asked them to erect the walk-in castle. We recorded the time it took them to set it up and took pictures and limited video.

After we verified the frame with shock cord worked well, we asked other IQP peers to set up the walk-in castle with added directions, walls, and roof. We recorded any situations

where they struggled and the amount of setup time. We also noted any suggestions they had for improvements to the walk-in castle.

After secondary modifications were made, we were able to conduct the final step of testing. We asked Royal Armouries staff to assemble and disassemble the walk-in castle including the attachment of roof and wall material. Again we noted any issues or comments.

Dress-up

We visited the Ragged School Museum to test our altered dress. We found a girl four years of age willing to try the dress on for us. We put the dress on her and noted the difficulties we had. We recorded how well the dress fit her around her neck and waist. She then ran around the play area wearing the dress so we could see how well the length stayed.

Velcro Knight

We did not budget enough time to produce the Velcro knight, so we were not able to test our Velcro knight on nursery aged children. We received the Velcro knight back from the embroidery company too late. The Velcro knight is closely related to the Bag O' Bones, the only difference being that the armour must be put on starting at the feet and working up. The order in which the bones are put on the Bag O' Bones does not matter. Bag O' Bones has been used on multiple occasions by children and they find it fun and educational. Using this information, we concluded that the Velcro knight would also be fun and educational for nursery aged children. The Royal Armouries staff was familiar with Active Design's Bag O' Bones and how it works, so we did not find it a problem that we were not able to test it on the nursery aged children.

3.2.5 Finalizing Materials

Based on the results of the tests, Section 4.2.4, we made modifications to our educational objects. Once these modifications were completed, we had portable, soft-play educational objects as deliverable products.

Walk-in Castle

After seeing the results of our first test on the walk-in castle, Section 4.2.4, we added some general directions to ease the assembly. The best way to begin assembly is to begin at the top. To identify the top joint, we coloured it to make it easily identifiable. By doing this, it would make the task of assembling the castle easier.

Dress-up

The test results of the dress-up costume, Section 4.2.4, alluded to the need of adding more Velcro. More soft side Velcro was added to the neck and waist area to add the ability of making it even smaller. Additionally, more soft side Velcro was added to the inside of the petticoat. The petticoat was also cut up the back and attached to the dress. This made the dress one piece instead of two and eased the act of shortening the dress for children.

Velcro Knight

The only modification that we have made to the Velcro knight was having the pieces of armour embroidered. Originally, we had planned on sewing all the details on the armour by

ourselves, but this would take more time than was available. Also, we felt that the professionally embroidered armour would look more impressive

3.3 Summary

Once we gathered information from the nurseries and used our creativity skills, we were able to prototype certain ideas for educational objects. Based on these prototypes, we designed and tested educational objects. We will present the results and analysis of these methods in the next section.

4 RESULTS & ANALYSIS

This project had three basic results: information about nursery children and the classroom, three portable educational units as deliverable products, and recommendations for additional educational materials. This section elaborates on the information extracted from the analysis of our information collected at the nursery schools, how we developed and produced educational objects, and recommendations for educational objects we did not choose to develop.

4.1 Nursery Schools

When we visited the nurseries, we learned what types of activities and educational resources were available to nursery school children. The three nurseries we visited had their classrooms divided into different areas for certain activities. For example, the book corner contained desks and little cushions along with many different books. In the math area, there was a table with a scale and blocks of different weights, colours and shapes. The writing area had desks, pencils, crayons, markers and paper for the children to practice their writing skills.

Through our observation of the children at play, we were able to see the activities that they preferred. While the children were inside, either teachers directed organized activities or the students participated in free play. Some children were colouring, drawing, painting, using play-dough, doing puzzles, and using the computer. We found that while the children were outside on the playground, many were playing on balance beams and in the playhouse.

Additionally, we learned about the student and teacher interaction in the classroom through interviews. The teachers told us that children learn best when they have first hand experience; they learn by being involved. Children also need to be able to manipulate the

toys and materials. The most popular activities are sand, water, dress-up, physical activities, and any reading or writing activities with the adults.

From our interviews, we were able to learn about a child's capacity to learn about the past. We were informed that children three to four years of age live "here and now." They can understand differences between new and old, but do not have a concept of time. They may remember things that happened the previous day, but mainly remember special events that may have occurred previously in their lives. Children can be taught simple ideas about the past dependent upon how it is taught.

During our interviews, the teachers alluded to the types of educational materials they would like in their classroom. All of the teachers said that dress-up and costumes are a useful technique when teaching about the past. They would really like to see props involving kings, queens, knights, and crowns. Nursery teachers stated that it is better to allow the child to use his or her imagination when drawing instead of handing the child a pre-drawn picture to colour. An example of this was to put a crown in front of the children to draw their own interpretation of it and then decorate it with available art materials.

4.2 Educational Materials

With the information we gathered at nursery schools, we began developing educational objects about the history of HM Tower of London. This section elaborates on the results of our efforts towards brainstorming, choosing educational objects to pursue, prototyping, construction, testing and finalization.

