FAMILY PLAY-LEARNING THROUGH INFORMAL EDUCATION

MAKE AND PLAY ACTIVITIES WITH TRADITIONAL THAI TOY ACTIVITIES AT A SCIENCE MUSEUM

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Abstract

This thesis charts the outcomes of family play-learning through make-and-play activities with traditional Thai toys activities (TTTA). Family learning is a component of inter-generational learning, and the research explores this through 'edutainment' activities within the informal educational system of a science museum. The thesis also identifies key factors that influence family play-learning through TTTA and explores the nature and impact of traditional Thai culture, local wisdom and Western modern science after participation with the TTTA.

Participants in the toy-making activities at the National Science Museum, Thailand are members of the general public, day visitors to the museum who volunteer to join the activities, and represent all age groups. They also have varied levels of educational achievement, backgrounds in science and dispositions towards play. The research follows 93 families, including children, teenagers and adults, a total of 179 participants. Participants' dispositions towards play are collected through self-reporting questionnaires based upon Barnett's (2006) work on playfulness; data on their individual and group actions have been collected in terms of their levels of enjoyment and engagement with the tasks, and learning outcomes.

The data from structured routine observation indicates that, within the make-and-play activities, there is a two-way transfer of learning from older to younger, and from younger to older. The analysis of family learning is based upon Bandura's (2005) social cognitive theories, used here in relation to informal museum education. Family play-learning is seen as significant, where more experienced members of the family transfer their knowledge and role-model skills to their children or younger members of the family. There is also an upward transfer where discerning youth model the fun and creativity they bring to the tasks.

The Toy Learning Outcomes Questionnaire (TLOQ) has been used to study families' learning outcomes from the TTTA with 51 families composed of 125 participants in total. The TLOQ is based upon work of the Research Centre of Museums and Galleries at the University of Leicester (Hooper-Greenhill, 2007), and uses a four-point Likert-style scale to explore seven areas of interest: (i) knowledge and understanding; (ii) skills; (iii) attitudes and values; (vi) enjoyment, inspiration and creativity; (v) action, behaviour and progression; (vi) scientific learning, and (vii) attitude towards Thai local wisdom. The findings show that families appear to have learned most in relation to two of these areas, 'scientific knowledge' and 'Thai local wisdom', when compared with the other areas.

Data from semi-structured 'exit interviews' at the end of the activities, explore this clash of cultures, between Western modern science (WMS) and Thai local wisdom (TLW). This allows for a discussion of the integration of knowledge systems versus distinctive and separate fields. Findings from the interview data indicate that participants treat the TTTA, and work of the museum generally, bi-gnosically: they had positive yet parallel attitudes towards both domains of knowledge.

The overall outcomes of this body of work indicate two main factors that encourage family play-learning: (i) the *context* of the play, which emphasises participants' personal engagement, social relationships, and the physical setting (the environment and resources in the TTTA); and (ii) the *conditions* to play, playfulness of the participants and the opportunities they take to learn together through play. The thesis concludes with the implications of this work and recommendations for further research.

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ABBREVIATIONS

APEC	=	**Asia-Pacific Economic Cooperation**
BGI	=	**Bi-gnostic Interview**
DIKW	=	**Data Information Knowledge Wisdom**
EO	=	**Engagement observation**
FPLO	=	**Family play-learning observation**
FMLHQ	=	**Families' motivation of learning at home questionnaire**
GLO	=	**Generic Learning Outcomes**
IPST	=	**Institute for the promotion of teaching Science and Technology**
IRB	=	**Institute Review Board**
LW	=	**Local wisdom**
NIACE	=	**National Institute of Adults Continuing Education**
NSM	=	**National Science Museum, Thailand**
ONIE	=	**Office of the Non-formal and informal Education**
OTOP	=	**One Tumbon (sub-district) One Product**
PO	=	**Playfulness observation**
PQ	=	**Playfulness questionnaire**
SMEs	=	**Small and Medium Enterprises**
TLO	=	**Toy learning outcomes**
TLOQ	=	**Toy learning outcomes questionnaire**
TLW	=	**Thai local wisdom**
TTT	=	**Traditional Thai toy**
TTTA	=	**Traditional Thai toys activity**
WS	=	**Western science**
WMS	=	**Western Modern Science**

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CHAPTER 1
INTRODUCTION: AIMS AND PLANS

1.1 Introduction

This chapter outlines the purpose behind this thesis entitled, **Family play-learning through informal education: Make and play activities with traditional Thai toy activities at a science museum.** It gives a concise background as to how I became interested in family play-learning through traditional Thai toy activities at the National Science Museum, in Pathunthani, Thailand. This chapter gives a short description of the educational system in Thailand; of informal education and family learning; family play-learning in a science museum; of toys, play and learning through play and family play-learning through traditional Thai toys. It also discusses the rationale and significance of this particular research. Moreover, this chapter gives a brief introduction to the National Science Museum, Thailand and the nature and impact of traditional Thai culture and local wisdom, of modern western science and of the combination of knowledge systems called bi-gnosis. I state the objectives of the study, research questions, methodology, and finally I present outlines of the organisation of the thesis in five different chapters.

1.2 Background

My experience as a science educator in the Science Museum of the National Science Museum in Thailand extends over twelve years from the opening of the Science Museum in 2000, and my professional experience of working in the exhibition section led me to this research on family play-learning with the traditional Thai toy activities (TTTA). This in turn has led to a discussion of bi-gnostic learning and those factors within a science museum that encourage visitors' learning with the activities.

I had responsibility for one part of an exhibition in the Thai traditional technology gallery that emphasises what is called 'Thai local wisdom technology', local technology that is explained through scientific terms. As for the science educational section, I also developed several educational activities for the science museum, for example, I ran science cultural camps, science shows, science drama events, organised

science toys and the 'traditional Thai toy activities' (TTTA). Each activity has different interest points but the TTTA seems to be more interesting because, as I discuss later, it is a unique activity that derives from two knowledge systems, both Western modern science (WMS) knowledge and Thai local wisdom (TLW).

Apart from school tours, the largest groups of visitors at the science museum are families. From personal experience over a long period of time, I found that most family groups enjoy participating in the activities in a science museum on weekends, and are an excellent group to encourage into educational activities. From this came my interest in studying how family learning takes place in a science museum, especially, how family play-learning can occur through make-and-play activities with the gallery's traditional Thai toys (TTT). There is little (or no) such research in Thailand, and so this represents the first form of family play-learning research in the Science Museum in Thailand. My experience as exhibitor and science museum curator also led me to study factors that encourage visitors' (family groups) learning with the museum's activities. My intention is that the results of this research will benefit the exhibitions and activities at the National Science Museum in particular, as well as other museums more widely.

Based upon my experience, have evolved four interesting research issues from the science museum's educational service:
1) Factors that encourage family play-learning in a science museum, including the environment, resources, participants' character, the types of toys, engagement with the activity
2) Make and play activities with traditional Thai toys, and toy-learning outcomes
3) Family play-learning, its delineation and exploration
4) Bi-gnostic learning as this happens in the museum setting

Aligned to these four key issues, the research investigates with family groups who visit science museums and who volunteer to participate with TTTA in the activity areas. As stated above, while there has been considerable research and published discussion about science learning, museum science education and science literacy

more generally, this study is an initial body of work about family play-learning and bi-gnostic learning. There has been some research on bi-gnostic learning, though not all of it has been set in science museums. In the same way, family learning in museums has been researched and published in many papers, but family play-learning with TTTA at a science museum is an original research in this area. A discussion of the work of the National Science Museum is presented to set the scene.

1.2.1 The National Science Museum, Thailand

The National Science Museum Thailand (NSM) was founded to be the organisation responsible for the development and management of five museums, which include (1) the Science Museum, (2) Natural History Museum, (3) Information Technology Museum, (4) Rama 9 Museum and (5) NSM Science Square. The mission of NSM is to develop learning resources in science, technology and biodiversity for Thai society through science communication, activities, research and development and various educational programmes that enhance knowledge, understanding, attitudes, skills, procedures, conscience and imagination. The museums also seek to encourage the active participation of individuals in the development of science and technology to support and sustain the development of the nation (The National Science Museum, Thailand, 2004).

The Science Museum itself, the first part of NSM, opened in 2000, and is an iconic building, a unique structure that reflects a fascination with modern science and technology. There is an exhibition area of some 10,000 square metres that displays more than 250 hands-on exhibits and models about science and technology in everyday life (see Figure 1.1). Its interactive concept introduces visitors to fun learning experiences and encourages lifelong learning. The Science Museum's mission is to develop science exhibitions and science activities for Thai people to make them more aware of the importance of science and technology in everyday life. At the same time, its mission is also to encourage awareness of the value of conserving traditional Thai technology and Thai wisdom.

Figure 1.1: The Science Museum and exhibitions within the Science Museum

Source: National Science Museum, Thailand (2004: 3, 33, 87)

The exhibitions and activities to support scientific knowledge comprise six main galleries: 1) Introduction, 2) History of science and technology, 3) Basic science and energy, 4) Science and technology in Thailand, 5) Science and technology in daily life and 6) traditional Thai technology. There are numerous educational activities which include science camps, science laboratories, science shows, science drama, science walks and rallies, science toys and traditional Thai toy activities (The National Science Museum, Thailand, 2004).

It is to be noted that the Science Museum provides the main ingredients that encourage visitors to learn scientific knowledge. However, it is in the Traditional Thai Technology gallery and toy activities (TTTA) that the museum's visitors confront the two knowledge systems most, where Western Modern Science (WMS) sits alongside Thai Local Wisdom (TLW). It is here that bi-gnostic knowledge occurs.

TTTA offers two main facilities for participants to learn, these include the environment and the resources. The environment of TTTA comprises the exhibition, the collection of traditional toys and traditional Thai atmosphere. The traditional Thai toys exhibition presents the background of the toys, the type of toys, toys that relate to local wisdom and the science 'inside' the toys. The traditional Thai toy collections allow visitors to touch and play with a variety of Thai toys, and the exhibition and collection allows all visitors to explore, learn, make and play with these toys (National Science Museum, 2007).

The resources of TTTA comprise the Explainers (the on-hand museum staff), Assistants, materials to make the toys, and a toy handbook. The Explainers introduce and lead the activity, and the Assistants are helpers for participants in each group. TTTA provides materials to make the toys and the TTTA handbook is free to participants. The toys handbook provides all information about TTTA, such as the background of TTTA, the science and local wisdom of the TTTA, and methods to make the toys – both during the museum activity and later, when at home.

This TTTA activity has been in operation for visitors for about 3 years. In this study I investigate how factors such as the environment, resources, participants' character, type of toys and engagement with the activity, encourage family play-learning and learning outcomes from the TTTA. More detail on factors that enhance family play-learning with TTTA are presented further in Chapter 2.

1.2.2 Modern Western Science and Thai local Wisdom

Since the financial and economic crisis of 1997, the Thai government has redirected the vision of Thailand in all aspects, relating to both science and technology and resurgence in 'Local Wisdom'. Thailand needs to be self-reliant and less dependent upon technology. At the same time, the country requires a balance between locally developed science and technology, local culture and wisdom, with 'imported' Western science and technology. The sense of this is that Thailand should use both its own science and technology and Western science and technology to leverage local wisdom, which relates in particular to Thai's life style (Tinnaluck, 2005). So, the government

seeks a new balance of economic competitiveness and cultural self-reliance. Thai educational policy has an emphasis on developing scientific knowledge for economic competitiveness, but also contributing to the preservation of the national cultural heritage by using life-long learning and educational decentralisation (Witte, 2000). The science education policy of Thailand gave emphasis to developing scientific literacy through educational reform in 1999 (IPST, 2001). The goals of scientific literacy highlight the scientific knowledge, the nature of science, and the relationship between science technology, society and local wisdom. Specifically, Section 23 of the National Education Act 1999, amended in 2002, notes that the education system through formal, non-formal and informal education must emphasise scientific and technological knowledge and skills, as well as knowledge about religion, culture, Thai wisdom, and the application of such wisdom (Office of the National Education Commission, 2002).

Some schools are more developed than others in the teaching and learning of science, and in emphasising the relationship between science, technology, and local wisdom. For example, some schools develop students' scientific literacy through local wisdom, as might be seen in King Bhumibol Adulyadej's philosophy of a sufficiency economy, moral infusion, and the Buddhist way of life (Yuenyong and Narjaikaew, 2009). This philosophy of economic sufficiency is very important in Thailand because it is intended to help address current developmental challenges and underscores ways of living and working that is a motivation towards a crucial goal. The strategy of this philosophy emphasises the balancing of broad human activity (Western science) and the immediate community (local wisdom). The strategy also suggests that people adapt to modern science and technology to develop their occupations and improve their daily lives (Taylor, Littledyke, Eames and Coll, 2009). At the same time, they are exhorted to follow the Buddhist principle of the 'middle path' as a guiding principle for people at all levels to be aware of the balance of both forms of knowledge and seek to find suitable ways to blend these different forms together for the sustainable development of the nation.

Yuenyong and Narjaikaew (2009) pointed out that while Thai scientific educational research, articles, national tests, teaching and learning emphasise scientific achievement, outcomes and 'products' there has been little concern about science as a 'way of knowing'. This is reflected in the exhibitions in the Science Museum, so that some 80% comprise scientific knowledge and only some 20% are Thai local wisdom. Na Thalang (1995) pointed out that local wisdom has developed as a part of the development of local people. He advocated integrating local wisdom with science in science classes to allow learners to 'proudly display their conceptual knowledge'. Learning science based on local wisdom, he said, may enhance learners' ability to investigate and explain the science behind that local wisdom (p.343). Bi-gnostic learning differs from this, however, and entails learning through both systems of knowledge, and then having the choice of which way to respond. Having more than one form of knowledge is a personal and community resource that gives more choices in action and thought, therefore more freedom (Aikenhead, 2001). In this research, bi-gnostic learning means one activity can provide two knowledge systems to learners. Each knowledge system has different content and values. In terms of values, both scientific values and the values of local wisdom are made explicit in the traditional Thai toy activities (Kanhadilok and Watts, 2013b). Bi-gnosis in this learning situation emphasises the learning of scientific knowledge and local wisdom through traditional Thai toy activity (TTTA) at a science museum. Bi-gnostic learning in Thailand was reintroduced into the education system after 1997 (Tinnaluck, 2005).

In terms of scientific knowledge, TTTA allows family groups to learn scientific knowledge from several kinds of traditional toys from the exhibition and the collections of the toys. Participants learn biology, physics and environmental science from the TTTA. For example, one of the toys is a 'coconut mouse' which uses a rubber-band motor to move, and is used to foster participants' learning of scientific knowledge regarding energy, force and motion (see Figure 1.2).

Figure 1.2: Coconut mouse toys

Source: Kanhadilok and Watts (2013b: 43)

The materials to construct the toys are coconut shells, and would allow participants to learn about biology and environmental science because they are made from natural materials. The traditional Thai toys encourage family groups to develop science skills such as experimentation, observation, collection, organisation of data, discussion and the drawing of conclusions. Moreover, this activity provides cognitive, affective and psychomotor skills that are important for children's development as well as adults' learning.

Within the TTTA, Thai local wisdom provides the opportunity for participants to learn Thai traditions, culture and local wisdom. Traditional Thai toys are objects for children to play with that are made from the natural materials found in the local environment. These toys represent local wisdom, culture and society. Making and playing with the traditional toys not only allows participants to learn scientific knowledge, but also fosters learning about local wisdom. This kind of learning has been separated into eight types of local wisdom (adapted from Somkanay, 1992) as follows:

(1)   Home and community values: due to the 'pride' of the community

(2)   Morals, custom and culture: this is the way of life

(3)   Narrative tales and community stories: history, background or the story of the community

(4) Art and artefacts: learning about Thai art and culture

(5) Local occupations: following the principle of sufficiency economy, individuals have to depend on themselves and develop their occupations according to changes in society

(6) Points of view, beliefs and principles: individuals have to adapt modern technology to use in their community, make it available for environment and lifestyle

(7) Creativity: imagination and integration of ideas and artefacts

(8) The economics of OTOP: One Tumbon (Sub-district) One Product), the product of the community's wisdom.

The details of these eight types of local wisdom as they are learned through TTTA are described further in Chapter 2. My belief is that there is significant benefit to be derived from the TTTA activity, not least to encourage participants to learn both scientific knowledge and local wisdom in one activity. That is, it is a unique activity that provides access to two knowledge systems. This activity follows the purpose of the National Science Museum, which is to encourage people to learn scientific knowledge and local wisdom together. This is my first point of interest. I discuss more bi-gnostic learning in more detail in Chapter 2.

1.2.3 Make and play activities with the traditional Thai toy activities

In general, books and journal articles discuss the learning of science in a science museum with emphasis on visitors' learning from the exhibition. For example, the Practical Evaluation Guide: Tools for Museums and Other Informal Educational Settings book (Diamond, Luke and Uttal, 2009) places emphasis on the exhibition, such as learning from the exhibitions, education from the exhibition and how to evaluate visitors' learning from the exhibition. There has been only a minority of chapters or articles that emphasise learning or evaluations of activities in the museum.

In this research, I am interested in this situation, and the design and purpose of the study is to emphasise family play-learning within the TTTA, and evaluate this activity in the Science Museum.

Traditional Thai toys are very interesting not least because the old traditional toys are hard to find in present-day markets. Specialists in traditional toy making produce them from natural materials found in the local environment, and so they differ within each local community. Traditional Thai toys are made from local or waste materials. Playing with traditional Thai toys reflects local wisdom, ways of life and the cultures of the community. In this way, traditional Thai toys represent local wisdom, culture and society and they are designed to promote happiness: physical, mental, social and spiritual contentment. Traditional Thai toys are also the equipment, objects or tools for children to play with and learn through playing. Learning through play creates playfulness, creativity, imagination, and intelligence in the players. These toys can promote the development of emotional and social skills when children play with the toys with friends, it can lead to sharing, teamwork and social communication (School of Architecture and Design, 2007).

Furthermore, many kinds of traditional Thai toys encourage scientific skills and scientific knowledge (Kasetsart University Research and Development Institute, 2004). Learning science through traditional Thai toys aims to encourage learners to seek both scientific knowledge and Thai local wisdom. Nearnchalearm (2005) points out that playing with traditional Thai toys helps children to develop both learning processes and scientific process skills, for example, measuring, observing, predicting, making decisions and inferring. He argues that learning science from such cultural tradition promotes attitudes toward science that make the link between these two forms of knowledge and understanding. For example, in this research the coconut mouse toy and the paper caterpillar are in a group of toys using springs, so that – as noted earlier - participants can learn about energy, force and motion. A second example is a flying bird toy that allows participants to learn about the earths' gravity. Moreover, traditional Thai toys can reduce problems surrounding present-day toys by, for example, reducing the choice of plastic toys, saving money for other toys. Families can work together with happiness and warmth, provide relationships between children and friends at the school, and conserve traditional Thai toys (Child Institute and child Foundation, 2007).

On the other hand, traditional Thai toys have some limitations because the bodies of traditional toys are made from natural materials such as bamboo, coconut shell, palm leaves and so on. These materials were easy to find in the past but, at present they are quite difficult to find in a city. Also these materials are not permanent and are broken easily. However, I think the weakness of these toys is also a strong point that fascinates visitors to the science museum. The difficulty in finding the materials, and the making of the toys can make participants aware of the value of traditional Thai toys for learning both science and local wisdom.

1.2.4 The Traditional Thai toy activities (TTTA)

The TTTA is a 'play-zone1' in the Science Museum that is available for learning according to the model of two zones of play in figure 1.3. The two zones represent the available and unavailable environments for playing. Zone 1 is a play zone that is suitable for play, for example beaches, playgrounds, theme parks, gardens, science museum, etc. Zone 2 is intended to represent the opposite, a no-play zone that is inappropriate for play. This model also represents the context of play: personal, social and setting and the conditions of play: opportunity and disposition for play. The detail of this model will be outlined more in chapter 2.

Figure 1.3: The model of two zones of play
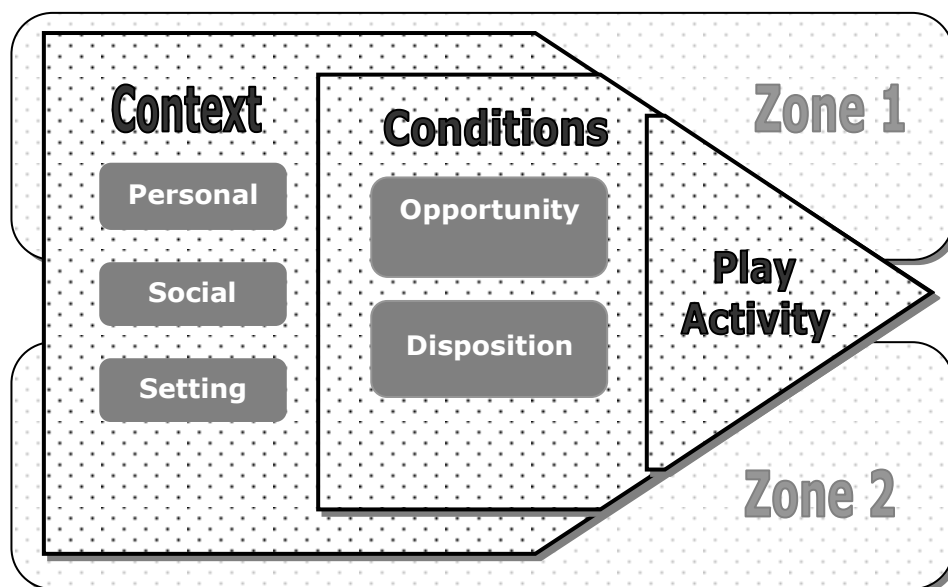
Source: Kanhadilok and Watts (2012c:882)

The traditional toys are the props of the play. They are the objects or equipment with which individuals - children and adults - play for both enjoyment and knowledge, both cognitive and imaginative (Frobose, 2008). In this case, traditional Thai toys are used to stimulate learning, knowledge, imagination, construction, and encourage awareness of values (Kanhadilok, 2011). For example, research shows (Goolnik and Curtis, 1995) that hands-on playthings like these are seen to be more fascinating for visitors (children and adults alike) in a museum because they can be handled, and enable the practice of many skills, therefore they are interesting and enjoyable.

TTTA has been developed under a constructivist theory of learning (Taber and Watts, 1983), which focuses on understanding. Constructivism is a model of how learning takes place and implies that adults and children are always active agents in the process of meaningful learning. Children learn not simply by receiving transmitted knowledge, but by interpreting experiences and information against schemas of prior knowledge. For example, activity-based or hands-on learning allows for meaningful 'grappling with the concepts under study' (Cobern, 1996:3). Traditional Thai toy activities also allow participants to experience pleasure by learning-through-doing in making and playing with the toys. Learning-by-doing at the TTTA uses toys based on elementary scientific principles which closely simulate real-life scenarios, give enough scope for innovation, challenge and make learning science playful and exciting (Cross, 2002).

Thus, TTTA aims to encourage people who participate in the activity to learn scientific knowledge in parallel with local wisdom through making and playing with traditional Thai toys. This aim follows the mission of the organisation that is to develop 'edutainment' learning resources in science and technology for people. Also, TTTA was designed for playfulness, through the enjoyment of making toys themselves and acquiring a playful mood from playing with the toys with their friends or family. This research, then, also sought to find out how families can be playful within the activity, how they can learn all the processes of the activity, how they respond to the Explainers, recognise the learning process and how they create the toys from their own skill and imagination.

1.2.5 Family play-learning

Family play-learning is not simply family 'support' in learning, but is a subset of inter-generational learning. In this study, I am interested in that form of inter-generational learning, where family groupings influence and learn from each other. In this respect, I use the term 'family play-learning' to describe family learning with the make-and-play activities through the TTTA at the Science Museum. I have chosen to discuss four dimensions of family learning of this kind drawn from the literature: (1) its non-addictive nature, (2) the levels of social collaboration, (3) the extent to which it is embedded in meaningful activity, and (4) how it is initiated by learner's interest or choice.

This study focuses on the transmission of attitudes, beliefs and practices and the modelling of behaviours between generations, and how or whether family learning is realised. In terms of role modelling I turn to social cognitive theory. Social learning theorists like Bandura (2005), for example, state that the learning process starts with the learner modelling the experiences of other people in a particular social setting. This develops into the learner copying, or emulating others, adults and siblings, and then on to a self-controlled level (Zimmerman and Schunk, 2001). Bandura (1986, 2001) contends that, to promote effective modelling, a role model must make sure that four essential conditions exist; attention, retention, motor reproduction, and motivation. That is, 'vicarious learning' through familial role-modelling concerns learning through observing the actions of others in the family, and its effectiveness depends upon how well such people are able to support the learning of others. Support from 'trusted others' is important, not least because they are able to share concerns about their own lack of confidence and also to realise how common it is to have difficulties in certain areas (Kanhadilok and Watts, 2012c)

The tasks and activities that are described below have been conducted within a very sociable, non-didactic setting, where multi-age family groups chose to participate in meaningful activities. Within this, research has sought to identify examples of:

>   **(1) Level 1 attention**: Where one member of the family group initiates a task and acts as a role model. He or she gains the attention of the others as they watch the task unfold.

(2)Level 2 retention: Where other members of the family then begin tasks of their own, guided by the better, more accomplished, more experienced members of the group.

(3)Level 3 motor reproduction: Where the 'learner' members of the family gain achievement in their tasks supported by, but largely independent of, their family role models

(4)Level 4 motivation: where the learners will try to take what they have learnt from the setting and repeat, adapt and improve on what they have been doing.

In these make-and-play activities, the conditions for family learning are good (very attentive, close social collaboration, high levels of interest and meaningful activity). For example, the tasks create opportunities for direct and reciprocal learning, within a very sociable, non-didactic group setting. Various levels of skill and understanding are simultaneously and transparently on open display, and - in an atmosphere of mutual trust–family members can provide positive feedback and guidance to parents and siblings.