4.2.1 Brainstormed Ideas

Through our organized brainstorming sessions, we produced a list of ideas for each historical character related to HM Tower of London. The complete brainstorming results can be found in Appendix **E**. A few examples for each character are included in this section.

We sparked our creativity and brainstormed many ideas related to castles. Among our most promising ideas were a pop-up Tower, a cloth board game, molds for play-dough or food, and dollhouse with figures. The pop-up Tower was a near replica of the White Tower at HM Tower of London. All four sides would have been decorated with white brick and crenellations, i.e. battlements or indented parapets, depicted in Figure 4.1. Amongst the walls was a doorway with drawbridge and portcullis to make the design more appealing and interesting to children. The cloth board game had a top-view or three-dimensional representation of the White Tower for children to move their pieces by picking up colored cards and moving to the appropriate next square. Molds or cookie-cutters were in the shape of a castle fabricated from either plastic or bent tin for use with play-dough or food. Other ideas included bricks, blocks, or Lego's for children to help build the setting of HM Tower of London, a blow-up castle or tower, and a full-size castle decorated wall.

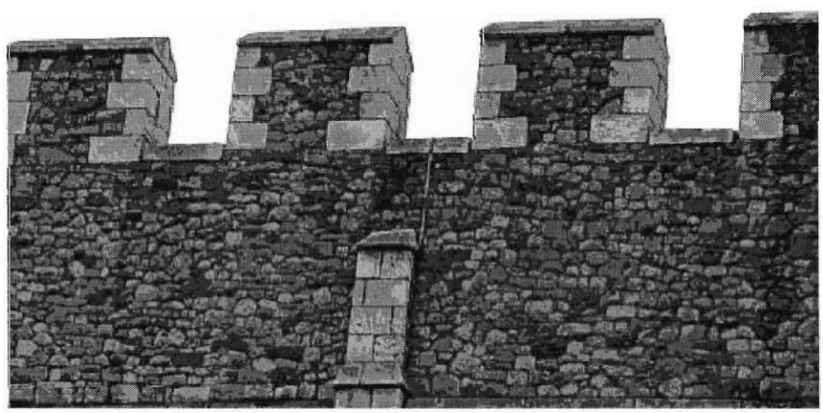

Figure 4.1: Crenellations

There were many different concepts for educational objects related to armour. Dress-up costumes, a Velcro person, craft projects, and board games were our primary ideas for educational objects. Pre-made dress-up costumes would include shields, helmets, and horses with armour. An elaborate suit could be constructed from the soft or loop-side of Velcro and each piece of armour with laminated foil over cardboard and corresponding hook-side material. Crafts included making and decorating shields and helmets. Additionally, pieces of chain mail would be something that children would benefit from holding and manipulating to understand its composition. These designs would have conveyed the manner in which armour was worn and put on in different pieces.

Many of the ideas for knights were closely related to armour. Ideas included colouring book topics such as a knight and horse, knights with a sword, or a knight fighting a dragon. Activities such as dressing the knight, and 'which one of these is not like the other' were also considered. Dressing the knight was a page in an activity book split down the middle. One side of the page had pieces of armour and the other side has corresponding body parts. Children could then match the piece of armour with the appropriate body part by drawing connecting lines. Another idea was to erect a child-size maze with the goal of finding their steed or a princess at the end. Children would learn of a knight's bravery and courage in the face of a challenge.

Crowns are very special and are worn by important people. These symbols of power and sovereignty would have caught the interest of children immediately. Projects to decorate a crown from perforated or pre-cut cardstock may be done using sequins, marbles, fur, or anything shiny and bright to represent the brilliance of a real crown. Lessons that brought crown replicas to preschools or other education centers would have allowed children to sketch a picture of a crown firsthand. Letting children three to four years of age have

physical contact with a crown and duplicating it on paper before decoration reinforces the information presented with the crown.

We brainstormed a few ideas for guardsmen. Included was a tall dress-up hat lined with black fur lined material to fit a child three to four years of age. They could wear these hats in staring competitions since guardsmen are disciplined not to change facial expression. Any type of activity that kids would be able to role-play, as a guard, would be both entertaining and educational.

We came up with ideas related to living history at HM Tower of London, yeoman warders. Dress-up in the different coloured uniforms of a warder was a promising concept. Furthermore, children could use pre-cut pieces of felt to decorate their own uniforms. These supplies are often available at nursery schools or could easily be brought to the sites of the outreach programmes.

Ravens are characters in a legend that involves HM Tower of London. In addition to being told the legend or the story of Charlie the Raven, children could dress-up in a raven mask or costume. Following the stories, the kids could sketch their own ravens to be decorated with feathers or black felt material.

A select lot of ideas related to the historical characters of HM Tower of London were chosen to be prototyped and then further developed into complete designs. The remaining topics were recommended for future implementation.

4.2.2 Chosen Concepts & Prototypes

We prototyped two ideas from the original brainstormed list before initial ideas were eliminated. We came up with many different pages for an activity book and a prototype for

the castle bean bag toss. Instead of continuing to prototype all of our ideas from the nursery list, we decided to wait until we chose the top four educational objects to prototype.