In the table 1.1 I brought together some of the element of family play-learning and Bandura's levels to explain the behaviour of more experienced members and learners of family groups in four levels of family play-learning.

Table 1.1: Four levels of family learning

Level of action	Non-didactic	Social collaboration	Meaningful activity	Learner interest and choice
Level 1 (Attention)	More experienced members of group observe and try to understand how to make and play with toys	More experienced members of group learn how to make and play with the toys from others	The activity inspires families to join the activity	The traditional Thai toys are interesting to make and play with

Level 2 (Retention)	Learners learn making and playing with the toys from more experienced peoples' guide	More experienced members of group cooperated with Explainer and guide learners in their group and other groups to make and play with toys	Families have enthusiasm to join the activity. More experienced members could guide the learners	Guides others to making and playing with the toys is interesting
Level 3 (Motor reproduction)	Learners make and play with the toys by themselves	Learners make and play with the toys with their family and other people.	The activity inspires learners to learn making and playing with toys by themselves	Making the toys by themselves is very interesting and could gain skills and understanding from the activity.
Level 4 (Motivation)	Families could repeat making the toys again	-Makes new toys with others - Teach others to make the toys - Talk about the toys to others	Useful to adapt knowledge and understanding from the toys activity to study or work	Interest in imagination and creativity from making and playing with other toys

Source: Adapted from Bandura (2005:18)

According to the table 1.1, it is to be not that four levels of family play-learning is non-didactive nature that more experienced members of family transfer their knowledge and skills to learners through guidance lead to learners could make and play with the toys by themselves. Family play-learning also encourages social collaboration that all members of family work and play together or with others. So, it is the meaningful activity that inspires families to learn making and playing with the toys and gain skills and understanding. Family play-learning also stimulates learners' interest and choice through make and play activities and the interest of making the toys by themselves.

It is clear that family play-learning is very interesting in the study of how families transfer attitudes, beliefs, practices and the modelling of behaviour between

generations. This research investigates family play-learning with the TTTA, how this transfers knowledge and skills to members of the family and how each family engages with the activity. The outcomes of family play learning will benefit family learning research in science museums, in science museum education and science education in Thailand.

1.3 Objectives of the Study

As educational research, this study aims to develop our knowledge and understanding of family play-learning through make and play activities with traditional Thai toys at the Science Museum. Moreover, this research isolates and describes the factors that encourage family play-learning, which include the participants' character, the traditional Thai toys, participants' engagement, and environment and resources in the activity. The study is concerned with family play-learning outcomes through participating with traditional Thai toy activities and also explores the nature and impact of traditional Thai culture, local wisdom and Western modern sciences after participating with the TTTA.

1.4 Rationale and significance of the Study

Traditional Thai toys are the instruments used to encourage participants to learn science that is interspersed with Thai local wisdom. The traditional toys are rare to find at present. They have movement; are made from natural materials and have been designed using the local knowledge, wisdom and elements of cultural heritage. They are intended to inspire the younger generation to engage with and learn from them. Furthermore, they have many kinds of scientific knowledge associated with them, such as the rotation of spinning tops, the use of coiled springs, gravity toys, 'life force' toys and puzzles (Department of Non-Formal Education, 2001).

The rationale behind this research study is that it is possible to identify family play-learning to take place in a science museum through traditional Thai toy activities, that it is possible to evaluate some factors that enable this learning, and that it is possible to measure the family play- learning outcomes from make and play activities with TTT and bi-gnostic learning which include both local wisdom and scientific knowledge.

The significance of this study is that it will benefit educators, activity designers and museum curators, in developing science and traditional Thai culture and local wisdom exhibitions and activities. This research will also encourage museum educational teams to understand family play-learning and visitor's learning outcomes from the activities and factors that encourage families' learning in a science museum.

1.5 Research questions

This study was designed around the following four questions in order to achieve the objectives underpinning this research:

1. What family play-learning and learning outcomes can be achieved through traditional Thai toy activities in a science museum?

2. To what extent do traditional Thai toy activities influence family bi-gnostic learning?

3. How does learning with traditional Thai toys affect the relationship between participants' character and engagement, the environment and resources?

4. Can the model of family play-learning through traditional Thai toy activities effectively be used to monitor family play-learning?

1.6 Methodology

This research study uses multiple methods, both numerical and qualitative, in order to gain both a broad overview and an in-depth understanding of family play-learning in a science museum. Quantitative and qualitative research methods offer different kinds of evidence and, in this research, they are used to complement each other. In this study, questionnaires were used to produce quantitative data, whereas observations and interviews generated qualitative data. The primary data from questionnaires provide the essence of playfulness character of family and family play-learning outcomes in a science museum, observations are used to explain how family play-learning, their playfulness character are engaged with the activity. The interview was used to explore families' opinions about traditional Thai culture, local wisdom and Western modern science. Then, the data were analysed to draw conclusions.

1.7 Organisation of the Thesis

This research has been organised into five different chapters. The first chapter has introduced the research background and thesis plans. The second chapter reviews the relevant literature. In this, I discuss family play-learning in an informal educational setting; theories of play and learning for adults, teenagers and children, and bi-gnostic learning that includes traditional Thai culture, local wisdom and Western modern science. This chapter is designed around the theory-then-research method for carrying out research, which helps to provide a hypothesis for this thesis. The third chapter describes the research methodology and the shape of the methods to the study. In the fourth chapter I present the results of the study, data analysis and summary of the findings. The fifth chapter concludes the research with a discussion of the key findings, conclusions and recommendation for further work.

CHAPTER 2
EDUCATION IN THAILAND,
THE SCIENCE MUSEUM, FAMILY PLAY-LEARNING WITH
TRADITIONAL THAI TOY ACTIVITIES AND
BI-GNOSTIC LEARNING

2.1 Introduction

The main objective of this chapter is to review of the relevant literature of this research. The background of the Thai education system is described, along with key aspects of education policy. This chapter discusses informal science education; science museums and traditional Thai toy activities; family play-learning and the importance of play and learning through play. It also explains the importance of traditional Thai toys to encourage bi-gnostic learning: the relationship between scientific knowledge and local wisdom.

2.2 The background: education in Thailand

To study family play-learning through informal education, I briefly discuss the educational system in Thailand, particularly in relation to informal learning in a science museum in Thailand.

According to the National Education Act of 1999, amended in 2002, education in Thailand has been decentralised and compulsory education has been extended from six to nine years. The beginning of enrolment in the basic education system is at the age of 6. The system of education then provides 9 years of compulsory education and a total of 12 years basic education which are guaranteed free by the Constitution. The educational system consists of three types: formal education, non-formal education and informal education.

2.2.1 Formal education

Formal education emphasises the aims, methods, curricula, duration, assessment and conditional evaluation of the school system within public and private schools (Office of Education Council, 2004). Formal education services are separated into four parts:

Early years education, Basic Education, Vocational and Technical Education and Higher Education as illustrated in Table 2.1 below.

Table 2.1: Types of formal education in Thailand (The Office of the Education Council, 2004:10)

Type of education	Details
Early child-hood education	Early child-hood education starts from the age of 3 and continues to the age of 5. The majority of early childhood education is provided by government primary schools and private schools.
Basic education	Basic education provides 6 years of primary school, followed by 3 years of lower secondary (the compulsory education totals 9 years) and 3 years for upper secondary education. The core subjects from the National Curriculum are science, mathematics, social studies, health and physical education, religion and culture, art, career and technology, and foreign languages. All subjects focus on responding to student's specific interests.
Vocational and technical education	Vocational and technical education is divided into three levels: upper secondary (Lower Certificate of Vocational Education), post secondary (Diploma or Vocational Associate Degree) and university level (leading to a degree).
Higher Education	Higher education is provided at colleges and universities. These have two levels of educational accomplishment: diploma level and graduate degree.

2.2.2 Non-formal education

The government provides lifelong learning opportunities for people of all ages. This education consists of early childhood educational services, literacy programmes for adults, general non-formal education classes, vocational non-formal education at community and technical Colleges, and public training activities (APEC, 2011). Strategies of non-formal education in Thailand include developing a range of life skills through distance learning, establishing workplace and community learning centres and promoting the joint sharing of resources with the formal school sector. In order to support the promotion of lifelong learning in the non-formal education sector, internet connections have been made increasingly accessible in rural areas and system improvements have been implemented to provide recognition of prior learning and facilitate credit transfer (Ministry of Education, 2008a).

2.2.3 Informal education

Informal education provides a range of education choices for individuals learners. The purpose of informal education is to promote ideas and learning outside the formal classroom. This type of informal education in Thailand is provided by many learning sources at the national and local levels. For example, library programmes, science museums, science and technology centres, educational television programmes and radio programmes (The Office of Education Council, 2004). The strategy of informal education is to encourage the educational resources which emphasise both educational technology components and local wisdom components (Ministry of education, 2008b). I will return to discuss 'local wisdom' more fully later in this chapter.

Since the financial and economic crisis (1997), Thailand has had to consider the balance of economic competitiveness (science and technology) and local wisdom. So, the educational policy emphasises the development of scientific knowledge for economic competitiveness and contributing to the preservation of national wisdom through life-long learning (Witte, 2000). Also, the educational policy of Thailand gives emphasis to developing scientific literacy and knowledge about religion, culture and Thai wisdom through educational reform in 1999 (IPST, 2001). Section 23 of the National Education Act 1999, amended in 2002, mentions the education system

through formal, non-formal and informal education which emphasises on knowledge and complementary education, morality and learning processes. All componentss of education provide five main forms of knowledge as follows:

(1) Knowledge about oneself and the relationship between oneself and society, namely: the family, the community, the nation, and the world community; as well as knowledge about the historical development of Thai society and matters relating to politics and the democratic system of government under a constitutional monarch;

(2) Scientific and technological knowledge and skills, as well as knowledge, understanding and experience in management, conservation, and the utilisation of natural resources and the environment in a balanced and sustainable manner;

(3) Knowledge about religion, art, culture, sport, Thai wisdom, and the application of wisdom;

(4) Knowledge and skills in mathematics and languages, with emphasis on the correct use of the Thai language;

(5) Knowledge and skill in pursuing one's career and the capability of leading a 'happy life' (Office of the National Education Commission, 2002:11).

This study is consistent with the first, second and third forms of knowledge that the National Education plan expects to provide to all education systems. Moreover, as will be discussed later, the traditional Thai toy activity (TTTA) at the National Science Museum is an informal educational environment that provides scientific knowledge and local wisdom that follows the education policy of the government as explained below.

2.2.4 The Government's education policy

Under the 1992 National Scheme of Education and the Eighth National Education Development Plan (1997-2001), education is based on accomplishing five aims as follows:

(1) Promoting individual wisdom, thought, intellect, and morality to create a balanced development between spiritual, material, and economic growth;

(2) Awareness of the importance of the conservation of natural resources;

(3) Promoting Thai language and Thai culture in order to optimise the use of modern languages relevant to the local needs;

(4) Discovery of the proper balance between dependency and self-reliance is an essential basis for cooperation at an individual, community and national level in order to promote sustainable development;

(5) Define basic education as comprehensive of primary and secondary education and to extend opportunity to all people (APEC, 2010).

I believe in a proper balanced development between local wisdom and economic growth (Science and technology) to promote sustainable development of the nation. This balance is not exactly 'integration' but it is a 'two knowledge' system work alongside with each other.

According to the National Education Act 1999, amended in 2002, in section 23 as stated above, the Ministry of Education transformed the education system, the strategy being to enhance moral and ethical values and to improve the quality of education. This strategy follows from the Philosophy of Sufficiency Economy of His Majesty, King Bhumibol Adulyadej, which emphasises the moderation and harmony of local communities. The core programme includes: teaching moral education through the Philosophy of Sufficiency Economy; improving the standard of competence for teachers; developing science laboratories for schools and integrating local wisdom and culture into the national curriculum (Ministry of Education, 2008a).

However, in the National Education Plan (2002-2016) the aims also emphasise the balance of all aspects of the quality of life. The Plan incorporates human-centred development that promote the programmes of education, religion, art and culture. This Plan comprises three purposes and eleven policy guidelines for implementation as summarised below:

(1) All-round balanced human development
This purpose provides four policies: (1) Enabling all people to have access to learning, (2) Learning reform for the benefit of learners, (3) Inculcating and strengthening morality, integrity, ethics, and desirable values and characteristics, (4) Manpower

development in science and technology for self-reliance and an enhanced competitiveness capacity.

(2) Building a society of morality, wisdom and learning

This specifies three policies: (1) Developing a learning society to create knowledge, cognition, good behaviour and integrity of the people, (2) Promotion of research and development to increase the knowledge and learning of Thai people and Thai society, (3) Creation, application and dissemination of knowledge and learning.

(3) Development of social environment

This purpose includes four policies of education: (1) Promotion and creation of social and cultural capital limitation, (2) Limitation, reduction and elimination of structural problems for social justice, (3) Development of technologies for education (4) Systematization of resources and investment for education, religion, art, culture and local wisdom (Office of the National Education Commission, 2002:19).