To encourage feedback from nursery teachers, we eliminated ideas from our original list. Presenting a list that was too long may have daunted teachers and limited the amount of time spent on considering each concept. The list presented to teachers was less than a page long and appropriately categorized. This list can be found in Appendix **F**.

Top Ten Concepts

Using the decision matrix described in Section 3.2.2, we scored the potential ideas using each criterion to give a total weighted score for each individual idea. The best concepts were those found to have the highest weighted score at the end of this task. A comprehensive table with each individual criterion value can be found in Appendix **G**. The following is a list of our ideas and their corresponding scores:

Place	Material	Score
1.	Dress-up	156
2.	Walk-in Castle	153
3.	Velcro Knight	152.3
4.	Puppets	151.25
5.	Make-Your-Own Shield / Crown	144.25
6.	Pre-cut Ravens	138.75
7.	Dollhouse with Figures	134
8.	Cloth Board Game	131
9.	Bean Bag Toss	126
10.	Paper Dolls	118.5

Best Four Concepts

We decided to pursue four of the ten ideas for deliverable products. Our first potential object was dress-up because we originally thought it would be a quick and easy modification. Next, we chose to pursue the walk-in castle since the Royal Armouries staff really wanted to have this to set the scene of lessons. Once we chose the walk-in castle, we eliminated the other ideas related to castles: dollhouse and bean bag toss. Ideas that were better activities than lessons were eliminated: make-your-own shield or crown, pre-cut ravens, and cloth board game. Puppets and paper dolls could teach the same lesson, but puppets would work better for storytelling. Lastly, we chose to pursue the Velcro knight. The four educational objects we chose to pursue happened to be the four best ranked in our decision matrix: dress-up costumes, a walk-in castle, a Velcro knight, and puppets.

4.2.3 Material Designs

With all of the information we gathered through our interaction with nursery school children, their teachers, and many other visits and interviews, we were able to begin designing educational objects. This section elaborates on the actual designs of our top four choices for educational objects for the Royal Armouries staff at HM Tower of London.

Walk-in Castle

The walk-in castle was one of our most sought after and labor intensive designs. The most challenging portion of this task was to find appropriate materials that fit our needs.

However, the concept of a walk-in castle remained straightforward and only slight modifications were necessary to achieve a prototype.

The first design of the walk-in castle was very basic. It began as a four-sided cube with neither top nor bottom. Each side was decorated with crennellations along the tops and brick outlines on each face. The entrance to the miniature White Tower was to have a drawbridge and portcullis. We planned on making the drawbridge a cutout piece attached along the bottom of the castle and lowered by two "chains," made from either string or other material, on either side. A black steel grid would have simply been painted or drawn onto the castle along the top of the entrance to give the illusion of a true portcullis. Additionally, thin-long windows may have been added to demonstrate how castles were built for defense as well as regal dwellings.

A few necessary alterations were made to the initial design in order to reach a product that was able to be tested. Our search for make-your-own tent kits was unsuccessful. After our visit to the Story Tents, we were able to model our walk-in castle on their idea of using a pre-built kids garden gazebo that could be modified to look however we chose. The pre-built gazebo can be found in Figure 4.2. As soon as a proper kit was found, measurements for each side could be made. The kids garden gazebo purchased met our criteria for something that could hold between four and seven children.

Figure 4.2: Kids Garden Gazebo

A major difference between the gazebo and our original design was its roof. Removing the roof would have hindered the structural integrity of the castle so greatly that it was not an option. We decided on a mesh roof instead that would hold the construction together, give teachers the ability to see inside, and appeal to the children by providing a greater sense of intimacy.

The kids garden gazebo also fit our need for a portable design. Each side was comprised of two separate rods that were connected with flanged joints in the center. We decided to string shock cord throughout the rods to keep them together as well as make assembly as simple as possible. The shock cord made our design more portable and easier to use which were both important factors.

Dress-up

Using one of the original costumes the Royal Armouries staff uses for dress-up activities, we altered it to fit a child under five years of age. We cut the dress directly up the seam in the back of the dress and added 25 inches (63.5 cm) of Velcro to make it easier for a child to put on. The child would just have to put out his or her hands and step into the dress.

After doing this, we added strips of Velcro that were 5 ¾ inches (14.5 cm) to the right side of the neckline. To the left side of the neckline, we added strips of Velcro that were 3 ¾ inches (8cm) in length. To the right side of the waistline we added 6 ½ inches (16.5cm) of Velcro. To the left side of the waistline, we added 3 ¼ inches (82cm) of Velcro.

To shorten the length of the dress, we added hook side Velcro to the bottom of the dress so it stuck to the inside of the petticoat and held at a shorter length. In the petticoat we added 5 strips, each approximately 28 inches (71 cm) in length. Using these strips, the outside of the dress could be folded up inside the petticoat and Velcro together to shorten the dress for a younger child. Slightly above that, we added a strip of soft side Velcro around the

entire bottom of the dress. This was added in case a child did not need the dress shortened so the hook side Velcro did not catch their clothing.

Velcro Knight

The design of the child size Velcro knight entailed choosing appropriate dimensions, materials, and a method of decoration. The silhouette portion or backing of the Velcro Knight was 1m by ½m. A cross section from one side to the other consisted of four layers: green loop nylon, wadding, blue loop nylon, and green loop nylon. The wadding was placed in between to make it sturdier because we were not able to get the material we had planned on using. The outside of the backing was green while the backing of the silhouette was blue and the silhouette of King Henry VIII was green.

In order to get our armour the proper size, we photocopied our original pieces of armour. Using these photocopies, we then went around each piece of the photocopy and added an extra ½ inch to the outside to use as a pattern while sewing. Each piece of armour consists of five layers: grey loop nylon, wadding, stiffener, grey loop nylon, and silver material. We individually sewed each piece of the armour together using the four layers. Finally, we added Velcro to the back of each of the pieces of armour so that they would easily stick on the silhouette backing of King Henry VIII. We were able to have all the finer details of each piece of armour expertly embroidered into it. This gave the final design of the child size Velcro knight a professional look.

4.2.4 Test Results

We tested the original designs of the educational units for ease of use, effectiveness, durability, and portability. This section presents the test results for each educational object.

Walk-in Castle

The testing of the walk-in castle was done in two separate steps. The first step was performed after the shockcord was added to the gazebo structure. We were able to have another IQP team, two people, assemble and disassemble the walk-in castle frame. Their measured times for assembly and disassembly were relatively the same at about five minutes. This is an improvement over our original time of about ten minutes each when the shockcord was not added.

The test subjects expressed an interest in a few minor additions to our project. The first would be to make an instructional sheet or pamphlet with simple assembly instructions. We found that it would be easiest if users began assembly at the apex of the castle, constructing the roof, and then worked their way down to the legs. Conversely, disassemby should begin at the legs and work to the apex. In order to aid in this task, we needed to color the apex joint a different color than the rest. Hopefully, this will decrease test times.

The second stage of testing went well. Royal Armouries staff members were asked to assemble and disassemble the castle including the walls and roof. After modifications were made to the apex joint, construction was much simpler. The addition of the mesh roof and castle walls added several minutes to the test times, but remained at acceptable levels. The walk-in castle tests were successful overall.

Dress-up

Dressing the child four years of age in the costume was quite a task. We had no problems getting the child into the dress beyond observing that the neck and waist were still too large. The problem had arisen when we attempted to shorten the dress. The petticoat was not staying around the child's waist and made it longer than it should have been. The part of the dress that had been attached to the petticoat by Velcro fell down quite a bit in the front. This led to another problem where there was not enough Velcro attached to the inside of the petticoat.

4.2.5 Finalized Materials

After carefully producing and testing our material designs, we made corrections to each educational object. This section describes in detail what the finalized objects look like: the walk-in castle, the altered dress-up clothes, and the Velcro Knight.

Walk-in Castle

Following the testing phase, we were able to make final modifications to the walk-in castle to make it more complete and easier to use. Our last alterations of our design included incorporating the drawbridge and portcullis. The portcullis is black fabric stitched into the doorway. The drawbridge is brown fabric that is attached to the castle walls using rivets and keychain loops. Material was fastened to the roof along each seam to increase durability. This should minimize the longterm effects of stretching the mesh material over the castle

frame. With its increased durability and ease of setup, the walk-in castle design was complete. The finalized castle assembled and stored can be found in Figure 4.3.

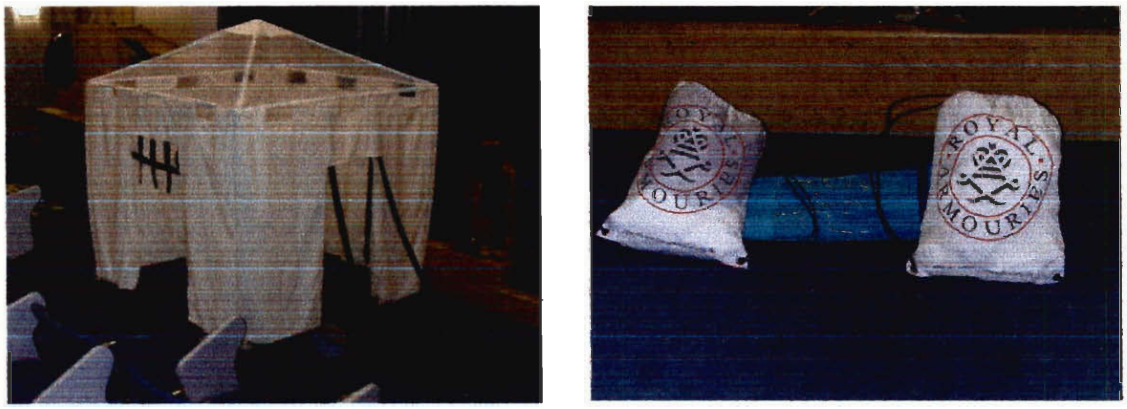

Figure 4.3: Walk-in Castle, assembled (left) and stored (right)

Dress-up

The final object consisted of the dress and petticoat sewn together as if it were all one piece. Previously, we cut straight down the back of the dress, which is what had to be done to the petticoat as well, so they would fit together properly. This assured us that there would not be any problems with the petticoat falling of the child's waist. Along with this, we had to add more Velcro to both the waist and the necklines in order for it to better fit a younger child. We had to make both even smaller than we had the first time. The last adjustment we made to our prototype was to add more vertical strips of Velcro to the original petticoat. We added 5 more strips of Velcro the same length to the petticoat. This will make it easier for a child to Velcro the bottom of the dress up in order to make it shorter, so that it will fit him/her better. A picture of the inside of the dress and the dress shortened can be found in Figure 4.4.