The emphasis in this study is on scientific learning and local wisdom, and follows the policy of education, the National Education Act and the National Education Plan. This research aims to explore the gap between scientific learning and local wisdom. Yuenyong and Narjaikaew (2009) stated that the goals of scientific literacy highlight scientific knowledge, the nature of science, and the relationship between scientific technology, society and local wisdom. They note that:

> Thai scientific education research, articles, national tests, and teaching and learning enphasise scientific achievement with little concern about science as a way of knowing. However, some attempts at developing scientific literacy have been made recently. Some school curricular, teaching and learning has tried to organize scientific learning emphasizing the relationship between science, technology, and society based on the Thai context. Such cases seek to develop students' scientific literacy through local wisdom; especially, King Bhumibol Adulyadej's philosophy of sufficiency economy, moral infusion, and the Buddhist way of life (p.1).

However, one of the aims of this research is to study bi-gnostic learning outcomes from the TTTA. Bi-gnostic learning (as stated in Chapter 1) means that one activity can provide two knowledge systems, to include scientific learning and local wisdom. So, bi-gnosic knowledge in this study will be consistent with scientific education,

informal scientific education and local wisdom education in Thailand as discussed below.

2.3 Scientific education in Thailand

Scientific education in Thailand focuses on the development of school science curriculum and science teaching. According to the National Education Act 1999, scientific education in Thailand emphasises the development of teaching and learning processes. The government established the Institute for Promotion of Teaching Science and Technology (IPST) to play a major role in the teaching and learning of science, mathematics and computer education in Thailand (Boonklurb, 2000). The IPST also provides four missions to develop teaching and learning of science and technology in Thailand, which are to promote and execute:

(1) The study and research of curricula, teaching techniques and evaluation in science and mathematics at all education levels;

(2) Training programmes for teachers, instructors, lecturers, and students;

(3) Research, development and the production of scientific equipment and materials for teaching science and mathematics;

(4) The preparation of texts, exercises, references, supplementary materials and teachers' guides in science, mathematics and technology (Klainin, 2010).

Furthermore, one of the main missions of the IPST (2001) is to set up a national science curriculum, which highlights the learning of science as :

1. A developmental process so that the learner acquires proper knowledge, processes, and attitudes.

2. A lifelong process and basic scientific learning is important for greater understanding, better appreciation of nature and the environment (IPST, 2001).

The content of a science course contains knowledge of universal and local resources. The universal knowledge comprises similar topics to a school science course in other places. As for the local segment, this includes suitable topics for the country such as the environment and resources in Thailand. Also, science lessons aim at enabling learners to learn the subject with emphasis on scientific processes, obtaining essential

skills to seek and construct knowledge by investigation and problem solving. Also, the process of learning allows students to participate in all stages of learning with hands-on activities at each level. The main content of science lessons from the IPST Science Curricula (2008) in all levels are described as follows:

1. Living Things and Living Processes

2. Life and the Environment

3. Matters and Properties of Matters

4. Forces and Motion

5. Energy

6. Processes that Shape the Earth

7. Astronomy and Space

8. Nature of Science and Technology.

Against the backdrop of scientific education in Thailand, it is to be noted that the TTTA provides scientific knowledge, skills, communication skills, awareness of the relationship between science, humanity and the environment, and the awareness of the value of science and technology. Also, the content of TTTA relates to half of the main content lessons of science in the National Science Curriculum, including *Life and the Environment*, *Forces and Motion, Energy and the Nature of Science and Technology.* When children participate in the TTTA, they learn about science in some aspects of their study in school. As for adults, they see scientific knowledge in everyday live and urge their children to understand science further.

The TTTA also relates to the National Education Plan (2002-2016) with emphasis on human-centred development integrated with the education of religion, art and culture. The first purpose of this plan is to develop human learning that emphasises the balance between human development of morality and wisdom with science and technology. The second is to build a society of morality, wisdom and learning that focuses on increasing knowledge and learning Thai morality and local wisdom. Also, the TTTA follows a third purpose that wants to develop a social environment including the promotion and creation of society and culture, the development of education, culture and local wisdom.

It is clear that the TTTA relates to the National Science Curriculum and the National Education plans that emphasise the balance between science and Thai local wisdom. I agree with this policy of balance in order to develop Thai people because Thai local wisdom is the way of Thai life that depends on their community and environment. When Thai people learn more about their communities and resources, they will learn the way to develop their communities through science and technology together with their local wisdom.

In my view, scientific knowledge and Thai local wisdom should be kept separate for study and for making educational policy because these two forms of knowledge are different. They are different in terms of the origin of knowledge, transition, theoretical knowledge, value and approach, which is discussed below. The two types of knowledge should not become some mixture, integration or infusion but they should study, work and develop in parallel and as complements to each other.

I also think that Thai local wisdom should be preserved and taught separately and distinctively in schools, universities and communities. My point of view sees scientific knowledge in parallel with Thai local wisdom. They should be studied, worked, and developed in parallel and should not be 'integrated', where that means some form of dilution of either. That said, they are sometimes closely related and each knowledge system can support the other. For example, the development of Thai local products can use scientific knowledge together with Thai local wisdom to develop the processes for producing textiles, pottery handicrafts. The traditional technology gallery at the Science Museum displays Thai local technologies and explains these through Western science. In this sense, the TTTA is one example of bi-gnosis where one activity provides two types of knowledge for the participants: participants could learn scientific knowledge in parallel with Thai local wisdom. It provides bi-gnostic learning and inspires them to study more.

2.4 Local wisdom education in Thailand

2.4.1 Wisdom

Russell Ackoff (1989) positions wisdom as the initiator of the DIKW hierarchy (Data, Information, Knowledge and Wisdom), in his article '*From Data to Wisdom*', published in 1989 (Sharma, 2011). According to the DIKW hierarchy, the content of the human mind can be classified into five categories.

1. **Data** comes from raw observation and measurements, for example, facts or figures

2. **Information** is created by analysing relationships and connections between the data; it is capable of answering simple questions "who/what/where and when."

3. **Knowledge** is the appropriate collection of information. Knowledge is a deterministic process. When someone memorises information, then they have amassed knowledge. Knowledge answers the question "how". Knowledge is a local practice or relationship between the works.

4. **Understanding** answers the question "why". Understanding is interpolative and probabilistic and it is also cognitive and analytical. It is the process of synthesising new knowledge from previously held knowledge. The difference between understanding and knowledge is the difference between "learning" and "memorizing".

5. **Wisdom** is created through using knowledge, through the communication of knowledge users, and through reflection. Wisdom evaluates understanding (Ackoff: 1989).

Russell Ackoff (1989) argues that while information *ages rapidly*, knowledge has a *longer life span* and only understanding has an *aura of permanence*. It is wisdom that he considers to be *permanent* (Markus, 2005:3). Ackoff (1989) also indicates that data, information, knowledge and understanding relate to the past, and dealt with what has been or what is known. Only wisdom deals with the future because it incorporates vision and design. With wisdom, individuals can create the future rather than grasp the present and past, but achieving wisdom is not easy; people must move successively through the other categories (Hey, 2004). This thesis uses the knowledge pyramid in Figure 2.1 to illustrate the DIKW hierarchy.

Figure 2.1 Knowledge pyramid model
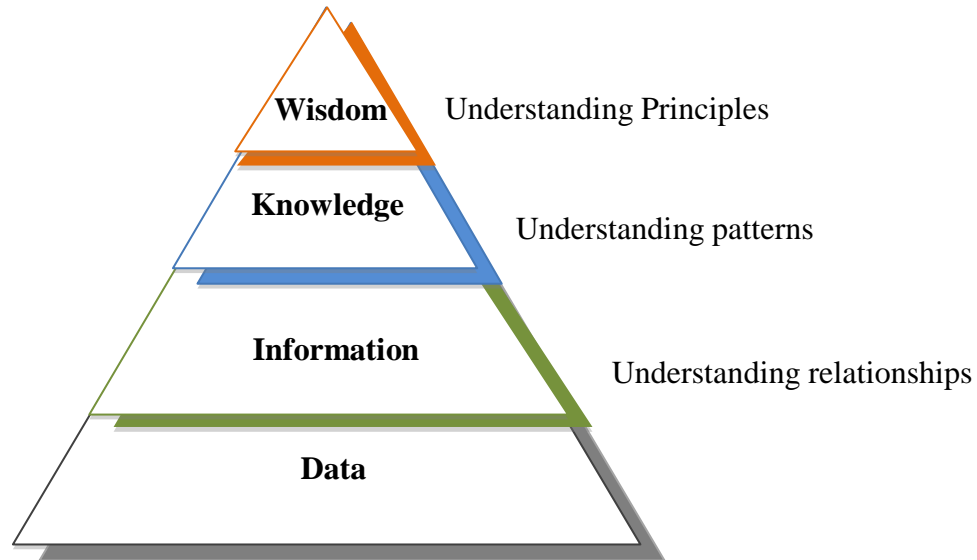
Source: Bela Markus, (2005:3) based on Ackoff's DIKW hierarchy

Maxwell (1984) defines wisdom as:

> "The desire, the active endeavour, and the capacity to discover and achieve what is desirable and of value in life, both for oneself and for others. Wisdom includes knowledge and understanding but goes beyond them as it also includes: the desire and active striving for what is of value, the ability to see what is of value, actually and potentially, in the circumstances of life, the ability to experience value, the capacity to help realize what is of value for oneself and for others, the capacity to help solve those problems of living that arise in connection with attempts to realize what is of value, the capacity to use and develop knowledge, technology and understanding as needed for the realization of value. Wisdom, like knowledge, can be conceived of, not only in personal terms, but also in institution or social terms. We can thus interpret the philosophy of wisdom as asserting: the basic task of rational inquiry is to help us develop wiser ways of living, wiser institutions, customs and social relations, a wiser world" (p. 66).

As stated above, moving from data to wisdom is not easy. People must learn successively through each category until they achieve wisdom. Thailand has several kinds of wisdom, for example wisdom about health, agriculture, local occupations, art, culture, customs and traditions. These have developed over a long period of time and have been transferred from wiser people or philosophers, generation after generation.

They have a value in and of themselves. This process of transfer has inspired me to conduct research about local wisdom and the conservation of Thai local wisdom.

2.4.2 Local wisdom

Local wisdom has many terms, which share the same main characteristics, for example 'indigenous knowledge', 'traditional knowledge' and 'local knowledge'. In this thesis, I use local wisdom to represent Thai local wisdom because the meaning of 'local wisdom' is close to the Thai word for 'Phoom Panya'. 'Phoom' means local and can also mean insightful and smart. 'Panya' means knowledge. In this case, to talk about Thai local knowledge, the actual translation of 'Phoom Panya' is closest to 'local wisdom'. The word 'wisdom' used in the case of Thai local wisdom is both a matter of translation and also a reflection of how the Thais perceive this age old knowledge, i.e. that it is the highest form of knowledge bound to geographical or community's context suitable for each locality. It seems that Thai people are proud of the word 'local wisdom', for the good reason that it has given rise to the resurgence of local wisdom in modern Thai life (Tinnaluck, 2005).

Tinnaluck (2005) also explains that 'wisdom is an accumulated experience rooted in a true understanding of nature, of which self or humanity is also a part. Wisdom is insightful knowing that everything is based on natural law. Wisdom can occur only through collected experiences and a mind trained in consciousness' (p.143). The office of the National Education Commission (2011) has defined local wisdom or Thai wisdom as a body of knowledge, abilities, and skills of Thai people that has accumulated over many generations through many years of experiences learning and development. Thai wisdom can help people to solve problems and encourage development of the way of life in accordance with the nature of changing times.

Seri and Nantasuwan (2002) argue that village people have to respect their ancestors, spiritual practices and nature. The characteristics of local wisdom must incorporate local knowledge transferred from the older members of the community to teach people about morals, ethics and to love nature. Tinnaluck (2005) pointed out that local wisdom is indigenous knowledge or local knowledge, which refers to the complete

knowledge, 'know-how' and practices that are maintained and developed by people over a long time within a natural environment. Bouson (1992) agrees that local wisdom refers to the process by which human's view themselves, their community and environment. This process comes from the root of their teaching of religion, moral precepts and customs, which transfer continually within the social group with the purpose of maintaining the peace of the community and individuals. This knowledge is used as a guideline for daily activities, which relates to families, neighbours, the village and its surroundings.

Na Talang (1994) adds a further dimension: this knowledge also includes a concept of the spiritual, not just human to human, or human to the environment but also human to the supernatural. This is knowledge, he says, that has always supported Thai people in the solution of their problems in daily life, and enabled Thai civilisation to 'balance the environment.'

From a different perspective, Pungkanon (1992) described Thai local wisdom, not only as the story of the Thai local community, but also the way local wisdom adapts to new knowledge. Pungkanon sees this adaptation to be of great benefit as it provides alternative choices between the 'international' and unique character of the community. Pongpit (1994), too, refers to Thai local wisdom as the knowledge derived from many parts of Thai people's daily lives, collected from both direct and indirect experiences, to solve problems with 'synthetic methods'. These methods can suitably adapt to the 'modern knowledge' to solve problems in daily life. I pursue this further when discussing bi-gnosis.