Figure 4.4: Altered Dress-up Costume, inside (left) and shortened (right)

Velcro Knight

When we tested our Velcro Knight, we did not have any problems. The Velcro seemed to be staying on just fine. All materials used and quality of construction seemed durable enough to last for a long time. Small loops were added for mounting to the inside of the walk-in castle. This will help make the interior of the castle more interesting while providing a method of hanging the child size Velcro knight on another of the portable materials. A picture of the finalized and stored Velcro knight can be found in Figure 4.5.

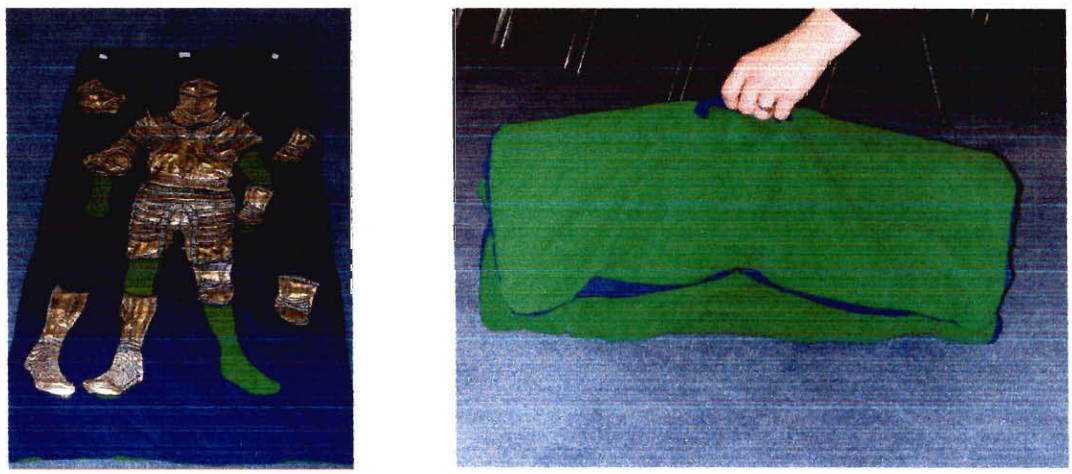

Figure 4.5: Velcro Knight, finalized (left) and stored (right)

4.3 Summary

Based on the information we gathered from interviews and observations, we were able to create a decision matrix that contributed to the process of deciding which educational objects to produce. From this matrix, we chose the top ten and then narrowed this down to four objects to pursue. We developed our object designs and tested them. We revisited our original designs and made corrections so that we would have finalized materials.

5 RECOMMENDATIONS

We brainstormed many ideas and would have pursued all the feasible ideas if we had the time and money. Since that was not the case, we were only able to produce our top three educational objects. The ideas in the top-ten list that we did not produce were left as recommendations for the Royal Armouries staff at HM Tower of London Education Centre for development in the future.

Puppets were one of our top four objects that we had chosen to produce, but we ran out of time and were not able to produce them. It had ranked fourth in our decision matrix. We had planned on making puppets, allowing the children to use the walk-in castle as a stage.

We had a few different ideas for puppets. As an activity, the children would make their own puppets using popsicle-sticks. Our soft play puppets would have been hand puppets. These would have been produced using pre-made hand mits as a base and adding the characters of the tower to each mit. The last idea for puppets was inspired by Hannah Dempsey from the Ragged School Museum. This was to make shadow puppets. Using puppets on popsicle-sticks, the children could shine lights on the walk-in castle and create shadows of the characters of the tower for those either inside or outside the castle, depending on where the light was shone.

Make your own crown or shield is an arts and crafts project to get the children involved in an activity related to HM Tower of London. This activity ranked fifth in our decision matrix. This entails allowing a child to look at replicas of both a crown and a shield and having them duplicate what they see. Using the picture they have just drawn, the children can decorate their drawing with sequins, fake jewels, fur, or anything shiny and bright. This activity can also teach children about how precious crowns are and how heraldry works on shields.

Pre-cut ravens are another arts and crafts project, which ranked sixth in our decision matrix. We thought of two closely related ideas that went along with this. Our first idea was to have a precut raven for the children to decorate with black felt and feathers. After visiting the nurseries and interviewing the teachers, we thought of another closely related idea. Teachers encouraged having the children visit HM Tower of London, see the ravens, and allow them to draw their own version of a raven. Then let them use the feathers and felt to decorate.