It is to be noted that Thai local wisdom is unique, has values and importance for Thai people. The background of why Thailand needs to develop Thai local wisdom along with science and technology is discussed below.

2.4.3 The importance of local wisdom in Thailand

Over the past forty years, the economic and social development of Thailand has emphasised that industry and technology be derived from western knowledge. During this time, Thai society only pursued western technology and culture from Europe and

America and was in danger of neglecting entirely Thai local wisdom and traditional ways of life. So, Thailand faced a range of economic problems, urbanisation, cultural and environmental destruction, all of which affected people's quality of life for a long time (The Office of the National Education Commission, 2011).

In 1997, a financial and economic crisis occurred that led to problems in agriculture in rural areas. There was unequal distribution of income and growth between urban and rural communities. At the same time, big business in urban areas had to close down, many people lost their jobs in the city and moved out to the rural sector, returning to their families' activities. The government worked to solve the problems in business and the financial sectors, especially in terms of the rural sector, which was accorded greater importance. The government began to realise the potential of the rural sector in absorbing jobless people from the big cities. The Social Investment Fund Project (1998-2002) was launched in all villages across Thailand (about 72,000 villages) with a national scheme to provide a fund of one million baht to each village. This project was aimed at all villages producing their own product (One Tumbon (sub-district) One Product (OTOP)) to promote the economy of the community and to revive the economy of the nation (Tinnaluck, 2005).

King Blumibol Adulyadej's philosophy of sufficiency economy was intended to help address current development challenges. The philosophy emphasises the balancing of human activity and the environment. Because, Thai people cannot separate the environment from human activities; what humans have taken from the environment and what they have returned to the environment reflects on human wellbeing (Taylor, Littledyke, Eames and Coll, 2009). The strategy of this philosophy was to encourage people to use the local wisdom in their community as a guideline to develop their work or their careers according to the local environment. The strategy also suggested that people adapt modern science and technology to develop and improve their products availability. These are the key strategies of a sufficiency economy to achieve sustainable development of the nation (Yuenyoung and Najaikaew, 2009).

Also, the government, through the Ministry of Science and Technology revived the strategy to solve the country's problems by promoting Small and Medium Enterprises (SME), which helped to reform the public economy and also, encouraged the rural sector. The strategy goals emphasise the use of science and technology in collaboration with the public and business sectors as well as supporting the rural sector. Besides which, the government wanted to promote and develop grassroots economy through science and technology paralleling the local wisdom (Tinnaluck, 2005). For more understanding about this strategy, I designed the model of adaptation of the local wisdom and science and technology to develop society and the economy of Thailand, as illustrated in Figure 2.2 below.

This is the original model that I developed from Tinnaluck's (2005) work as stated above. The purpose of this model is to explain clearly about the importance of local wisdom and Western science to revive the economy of Thailand. The model illustrates from the economic crisis, results, government's policy, both side of local wisdom and Western science and displays how two knowledge system work parallel to develop the products of Thailand (OTOP).

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                        ┌─────────────────────┐
                        │   Economic crisis   │
                        └─────────────────────┘
                                  │
                                  ▼
┌───────────────┐    ┌─────────────────────────────┐    ┌───────────────────┐
│ Local wisdom  │──▶ │ -Jobless people move from the│◀── │   Nature and      │
└───────────────┘    │  big city to rural sector    │    │ Local resources   │
                     │ -The poverty of rural sector │    └───────────────────┘
                     └─────────────────────────────┘
                                  │
                                  ▼
                     ┌─────────────────────────────┐
                     │      Government's policy     │
                     │            OTOP              │
                     │ (One Tumbon (Sub-district) One Product) │
                     └─────────────────────────────┘
                                  │ Policy
                                  ▼
                     ┌─────────────────────────────┐
                     │ Adaptation of the local wisdom to Thai │
                     │            society           │
                     └─────────────────────────────┘
                                  │
                                  ▼
        ┌────────────────────────────────────────────────┐
        │  ( Grassroots (people) )      ( Government )     │
        │                                                 │
        │  Wisdom Masters      ⟷     Policy and Funding    │
        │     Schools                Initiative and drive  │
        └────────────────────────────────────────────────┘
                                  │ Develop
                                  ▼
┌───────────────┐    ┌─────────────────────────────┐    ┌───────────────────┐
│ Local wisdom  │──▶ │ The rural sector and grassroots (people) │◀──│ Science and │
└───────────────┘    └─────────────────────────────┘    │   Technology   │
                                  │                       └───────────────────┘
                                  ▼
                     ┌─────────────────────────────┐
                     │      Knowledge from          │
                     │ Science & technology and local wisdom │
                     └─────────────────────────────┘
                                  │
                                  ▼
                          ( Products (OTOP) )
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Figure 2.2: The model of adaptation of the local wisdom, science and technology to develop the society and the economy of Thailand. Source: model based on Tinnaluck's work (2005: 6).

2.4.4 Thai local wisdom in the education system

The Office of the National Education Commission (1999) points out that the problem of providing Thai local wisdom within the education system reflects on the reduction of the transmission of local wisdom as follows:

1. Lack of Thai local wisdom trainers: Thai local wisdom experts are too old and numbers have declined due to a small number of heirs.

2. A large number of people are uninterested in Thai local wisdom: Many people are more fascinated with the values and national wisdom than Thai local wisdom leading to the forsaking of Thai local wisdom.

3. The education systems' lack of the balance of wisdom: The education curricular emphasises national wisdom rather than Thai local wisdom, especially, in formal, non-formal and informal education.

4. The continual lack of the creativity of Thai local wisdom knowledge: There has been no collection system to record and process local knowledge. Also, the research and development of Thai local wisdom is not taken seriously due to the fact that Thai local wisdom cannot adapt and is not suitable for use with a modern life style.

5. Lack of policies to encourage Thai local wisdom: There have been fewer policies to support the arrangement of Thai local wisdom education.

Therefore, the Office of the National Education Commission (1999) suggested that the government must develop serious policies to accelerate Thai local wisdom in the education system. Following the economic crisis, the government reconsidered, reviewed and re-evaluated the Thai social and economic development plan. The government and Thai policy makers sought a new balance in Thailand's social policy and economy. The new policy emphasises the orientation of the inward and outward flow of economic competitiveness and cultural self-reliance, through the development of the education system, with a focus on life-long learning (Witt, 2000). The policy also advocates the development of Thai local wisdom within all curricula in the education system, especially, King Blumibol Adulyadej's philosophy of sufficiency economy, moral infusion and Buddhist way of life as stated above (Yuenyong and Najaikaew, 2009).

So, the National Education Act 1999, in section 23, also provides policies to promote Thai local wisdom in the educational system (formal, non-formal and informal education), to contribute knowledge, morality, learning processes and knowledge about religion, art, culture and Thai local wisdom (Office of Education Council, 2006: 10).

I agree with this education policy to encourage Thai local wisdom, King Blumibol Adulyadej's philosophy of sufficiency economy, moral infusion and the Buddhist way of life to all educational systems because this knowledge is the base of the Thai people. Buddhism is the main religion of Thailand that teaches Thai people to be aware of the middle way and it is consistent with the philosophy of sufficiency economy that wants Thai people to be concerned about their communities, resources and the balance between scientific knowledge and local wisdom for sustainable development.

2.4.5 The strategy to encourage Thai local wisdom in the education system
The Office of the National Education Commission (1999) stipulates the strategy to "Return Thai local wisdom to the Education System." This strategy focuses on encouraging Thai local wisdom within the education system through teaching, learning and the transition of Thai local wisdom, covering three educational systems: formal education, non-formal education and informal education as illustrated in Figure 2.3 below.

Figure 2.3: The transition of Thai local wisdom in the three education systems
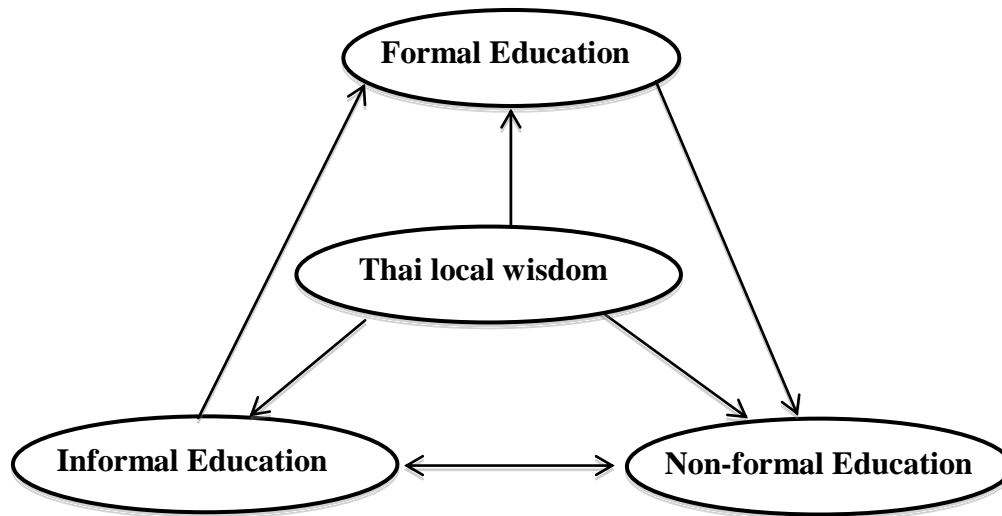
Source: Office of the National Education Commission (1999:180)

In this respect, Thai local wisdom in formal education adopts Thai local wisdom to the curricula of all subjects. The government established the organisation to respond to the development of Thai local wisdom within the education system and promoted Thai local wisdom experts to be teachers, lecturers and professors in the education system (Office of the National Education Commission, 1999).

Sungsri (2011) points out that this strategy assists in the development of the local curriculum for primary and secondary schools first. Thai local wisdom is adopted and included into the local curriculum by teachers, curricular scholars and local wisdom masters. The local curricula are different between each community and depend on local wisdom masters, resources and environments such as agriculture, sculpture, silk weaving and traditional food.

The policy of Thai local wisdom in non-formal education emphasises the establishment of Thai local wisdom learning centres in each community and promotes Thai local wisdom experts in the community to teach and transfer local wisdom knowledge to learners. The strategy emphasises a developing curriculum for adult learners, for example vocational subjects and quality of life promotion subjects. The curriculum offers lectures in classrooms through inviting 'resource persons' for

several training programmes with short and long-term training (Ministry of Education, 2008a).

As for the informal education, the strategy focuses on mass media, family, community and local wisdom experts to transfer Thai local wisdom knowledge to individuals. The policy encourages Thai local wisdom centres and the using of Thai local wisdom to develop the quality of life, support the happiness of individuals, develop close families, peaceful societies and a sustainable environment (Office of the National Education Commission, 1999).

As stated above, it is very important to develop local wisdom learning among Thai people. The financial and economic crisis experience illustrated that Thailand must keep a balance between Western modern science, technology and local wisdom (bi-gnostic learning). When Thai people have the awareness to balance this knowledge, Thailand will develop into a sustainable country. Also, NSM has the mission to provide lifelong learning resources and promote awareness of science, technology and local wisdom (bi-gnostic learning) to Thai people through traditional technology gallery and TTTA.

2.5 Bi-gnostic learning from TTTA

As stated above, TTTA provides bi-gnostic learning which includes the learning of science (Western science) and the study of local wisdom. Before discussing how TTTA's encourages bi-gnostic learning, I will compare and contrast Western science and local wisdom to give some understanding of both sides of learning.

2.5.1 Western science

In this thesis Western science knowledge is scientific knowledge. The origins of science derive from the ancient philosophers (e.g., Egyptian and Greek), then the evolution of science was marked by major social transformations in Europe and the Americas. These evolutions of science helped people to understand science and provided the scientific knowledge to explain nature. Some scholars call this Eurocentric knowledge or Western modern science and Western science (Aikenhead

and Ogawa, 2007). In general, Western science requires a large number of observations, in order to provide the statistical methods to detect the relationship of any given information (Dowie, 2011).

Canning (2002) makes a series of comments about Western science, first, that science is based on observation. A scientist changes things, if possible one aspect at a time, and observes the results. A naturalist, he says (p.17) is a scientist who lets nature make the changes, and then makes careful observations and speculates on cause and effect of the changes. Second, these observations are published, and must be reproducible to be believed. Scientists are taught to be skeptical and critical, they do not normally take data at face value. Because of this, scientific knowledge must be public knowledge. Thirdly, the scientific method works well on small details, the smaller the better, because in this way the scientist can control the changes more effectively. While this is easily accomplished, for example, in physics and chemistry, it becomes more difficult to use in other branches of science, for instance, in ecology, where variables are many and difficult to control.

2.5.2 Thai local wisdom

Thailand, the kingdom of legends, is one of the most fantasial countries in the world. It is full of culture and tradition, frequently told but often unexplained. Thai local wisdom is one of the hidden stories that has been the pride of the kingdom for centuries (Kanhadilok and Watts, 2013b). Many Thai people lead a peaceful, simple life, for example, growing rice to eat, weaving clothes to wear, and carving wood for household tools. They have special skills and knowledge, often acquired directly from the craftspeople, weavers, textile-workers, potters, bass artists, and fabric designers who make up the communal environment in which they live (Office of SMEs Promotion, 2010).

The Office of the National Education Commission (2011) defined Thai local wisdom as a body of knowledge, abilities, and skills of Thai people that has accumulated over many generations, through many years of experience, learning and development, and is seen to transfer from generation to generation, sometimes by the philosophers, or

wise men of the community. In reviewing the nature of Thai local wisdom, I suggest that its characteristics incorporate:

- *Stories* of, and within, local communities (Pungkanon, 1992)
- *Outcomes of collected experiences* through learning about the relationship with the environment, the relationship within a community and between different communities. This knowledge includes the concept of the supernatural (Na Talang, 1994)
- *Directly and indirectly solving problems* in daily life through collected experiences (Pongpit, 1994)
- A *body of knowledge, ability, and skills* that Thai people derive from their collection of experiences, their roots in Buddhism, Thai culture and belief (Office of the National Education Commission, 1999)
- *Knowledge about values, morals and ethics*, respect for ancestors, spiritual practices and nature (Seri and Nantasuwan, 2002).

Types of Thai local wisdom are compared in Table 2.2 below.

Table 2.2: Type of Thai local wisdom.

Somkanay (1992: 24)	Na Talang (1995: 5)	The office of the National Culture Commission (1995: 25)
1) Moral precept, thinking, belief and principle	1) Belief: belief between humans and nature, humans and the supernatural, and human with human	1) Health and protection
2) Local occupations	2) Life style: solving problems and adaptation with the environment and change of social and economy	2) Environment
3) Art, culture, custom and tradition	3) Art and handicraft: tools, objects and artefacts that have gained inspiration from the environment and several cultures from each part of Thailand	3) Agriculture

4) Point of view, practical principle and modern technologies that are used in the community	4) The learning process and behaviour: the transmission of wisdom and experiences through education and training	4) Business, management and welfare
		5) Production and consumption

As highlighted above there are many kinds of local wisdom. In this thesis, I have separated these perceptions into eight categories that include: (1) Home and community values, (2) Morals, customs and culture, (3) Narratives and community stories, (4) Art and artefacts, (5) Local occupations, (6) Points of view, beliefs and principles, (7) Creativity, as well as (8) the economics of OTOP.

2.5.3 Comparative characteristics of Western science and local wisdom

Comparison of the main characteristics between Western science and local wisdom, it might be useful to understand both sides of knowledge. However, this is not intended to show supremacy of one over the other, rather it tries to raise understanding of them both, which is illustrated in Table 2.3 below.

Table 2.3: Comparative characteristics of Western science and local wisdom

Western Science	Local Wisdom
Universal or global knowledge: This knowledge is generated in modern scientific institutions or industrial firms. It has the same "universal truth" not specific to where it is.	**Local:** Local wisdom is rooted in a particular community. It is a set of experiences generated by people living in the communities and it is context specific.
Explicit: This knowledge has been noted rigorously in the procedures of creation through	**Tacit:** Local wisdom is embedded in people who generate and use it. So, it is hard to

observation, experimentation and validation. These procedures can be specified and codified easily.	capture and classify this kind of non-formal knowledge.
Transmitted in written form, academic and education system: The knowledge is created and carefully documented. It transfers by teaching in a formal education system.	**Transmitted orally and culturally:** Local wisdom is rarely recorded in written form. It is mostly transferred through imitation or demonstration within a cultural context.
Theoretical knowledge: Knowledge is derived from hypotheses and scientific methods. Studies have been undertaken in laboratories or with scientific or mathematical models.	**Practical and experiential rather than theoretical knowledge:** Local wisdom is generated from experience, trial and error. It is tested through time in the "social laboratory of survival" of local communities.
No spiritual values: Knowledge of the creation process is separated from attitudes, beliefs and cultural dimensions. Nature is to be conquered or mastered.	**Founded with religious worldview, spirituality and social values:** Spirituality is an important and inseparable dimension of local wisdom. Nature is revered as mother or provider of all things.
Compartmental approach: The process of knowledge breaks down matters for study into the smallest components in order to reach into deeper and hidden facts of what is being studied.	**Holistic approach:** Humankind is considered part of nature. Natures' tendency toward equilibrium. It is the central theme of local wisdom

Source: Adapted from Tinnaluck (2005:109)

Mazzocchi (2006) points out that Western science and traditional knowledge or local wisdom systems have identified various characteristics and opposite views. Western science emphasises analytical and reductionist methods as opposed to traditional

knowledge, which focuses on intuitive and holistic views. Western science is positivist and materialist, whereas traditional knowledge is spiritual, it cannot make distinctions between empirical and sacred knowledge. He also states that 'Western science is objective and quantitative as opposed to traditional knowledge, which is mainly subjective and qualitative. Western science is based on an academic and literate transmission, while traditional knowledge was often passed on orally from one generation to the next by the elders' (p.2).

Bala and Joseph (2007) argue the possibility that today, indigenous knowledge or local wisdom can contribute to science. They suggest that it could also have contributed to scientific knowledge in the past. However, today, these contributions are ignored and the possibility is that they were also ignored in the past. Thus, opening a dialogue between indigenous knowledge and science's profile shows that current historical conceptions of the development of science may have profited from indigenous transmission in the past. For example, biotechnology has learnt from traditional cultures. It has also encouraged many multinational companies to undertake bio-prospecting in the traditional culture of medical, agricultural, ecological and other kinds of knowledge.

It is to be noted that both sides of knowledge have a unique method to study nature and adapt to human beings. Western science and local wisdom are important for development of Thailand. Thailand should use it own science and technology to leverage local wisdom, which relates to Thais lifestyle. King Blumibol Adulyadej's philosophy of sufficiency economy is intended to help address current developmental challenges. The strategy of the philosophy emphasises the balancing of Western science and the community (local wisdom). The strategy also suggests that people adapt modern science and technology to develop their occupations and improve their daily life. It is clear that Western science and local wisdom are important and, as described below, the TTTA provides for visitors of the science museum to learn and to be aware of the value of both sides of knowledge.

However, the National Science museum Thailand (NSM), as an informal educational environment, has the mission to provide lifelong learning resources and promote awareness of science, technology and local wisdom to Thai people. For more understanding about this informal educational environment (science museum), a description of the background and mission of NSM and the Science Museum to support scientific learning and local wisdom follows.

2.6 The National Science Museum, Thailand

On the auspicious occasion of Her Majesty the Queen's 60th birthday anniversary on August 12th, 1992, the Royal Government of Thailand through the Ministry of Science and Technology established the Science Museum Project as an expression of the deepest gratitude toward Her Majesty's graciousness in introducing science and technology in reviving and preserving the local wisdom among Thai people. This has led to the creation of job opportunities and an improved standard of living for the poor in the rural areas. The project has progressed very effectively.

With the approval of the Royal Thai Cabinet the National Science Museum, Thailand (NSM) is a state enterprise under the supervision of the Ministry of Science and Technology. NSM is responsible for the development and management of the Science Museum, Natural History Museum, Information Technology Museum, Rama 9 Museum and NSM Science Square. All museums are located in Technopolis, Khlong 5, Khlong Luang, Pathum Thani, Thailand. The NSM aims to be an organisation of excellence in providing lifelong learning resources and promoting awareness of science and technology, including biodiversity. The philosophy of the NSM is to be a non-profit organisation and an academic institution. The NSM organisation consists of five functions: collections, researches, exhibitions, education and information (The National Science Museum, Thailand, 2004).

It is to be noted that the NSM was born from the introduction of science and technology to revive and preserve the local wisdom for Thai people. So, the NSM is one of the informal science environments of Thailand that has a mission to develop learning resources in science, technology and local wisdom for Thai society through

science communication, activities, research and development and various educational programs that enhance knowledge, understanding, attitudes, skills, procedures, conscience and imagination. As state above the NSM has the responsibility to develop and manage five science and technology museums. This research is conducted at the Science Museum, so I will relate it directly to the Science Museum for learning of science and local wisdom because other museums in the NSM do not provide Thai traditional technology and local wisdom exhibitions or activities. The information about the science museum will follow.

2.7 Science Museum

The Science Museum opened to the public in 2000, with an exhibition and activity area of about 10,000 sq.m, which accommodates about 750,000 visitors per year. The mission of the organisation is to develop both Western scientific literacy and the traditional local cultural wisdom of Thai society. Its purpose is to foster awareness in its visitors of the importance of science and technology in everyday life, and in the sustainable development of the country through community understanding (The National Science Museum, Thailand, 2004). In general, science museums are sites of informal education for visitors all of ages, designed to help visitors understand more about contemporary science (Goolnik and Curtis, 1995).

Thailand's Science Museum aims to be the country's national centre for informal science education, encompassing both entertainment and scientific knowledge for visitors at all levels. The presentations of scientific knowledge and activities at the museum follow the mission of the organisation to encourage scientific knowledge and the relationship between science, technology, society and Thai local wisdom. There are several kinds of exhibitions and activities to support scientific knowledge. The exhibitions comprise six main exhibitions; 1) Introduction, 2) History of science and technology, 3) Basic science and energy, 4) Science and technology in Thailand, 5) Science and technology in daily life and 6) traditional Thai technology. The educational activities include science camps, science laboratories, science shows, scientific dramas, science walk rallies, scientific toys and traditional Thai toy activities (TTTA) (The National Science Museum, Thailand, 2004). This research emphasises

on TTTA at a science museum. So, the next section will describe the detail of TTTA as shown below.

2.8 The traditional Thai toy activity (TTTA)

Traditional Thai toy activity develops under the constructivist theory, which focuses on understanding. Constructivism is a model of how learning takes place. It implies a child is always an active agent in the process of meaningful learning. Children learn, not only by receiving a transmission but by interpreting a message and the sharing of prior knowledge is essential for communication. For example, learning from activities or hands-on learning allows for meaningful grappling with the concepts under study (Cobern, 1996).

Also, Traditional Thai toy activities allow participants to learn by doing through making and playing with the toys. Learning by doing involves understanding things while doing and experiencing them. It is the highest form of understanding. This can be done through hands- on activity and using toys based on elementary scientific principles which closely simulate real life scenarios, giving enough scope for innovation, challenge and makes learning science fun and exciting (Cross, 2002).

Moreover, TTTA allows family play-learning with the traditional Thai toys. Family play-learning is the inter-generational learning that older or more experienced members of the family learn TTTA process from the Explainer. Then they transfer their learning and skills to their children through teaching, guiding and helping. TTTA is suitable for family learning because the process of toy making is a skill that can be perfectly transferred from the more experienced person to the learner. So because, adults in the family group are more experienced and skilful they can teach their children to learn the TTTA (Kanhadilok and Watts, 2012c).

The Science Museum develops Traditional Thai toy activities for the visitors' learning of science and local wisdom. The development of this activity is adapted from Harlen (2000) that aims to provide:

1. Encouraging attitudes and stimulate curiosity

The activity might begin with the experience of playing with a variety of traditional Thai toy collections in the exhibition area. Participants would explore and play with different traditional Thai toys noticing how they work. For example, when they play with the coconut mouse toy, caterpillar paper toys or flying bird toys, they will discover how they move.

2. Opportunity for skills development

The activity allows participants to develop many skills through exploring the exhibition, making and playing with the toys. For example, they can develop cognitive skills from learning information of the traditional Thai toy through the exhibition and activity. Also, psychomotor skills will be developed when they make and play with the toys such as handling, making, playing or painting. While, they make and play with the toys with their families and friends, they will develop affective skills, which include social and emotional skills, for example, meeting new people, sharing, team working and managing their feeling.

3. Working cooperatively and combining ideas

There could be instructions for pooling ideas with their group (family), planning how to discover how the toys work and preparing a group report to others. At intervals in the work participants should meet together, share materials and tools to make coconut mouse toys and caterpillar paper toys and share ideas about how to decorate their toys and discuss why each toy moves differently.

4. Opportunity for scientific concept development

A main point of the activity is to enable children to recognise the role of energy in using springs. When they make and play with the coconut mouse toys and caterpillar paper toys, they will discover that these toys are able to move because of the twisted and untwisted elastic band inside the wheel in the toys. This is a spring. The springs provide the knowledge about energy, for example, when the springs twist, they store the energy and this energy is called "Potential Energy." On the other hand, when the springs untwist, they release the energy for movement, it is called "Kinetic Energy."

5. Relating to real life and everyday experience

Toys using springs allow children to learn about the springs that relate to real life and everyday experiences, such as the springs in the bed or springs in the vehicle that support flexibility. Also, the toys using springs encourage children to learn about changing energy from one form of energy to others forms of energy. For example: potential energy changes to kinetic energy and electric energy transfers to heat or light. According to the aim of traditional Thai toy activities, it can pass to the framework of a traditional Thai toy activity, which is illustrated in the figure 2.4 below.