A replica of a tower with figurines ranked as unit seven in our decision matrix. We hoped that a tower could be built about the size of a dollhouse along with many different characters that go along with HM Tower of London. The characters included in this could be kings, queens, princes, princesses, yeoman warders, guardsmen, knights, and ravens.

A cloth board game ranked eighth in our decision matrix. We were hoping that this would be a map of HM Tower of London. The object of the game would be for a knight to collect all pieces of armour as the player moves about the board (Tower). The child would roll a coloured die and move to that colour on the board while trying to collect all pieces of armour until the knight is fully dressed where the game would be over. The pieces of armour would be picked up in the order that a knight would dress himself, starting at his feet.

A beanbag toss ranked in ninth place in our decision matrix. This would be in the shape of a castle made out of wood or thick foam. It would have a portcullis and a drawbridge along with slits as windows. There would be different sized beanbags: some small enough to fit through the small windows and some too large to fit through the windows. This would teach a child that windows were small slits as a defensive measure to protect the castle. The bean bags could be colour coded or numbered corresponding to which opening they fit in thereby giving the game different levels of difficulty.

Laminated paper doll cutouts ranked as object ten in our decision matrix. The clothes to be put on each doll would be the attire that each character of the castle wears. Outfits included would be those of kings, queens, yeoman warders, guardsmen, knights, and ravens. The next section gives the conclusions of our project.

6 CONCLUSIONS

Over the duration of our project with the Royal Armouries at HM Tower of London Education Centre, we were able to deliver four educational objects. Delivering educational objects consisted of gathering information from nursery schools followed by brainstorming, prototyping, designing, testing, and finalizing educational objects.

For the purpose of having a basis of developing educational objects, we first visited nursery schools to gather information about how children three to four years of age learn. In the classroom, there are many different resources available for the children to play with. Children were either engaged in free-play or teacher led activities that included colouring, drawing, painting, play-dough, puzzles, books, music, science, sand and water, role-play, an outside play area, and computers. Of all the resources available, children were more interested in sand & water, dress-up, hands-on, play-dough, blocks, building, and teacher led activities.

In asking the teachers if a child could learn about history, children three to four years of age can understand simple concepts but don't understand "history." While children this age area able to understand differences between new and old, they are unable to grasp the concept of "a long time ago" and subsequently live in the "here and now." Beyond special events in their life, they are rarely capable of recalling events further than the previous day.

Teachers informed us about how they perceive children three to four years of age learn best. They stressed the importance of giving young children first-hand experiences and allowing them to explore things hands-on. They felt the most effective resources in their classrooms included costume and prop use in storytelling. Overall, any activities that allow them to use their imagination with different types of media help in teaching.

After collecting the information from nurseries, we brainstormed many ideas for potential educational objects. Within the scope of this project we were able to produce three finalized educational objects to be used by the Royal Armouries staff in their outreach programmes. The guidelines for each educational object were that they must be portable, durable, and teach a particular lesson related to HM Tower of London. The most limiting factors in producing educational objects were time and money. Our three deliverable products included a walk-in castle, alterations to costumes, and a Velcro knight. Remaining ideas were either discarded or documented as suggested materials for later development.

The educational objects we developed will assist Royal Armouries staff in teaching lessons about HM Tower of London. The portability of each design allows them to be easily transported to outreach sites such as libraries, nurseries and other community centres. Furthermore, the outcomes of this project allow the Royal Armouries to have a broader audience that includes children three to four years of age. The teaching staff will now be able to develop new lessons incorporating our educational objects. Nursery school children will learn about the important historical characters and places at HM Tower of London. This emphasis on teaching lessons about basic history related to HM Tower of London to younger children will aid in an earlier understanding of history.

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A APPENDIX A – NURSERY SCHOOL CONTACTS

In alphabetical order by school name in the following format:

Contact Name
School Name
Address
Phone Number

Fiona Singleton
Alice Model Nursery
14 Beaumont Grove
Stepney, London E1 4NQ
020 7790 5425

Ms. M. Chrystie
Hermitage Primary School
Vaughan Way
London E1 9PT
020 7702 1037

Miss C. J. Thomas
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Barking IG11 9AG
020 8270 6630

Matilda Delgardo
Matilda Day Nursery
St. Katharine's Way
London E1 9LQ
020 7480 6396

Mrs. J. Sheehan
St. Ann's Primary School Playgroup
Underwood Road
London E1 5AW
020 7247 6327

B APPENDIX B – NURSERY LETTER OF REQUEST

18th March 2003

Fiona Singleton
Alice Model Nursery
14 Beaumont Grove
Stepney, London E1 4NQ
020 7790 5425

Fiona Singleton:

We are a group of students from Worcester Polytechnic Institute in Massachusetts, USA, working on our Interactive Qualifying Project. This is a project that relates engineering to society. Specifically, we will be working with the staff at the Royal Armouries Tower of London to produce educational materials. These will be aimed at children less than 5 years of age to introduce them to the history of Her Majesty's Tower of London.