Figure 2.4: Framework of traditional Thai toy activity
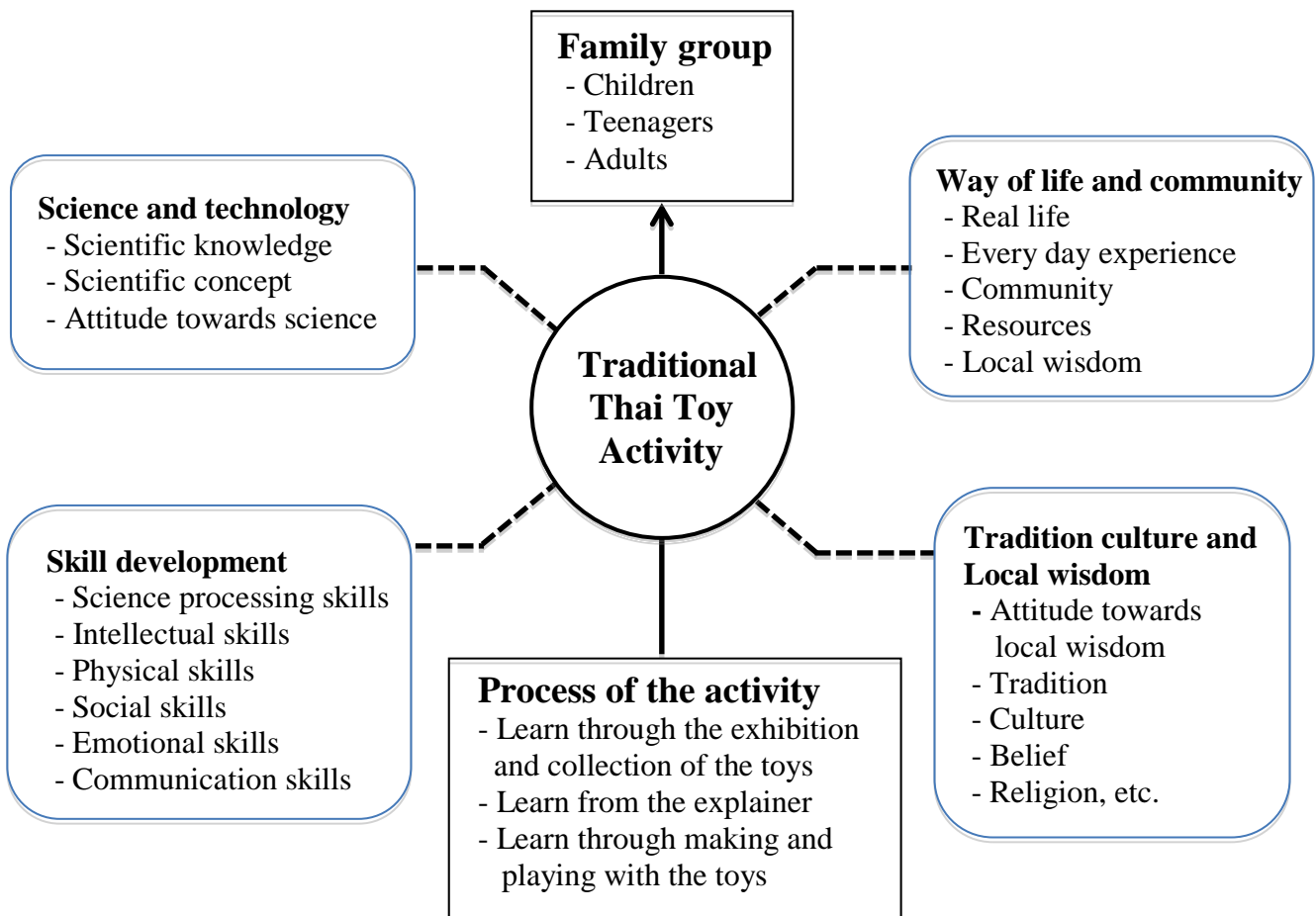
Source: Kanhadilok and Watts (2013b:48)

The components of traditional Thai toy activity

I developed TTTA at the Science Museum following the model of play activity (see figure 2.6) that provides the context of a setting (environments and resources), play activity and evaluation of learning outcomes from the activity. The details of these components have been presented below.

(1) Environments

The environments in the traditional Thai toy activity include the traditional Thai toy exhibition, collection of the toys and the atmosphere. The exhibition is located in the traditional Thai technology gallery in the Study Area. The exhibition combined with the collection of the toys there, are separated into six parts: spinning toys, toys using springs, sound toys, gravity toys, toys involving inertia and force and motion toys. The exhibition presents the background of the toys, the type of toys, science inside the toys and toys related to local wisdom. The exhibition and the varied collection of the traditional Thai toys also encourage curiosity and knowledge of the participants before they participate in the activity. Also, the atmosphere from the gallery encourages feelings about Thai local wisdom in the toy activity area.

(2) Resources

The traditional Thai toy activity's resources include Explainers, Assistants, sets of tools and materials to make the toys and traditional Thai toy activity's handbooks. The Explainer acts as the leader of the activity that has to introduce the whole of the activity and run the activity with the participants step by step. The Assistants are helpers of participants in their group. When participants miss the step or lose understanding of some part of the activity, Assistants will encourage that understanding and help to solve the problems of the activity. Sets of tools and materials to make the toys are provided in each group of activity. Participants have their own materials to make the toys and share the tools with their friends in the group. Also, for more understanding, participants will gain traditional Thai toy activity's handbooks that offer the whole content about the activity. Participants can use it to increase their understanding between the activity and after the activity or their home.

(3) Traditional Thai toy activity process

The process of the traditional Thai toy activity begins with the registration of the participants. After that, the participants are invited to explore, play and learn through the exhibition and collection of the toys, developing curiosity. Then, the participants have to go to the group and listen to the Explainer. The Explainer gives an introduction and a brief overview of the whole of the activity. The second step, the Explainer explains the background of the toys, the types of toys, the science inside the toys and how the toys relate to local wisdom. Also, the Explainer will demonstrate how to make and play with the toys on that day and discuss with the participants (adults learn from the Explainer). Thirdly, the Explainer allows participants to make the toys with their group (Adults guide their children make the toys). The activity separates participants into two groups. This step lets participants work with their group, share materials, tools and ideas on how to make and decorate the toys. Also, they have to discuss in their group about how their toys work and why their toys work differently. Then, they have to look for other friends in the other group to change the toys and play with other toys. This time, participants will discuss and share different ideas on how to make the toys with new friends. In the last step, the Explainer draws the conclusion and lets participants ask questions. After that, the Explainer makes an evaluation about the learning outcomes of the participants with the use of the Toy Learning Outcomes questionnaires.

(4) Evaluation

Traditional Thai toy activity aims to encourage visitors' learning of science and local wisdom. The science museum wants to be the place for all participants to gain learning outcomes from learning through traditional Thai toy activities. The learning outcomes from TTTA in this thesis are adapted from the generic learning outcome (GLO) and is based upon the work of the Research Centre of Museums and Galleries at the University of Leicester (Hooper-Greenhill, 2007). In this thesis, traditional Thai toy activity's learning outcomes is named "TLO" (Toy Learning Outcomes). TLO are separated into seven types of toy learning outcomes comprising knowledge and understanding; skills; attitudes and values; enjoyment, inspiration and creativity;

activity behaviour and progression; science learning and attitudes toward Thai local wisdom. The details of seven types of toy learning outcomes are as follows:

1. Knowledge and understanding: measures participants' learning from toys, making sense of toys and making links between toys and others.

2. Skills: measures how visitors can learn new skills or improve the existing skills, such as reading, writing, speaking, listening, thinking, making things, meeting people, sharing, team working and managing feelings.

 3. Attitudes and values: explores participants' feelings and perceptions that they can show their opinions or attitudes about the toys, science, Thai local wisdom and the museum. Also, they can increase their motivation and indicate positive attitudes toward science, local wisdom and traditional Thai toy activity.

4. Enjoyment, inspiration and creativity: explores the playfulness of participants, surprise, innovative thoughts, actions, creativity, exploration and inspiration.

5. Action; behaviour and progression: explores participants' action, behaviour and progression (Hooper-Greenhill, 2007).

6. Scientific learning: measures how participants learn science from traditional Thai toy activities and the attitudes toward science.

7. Attitude towards Thai local wisdom: measures the understanding of the participants about Thai local wisdom and their attitude towards Thai local wisdom (Kanhadilok and Watts, 2012c).

This study used TTTA to study family play-learning with the museum's activities. One of the purposes of this study also investigates the playfulness characteristic of participants with their learning during the activity and how the playfulness characteristic relates to the learning behaviour of participants. However, TTTA allows participants to learn by doing (making the toys) and supports learning through play with the traditional Thai toys (TTT). Also, TTTA would develop skills, actions, behaviour and progress from this activity and stimulate knowledge, understanding, attitudes, values, enjoyment, inspiration and creativity to participants after joining the activity as stated in the section of evaluation of TTTA. Furthermore, TTTA would provide bi-gnostic learning outcomes including scientific knowledge and local wisdom to participants.

To study family play-learning with the TTTA, the relevant review literature would describe family play-learning, playfulness and learning, experiential learning (learning by doing), learning through play and bi-gnostic learning through TTTA. The explanation and discussion of the literature will be presented below.

2.9 Family play-learning

Before describing family play-learning, I will discuss family learning and family learning in a museum, and then compare and contrast with family play-learning.

Family learning

Mackenzie (2010) states that family learning is about normal family activities that involve at least one adult and one child in an action, which creates learning. For example, enjoying a book, talking a walk, visiting the Post Office, baking a cake, fixing a puncture and playing computer games, all provide context for family learning (p.7). The National Family Learning Network UK defines family learning as being 'about families enjoying learning together' that includes members of the family (parents, carers and children) learning together, parents or carers learning separately with children or other family members, and children learning separately to share learning with other family members (Mackenzie, 2010).

However, family learning provokes wide-ranging discussion. It has been described as: parents and children learning together; parents learning more about how their children learn; parents taking up learning opportunities to benefit their own learning, including literacy and numeracy, parenting courses, or other courses which interest them; learning with siblings, grandparents, step family and close family friends, and – in some instances – adults learning from their children (Kanhadilok and Watts, 2012c).

'Families are the main context of learning for most people. Learning within the family is usually more lasting and influential than any other. Family life provides a foundation and context for all learning' (NIACE, 1995:132).

Where specific research evidence does exist it tends to focus on particular family dyads and specific areas: mothers working with their children's reading; fathers and

boy's physical skills, grandparent and grandchildren baking cakes (Kanhadilok and Watts, 2013b). Franz (2009) makes a similar point in her review of empirical research, that while there are a number of instances of particular good 'learning interaction', learning between the generations most commonly 'just happens incidentally while the generations are cooking and playing together'. Bandura (2005), for example, states that the learning process starts with the learner modelling the experiences of other people in a particular social setting. This develops into the learner copying, or emulating the others, adults and other siblings, and then on to a self-controlled level (Zimmerman and Schunk, 2001).

In this study I am interested in inter-generational learning, where family groupings influence and learn from each other. I have chosen to discuss four dimensions of family learning of this kind drawn from the literature: (1) its non-didactive nature, (2) the levels of social collaboration, (3) the extent to which it is embedded in a meaningful activity, and (4) how it is initiated by the learner's interest or choice.

The study will focus on the transmission of attitudes, beliefs and practices and the modelling of behaviours between generations, and if family learning is realised, or not. In terms of role modelling I turn to social cognitive theory. Social learning theorists like Bandura (1986, 2001) contend that, to promote effective modelling, a role model must make sure that four essential conditions exist; **attention, retention, motor reproduction, and motivation.** That is, 'vicarious learning' through familial role-modelling concerns learning through observing the actions of others in the family, and its effectiveness depends upon how well such people are able to support the learning of others. Support from 'trusted others' is important, not least because they are able to share concerns about their own lack of confidence and how common it is to have difficulties in certain areas.

The tasks and activities are described below, the study was be conducted within a very sociable, non-didactic setting, where multi-age family groups chose to participate in meaningful activities. Within this, the thesis has sought to identify examples of:

(i)   Level 1 action: Where one of the family groups initiates a task and acts as a role model. He or she gains the attention of the others as they watch the task unfold.

(ii)   Level 2 action: Where the other member of the family then begins tasks of their own, guided by the better, more accomplished, more experienced members of the group.

(iii)   Level 3 action: Where the 'learner' members of the family gain achievement in their tasks supported by, but largely independent of, their family role models

(iv)   Indications of Level 4 action: that the learners will try to take what they have learnt from the setting and repeat, adapt and improve on what they have been doing.

Family learning in museums

Family learning in museums places emphasis on family visitors which may include parents, children or some other member of the family, who engage and interact together in the museums. The main purpose of families to go to the museum is to gain enjoyable learning, new experiences and insights together. Museums do not help children to gain only confidence in themselves as capable learners, but also encourages them to develop relationships with adults in the family and support adults (parents and grandparents) as effective teachers of children (Black, 2005).