In order to successfully complete this task, we feel the need to get input from potential users. This would include visiting your nursery, if time avails, to interview teachers who work with children under 5 years of age and observing the students in the classroom to collect proper information to develop our educational materials. During our visit to your nursery, we hope to learn about the classroom structure, teacher-student interaction, and what types of toys or educational materials the students are drawn toward.

If you are willing and able to allow us to visit your nursery during the week of the 24th March, we would greatly appreciate it. We will attempt to contact you via telephone to follow up this letter on Friday, the 21st March to schedule a time to visit. Thank you in advance for your assistance.

Regards,

Alex DiDonato

Kate Leach

Melissa O'Bryant
Royal Armouries Research Team

C APPENDIX C – NURSERY OBSERVATION SHEET

Materials available to students:

☐ Coloring Books	☐ View-Master®	☐ _____
☐ Dress-up Clothes	☐ Arts and Crafts	☐ _____
☐ Dolls	☐ Blocks/Duplos®	☐ _____
☐ Board games	☐ Puzzles	☐ _____
☐ Sporting Equipment	☐ Story/Picture Books	☐ _____

How many students are involved in each activity?

☐ Drawing	☐ Board Games	☐ _____
☐ Reading	☐ Puzzles	☐ _____
☐ Dress-Up	☐ Play-Doh/Modeling	☐ _____
☐ Dolls/Action Figures	☐ Hand Puppets	☐ _____
☐ Singing	☐ Connect-the-dot	☐ _____

Types of toys that children play with:

_____

_____

_____

_____

Educational activities and their lessons:

_____

_____

_____

_____

Teacher / student interaction (free-learning / led activities & examples)

_____

_____

_____

_____

D APPENDIX D – NURSERY TEACHER INTERVIEW

1. How does a child three to four years of age learn best?

2. Are there any specific types of toys or educational objects that attract children of three to four years of age?

3. What do you feel is a child's capacity to learn history?

4. What are examples of learning activities done here?

5. What are a few of the most popular activities?

6. Are there any specific safety precautions that should be taken when developing materials for preschool children?

7. Do you feel lessons regarding castles, ravens, yeoman warders, guardsmen, crowns, knights and armour could be taught to children three to four years of age?

8. Do you already speak about HM Tower of London?

9. What works best for you when teaching?

10. Do you have any suggestions for educational objects?

E APPENDIX E – BRAINSTORMING EFFORTS

Overall

- Activity book
  - Mazes
  - Connect-the-dots
  - Coloring pages
  - Color by number
  - Matching
- Puppets / puppet show
  - Hand puppets
  - Paper on popsicle stick (good for take-home)
  - Paper bag puppets
- Dress-up (costumes of each character)
- 2-dimensional puzzles (6-8 pieces)
- Games
  - Similar to "Go Fish"
  - Memory
- Fabric story book
- Songs
- Stories
- Origami
- Lollipops in shapes of characters

Castles

- Pop-up Tower
- Bricks, blocks, big Lego's so kids can help build the Tower setting
- Cloth board games
  - Portcullises, draw bridges, small windows
  - Colors instead of numbers on dice
- Blow-up castles / towers
- Molds for play-doh / food
- Dollhouse – replica of Tower with characters
  - Moat with water around it
  - Working drawbridge
- Full-size wall to hide behind with drawbridge, portcullis
  - Mat on floor with a moat – you can't step in the water to get to the castle or you'll drown

Armour

- Dress-up
  - Shields
  - Helmets
  - Horses w/ armour
- Kid-size Velcro person
  - Foil over cardboard & laminated for armour with Velcro on the back

- Soft side Velcro jumpsuit to Velcro armour onto them
    - Without jumpsuit – wrap around fabric with Velcro (moves at joints)
- Make their own shields (using heraldry "rules")
- Game: dress up the knight (and horse?) with armour as you travel around the board
- Chain mail – take home small piece
- Building helmets (for 5+)
    - Sweatband to keep it on head
    - Attach face mask to it to rotate it up
- One arm on armour is different

Crowns

- Burger King crowns & decorate
- Decorate with sequins, marbles, shiny, fur, (clothing) markers, feathers, pearls, cotton balls, pom-poms, felt, velvet, beads, jewels
- Pre-cut cardstock
- Physical crown as well as drawing
- Kings & Queens wore different crowns than Princes & Princesses

Guardsmen

- Hat for kids to try on
- Staring contests – others try to get them to change facial expressions
- Stories?
- Coloring book
    - Guardsmen in front of Queen / Tower
    - In a guards house

Yeoman Warders

- Dress up in different uniforms
- Felt activity – pre-cut pieces to glue onto uniform
- Activity book: which one of these is not like the other – missing an E or R or hat
- Coloring book
    - Big crowd with yeoman warders in parade
    - Beard
    - With horse & buggy

Knights

- Coloring book
    - Knight with horse
    - Near King or Queen
    - With a sword
    - Fighting a dragon
- Activity book
    - "Dress the knight" – match body part to correct piece of armour
        - (body of knight) | (pieces of armour)
    - Which one of these is not like the other? Armour with people in, and one without
- Board game – save the princess

- Kid-size maze – go find their horse / princess

Ravens

- Costume
- Masks
- 3-d maze – can't let the ball fall – relate to ravens leaving the Tower and it collapsing
- Stuffed raven – pre-cut felt stuffed with cotton balls glued together

F APPENDIX F – NURSERY LIST

- Activity book
  - Mazes
  - Connect-the-dots
  - Coloring pages
  - Color by number – how high can children 3-4yrs. of age count?
  - Matching – match knights body parts to his armour
- Puppets / puppet show
  - Hand puppets
  - Paper on popsicle stick (good for take-home)
- Dress-up
  - Raven, yeoman warders, guardsmen, crowns, knights/armour
- 2-dimensional puzzles (6-12 pieces)
- Games
  - Similar to "Go Fish"
  - Memory
  - "Dress the Knight" board game
  - guardsmen staring contests
- Lollipops in shapes of characters / Molds for play dough
- crafts (shields, crowns, stuffed ravens, felt uniforms – yeoman warders)
  - decorate with sequins, marbles, shiny, fur, markers (clothing), feathers, pearls, cotton balls, pom-poms, felt, velvet, beads, jewels

<u>Character Specific Ideas</u>

- Castles
  - Walk-in sized
  - Bean bag toss
  - Cloth board game
- Yeoman Warders, Guardsmen, Knights – "paper" dolls
- Child sized maze
- Ravens – pre-cut felt to be stuffed with cotton balls and glued together
- Knights / Armour
  - Child-size person to Velcro on armour pieces
  - Make your own shield

G APPENDIX G – DECISION MATRIX

where 1 is low and 5 is high & a higher total weighted score is best	Criterion	Portability	Safety	RA Staff	What teachers feel effective	What teachers want	Historical Linkage (effectiveness)	Stores / Catalogues (availability)	What kids want / play with	Time / Money	**Total Weighted Score**
Module	Overall => Weighting Factor =>	5	5	5	4	3	4.5	1	3.5	5	
Activity Book	Raw Score	5	4	1	2	1	3.5	5	2.5	4.5	ranked 12
	Weighted Score	25	20	5	8	3	15.75	5	8.75	22.5	**113**
Bean Bag Toss	Raw Score	4	4	2.5	3	3.5	3	3.5	4	4	ranked 9
	Weighted Score	20	20	12.5	12	10.5	13.5	3.5	14	20	**126**
Card Games	Raw Score	5	5	1	2	1.5	1.5	5	3.5	5	ranked 11
	Weighted Score	25	25	5	8	4.5	6.75	5	12.25	25	**116.5**
Cloth Board Game	Raw Score	5	5	4	3.5	2.5	3	4	2	3	ranked 8
	Weighted Score	25	25	20	14	7.5	13.5	4	7	15	**131**
Dollhouse	Raw Score	2.5	3.5	4.5	5	5	4.5	4	3.5	2	ranked 7
	Weighted Score	12.5	17.5	22.5	20	15	20.25	4	12.25	10	**134**
Dress-up	**Raw Score**	**4**	**4**	**5**	**4**	**5**	**5**	**3.5**	**4**	**4**	**ranked 1**
	Weighted Score	**20**	**20**	**25**	**16**	**15**	**22.5**	**3.5**	**14**	**20**	**156**
Food Molds	Raw Score	5	3	1	2	4	2	1.5	4	2	ranked 14
	Weighted Score	25	15	5	8	12	9	1.5	14	10	**99.5**
Paper Dolls	Raw Score	5	4	2	2	2	3	4	2	5	ranked 10
	Weighted Score	25	20	10	8	6	13.5	4	7	25	**118.5**
Pre-cut Ravens	Raw Score	5	5	2.5	3.5	3	3.5	2	3	5	ranked 6
	Weighted Score	25	25	12.5	14	9	15.75	2	10.5	25	**138.75**
Puppets	**Raw Score**	**5**	**4**	**4**	**4**	**5**	**4**	**5**	**3.5**	**4**	**ranked 4**
	Weighted Score	**25**	**20**	**20**	**16**	**15**	**18**	**5**	**12.25**	**20**	**151.25**
Puzzles	Raw Score	5	4	3	2.5	3	1.5	4	2	3	ranked 13
	Weighted Score	25	20	15	10	9	6.75	4	7	15	**111.75**
Sheild / Crown	Raw Score	5	5	3	4	3	4	2.5	2.5	5	ranked 5
	Weighted Score	25	25	15	16	9	18	2.5	8.75	25	**144.25**
Velcro Knight	**Raw Score**	**5**	**5**	**4**	**4**	**4**	**4**	**2.5**	**4**	**4**	**ranked 3**
	Weighted Score	**25**	**25**	**20**	**16**	**12**	**18**	**2.5**	**14**	**20**	**152.5**
Walk-in Castle	**Raw Score**	**4.5**	**4**	**5**	**4**	**5**	**4**	**4**	**5**	**3**	**ranked 2**
	Weighted Score	**22.5**	**20**	**25**	**16**	**15**	**18**	**4**	**17.5**	**15**	**153**