Family play-learning

In this thesis, I use 'Family play-learning' to describe family learning as making things and engaging in play activities through the TTTA at the Science Museum. Family play-learning is not family support that focuses on support by parents with issues such as mental health, poverty, disabilities and other factors to support fully their children's learning (Mackenzie, 2010). Family play-learning is not only normal family learning that families enjoy together with basic family activities in the above. Family play-learning is similar to family learning in the museum but what is a unique about family learning, with emphasis on making and playing activities for inter-generational learning, where family groupings influence and learn from each other to guide the

learners in the family group. The main content of family play-learning is adapted from the tasks and activities of family learning from Bandura (2005)'s work. In this thesis, I am interested in making and playing with traditional Thai toy activities to study family play-learning in a science museum. The method and the finding of family play-learning will be presented in Chapter 3 and Chapter 4.

Family play-learning with TTTA not only provides social learning, but it also encourages playfulness for all members of the family group. In this study, I am interested in how playfulness relates to the participants' learning during join the TTTA. The details of playfulness and learning will be presented below.

2.10 Playfulness and learning

Lieberman (1977) has offered a formal definition of playfulness where she concluded that it is a disposition, and described it as a 'lightheartedness' that goes beyond the childhood years through its component parts of sense of humour, manifest joyfulness, and spontaneity.

Glynn and Webster (1992) define adult playfulness in the following way:

> ... an individual trait, a propensity to define (or redefine) an activity in an imaginative, non-serious or metaphoric manner so as to enhance intrinsic enjoyment, involvement, and satisfaction. Playfulness is a multidimensional construct encompassing cognitive, affective, and behavioural components, which together constitute a continuum along which individuals range from low to high
> (p. 85)

Trevlas, Grammatikopoulos, Tsigilis and Zachopoulou (2003) point out that a playful disposition includes two factors, it depends on the external environment and the internal disposition of players. The external environment includes everything around the players, for example location, decoration, light, colour, sound and sound effects, etc. They have an influence on playfulness, for example, the fun park, which was decorated with colour, light, dressing; fascinating sound and excited playthings.

The internal disposition of the players has many underlying components. Lieberman (1965,1977) described, that the playfulness quality includes five components as follows:

1) **Physical spontaneity** is coordination and motor activity.

2) **Social spontaneity** refers to the interaction with others during play.

3) **Cognitive spontaneity** emphasises the imaginative quality of play.

4) **Manifest joy** is the expressive nature of play, expressions such as enthusiasm, enjoyment, lack of self-control and vocalization during play.

5) Sense of humour implies joking, teasing, and clowning (p. 12).

Rogers *et al.*, (1998) studied children's behaviour inventory and the outcomes of the study provides the concurrent relationship the playfulness and externality. They developed an instrument to measure the playfulness of children through a questionnaire with parents and teachers. Their results indicated that playfulness appears to be a valid construct, which can be reliably measured and which is distinct from external dependency. Playfulness is an internal consistent behaviour, it occurs through playing. Thus, it can define a behaviour as play and it seems reasonable to conclude that playfulness is a personality trait that can be scaled.

Barnett's (2006) study about the nature of playfulness in young adults, focuses on groups of undergraduate students to describe characteristics of highly playful or non-playful people with fifteen characteristics of a playful individual that resulted in four groups as follows:

1) Gregarious: Cheerful, Happy, Friendly, Outgoing and Sociable

2) Uninhibited: Spontaneous, Impulsive, Unpredictable and adventurous

3) Comedic: Clowns around, Jokes/teases, Funny and Humorous

4) Dynamic: Active and Energetic

From the results of this study, Barnett defines playfulness as a predisposition to frame (or reframe) a situation in such a way as to provide oneself (and possibly others) with amusement, humour, and/or entertainment. Individuals who have such a heightened predisposition are typically funny, humorous, spontaneous, unpredictable, impulsive,

active, energetic, adventurous, sociable, outgoing, cheerful, and happy, and are likely to manifest playful behaviour by joking, teasing, clowning, and acting silly (p.955).

In this study, I adapt Barnett's study (2006) to develop a playfulness questionnaire to explore the playfulness characteristics of visitors in the science museum but I cut three characteristics that have the same meaning in the Thai language this includes eliminating, Clown around, Jokes/teases and Humorous. I used only the funny characteristic to represent the comedic group. The details of this questionnaire I will discuss further in Chapter3.

The benefit of playfulness for learning

Playfulness is the predisposition to respond to a situation or activity in an imaginative and non-serious way, it also provides intrinsic enjoyment, involvement, satisfaction, amusement, humour and entertainment. Laughter is one of the outcomes of playfulness. Scientists found that when people laugh, the pituitary gland releases substantial quantities of 'endorphins' chemicals that can block the sensation of pain and produce overall feelings of euphoria. Endorphins also encourage people to feel happier, more relaxed and deceases stress when their levels increase. So, when people have more playfulness, the levels of endorphins will increase due to the feeling of pleasure (Mandal, 2011). It seems that playfulness benefits directly to physical and mental health of people.

Taylor and Roger (2001) studied the relationship between playfulness and creativity of Japanese preschool children through observation in a classroom, they found that the playfulness of children relates to creativity. The teachers described some non-playful children as being internally playful, and this internal playfulness was observable in a one-to-one interaction manifested as joy, sense of humour, and active involvement. These children exhibiting internal playfulness possessed a great deal of internal imagination. Another interesting theme that emerged from the data was the internal playfulness noted by the teachers. They regarded children's playfulness not only as overt behaviour but also as internal thought (imagination). One teacher's comments best described internal playfulness, "When children are playful, they are creative and can use a lot of imagination" (Taylor and Roger, 2001:46).

Glynn and Webster (1992) found that individual playfulness affects positively work perceptions, attitudes toward work and organisation, outcomes of work, including task evaluations, involvement, and performance.

Playfulness often results in both individual (children and adults) and organisational learning because it reduces boredom, releases tensions, prevents aggression and symbolises workgroup membership (Lieberman, 1977).

It is clear that playfulness will provide amusement and entertainment for people including children, young adults and adults. It also reduces the boredom and stress due to perfect physical and mental health. Moreover, playfulness is important in developing the imagination, creativity and problem-solving abilities. From my perspective, when people have playfulness, they have curiosity and enthusiasm. So, they have readiness and can be motivated for learning.

TTTA not only provides playfulness for participants, it also allows participants to learn by doing with making and playing with the TTT. The detail of learning by doing and the experience of learning will be discussed below.

2.11 Experiential learning

Kolb, Boyatzis, and Mainemelis (1999) defined experiential learning as the process whereby knowledge is created through the transformation of experience. Knowledge results from the combination of grasping and transforming experience (p.2). Experiential learning theory emphasises learner-centred learning and operates on the premise that individuals learn best by experience. This theory can be described as "learning by doing", in which learners gain experience through directly involving with the activity, including materials, processes and people. The experiential learning activity focuses on individually direct participation with the process of the activity.

Kolb (1984) described experiential learning:

- as a cyclic process involving setting goals, thinking, planning, experimenting and making decisions, and finally action, followed by observing, reflecting and reviewing
- Uses the participants' own experience and their own reflections about that experience, rather than lecture as the primary approach to learning. Experiential learning theory allows for the generation of understanding and allows for the transfer of skills and knowledge.
- Involves doing something and discovering what it is like, how it made the learner feel, what it meant to the learner, i.e. experiential learning is their experience and no one else's.
- Is, therefore, particularly effective in adult education as it addresses the cognitive, emotional and the physical aspect of the learner (p.25)

Experiential learning theory is obviously important for children's learning because children can learn from their actions, for example making, painting, writing, singing or coping. This theory will be the most effective when learners have internal motivation, which is a common characteristic of children and adults (Rogers, 2002).

Kolb (1984) points out that experiential learning theory offers the foundation for an approach to education and learning as a lifelong learning base on the analysis of social psychology, philosophy, and cognitive psychology. The purpose of the experiential learning framework is to emphasise the critical connection between education, work and personal development.

Rogers (2002) views that experiences lead individuals into learning. Experiential learning is a key element in contemporary discussion of lifelong learning. Adult learning generally used informal learning resources to learn something from their interest all the life span with lifelong learning. Experiential learning cannot only be a benefit but can be harnessed to enable the adult to continue into further forms of a lifelong education.

In my view, experiential learning would be effective for the learner through engagement directly with the process of the activities. So, those studying could learn individually based on their interests with the activities that allow learning by doing and they could gain experiences directly from the activities. However, experiential learning takes more time and costs more when compared with other types of learning. The learners have to spend their time and money travelling to places and their money for materials in order to engage in learning with the activities Also, the level of their learning depends on their motivation and previous knowledge. So, each learner in the activity may gain their knowledge differently. Experiential learning processes would be slow, when learners have more differences, for example, children and adults learn together in one activity. Adults would understand the activity more quickly than children because they have had previous experience. This is the disadvantage of experiential learning. On the other hand, the TTTA changes this disadvantage to a benefit through the family play-learning activities that allow adults who have had more experiences in the family groups to guide and help their children to learn the TTTA. Adults have motivation to assist their children to make the toys, while, children want to make them and keep them. When both ages group learn to make and play with the TTTA, they gain a deeper understanding about the activities when compared with other types of learning.

Hyland (1989) developed and revived Dale's cone to explain more experience learning. He divided the cone into two parts. The first part begins in the middle continuing to the top, it is a passive learning which is composed of verbal receiving and visual receiving. The second part is active learning including receiving and participating, and learning by doing. The movement from the top of the cone to the bottom shows the increase in learning with senses engaged. Passive learning is separate or uncoordinated, because it is not integrated. Whereas, the activities associated with active learning: participants, designs, demonstrations, simulations, and performances. These actions call for the harmonious interrelationship with multiple senses that increases people's capacity to learn and comprehend 90% of what they here, see, and do, etc. (see Figure 2.5).

Figure 2.5 Cone of Learning

10% of what we read	READING	Verbal Receiving	P
20% of what we hear	HEARING WORDS		A
30% of what we see	LOOKING AT PICTURES		S
	WATCHING A MOVIE		S
50% of what we hear and see	LOOKING AT AN EXHIBIT	Visual Receiving	I
	WATCHING A DEMONSTRATION		V
	SEEING IT DONE ON LOCATION		E
70% of what we say	PARTICIPATING IN A DISCUSSION	Receiving and Participating	A
	GIVING A TALK		C
	DOING A DRAMATIC PRESENTATION		T
90% of what we both say and do	SIMULATING THE REAL EXPERIENCE	Doing	I
	DOING THE REAL THING		V
			E

Developed and revised by Bruce Hyland (1989) from material by Edgar Dale Woods, Donald R. Source: Bruce Hyland (1989:4)

In my view, the Cone of Learning describes the fact that learners would learn 90% more through doing the real thing, simulating the real experience and doing a dramatic presentation. However, human learning also depends on the need, interest and motivation of the learners. So, some people would not learn by doing because it is not appropriate to their needs and some of them would have no opportunity to learn by doing because of the time and cost of the activities. Considering, verbal and visual reception these provide low effectiveness of learning but it would be suitable for some people to whom learning by doing is not suitable.

The TTTA provides the experiential learning for participants. As stated above experiential learning described as "learning by doing". Learners will gain experience through directly involving with the activity, including materials, processes and people. The experiential learning activity focuses on direct participation with the process of individual activity. Experiential learning is consistent with TTTA that participants have to learn by making the toys from the materials of the toys and the process of toy making from the Explainer individually. Especially, adult participants have to gain toy

making process experience before guiding their children. Also, the Cone of learning indicates that learning the real things by doing and conversation will enable learners to learn 90%. It is clear that experiential learning through learning by doing would encourage learner to learn the situation the most.

TTTA does not only provide the experience of learning by making the toys, but it also allows participants to learn through play with the toys. Learning through play provides many benefits to players that I will discuss below.

2.12 Play

Play is universal and important for children's development. Play is a way that children learn about themselves and the world around them (Davis, Larkin and Graves, 2002). Henderson and Atencio (2007) describe play as an integral part of development. Through play, children can develop their capacities in creativity, problem solving, logic, social knowledge, communication, self-regulation, cognitive processing and social development. Play behaviour is important for children to develop their social, cognitive and motor skills. Play might encourage establishment of social relationships between individuals (Nunes, Muecke, Sanchez, Hoffmeier and Lancaster, 2004). Snuggs (2008) agree that children learn through play. Play is how children begin to understand their world. Children can develop socialization skills by playing with their friends. Play helps children to learn how to solve their problems and develop the critical thinking skills by asking questions and finding out how things work. Through these activities children continue to strengthen their language development. Also, play helps children learn concepts and develop cognitive skills. Cognitive development places emphasis on developing functions of the brain such as thinking, learning, awareness, judgment, and processing information. Cognitive development is improved through play.

2.12.1 The type of play

Children like variety. During the day, they will change their type of play. Sometimes they play with the same toys but more often they use different toys to change

stimulation in different types of play. Six types of play are important for children's total development (Hughes, 2006).

1. Discovery plays (Exploring play)

Discovery play allows children to find out about things around them such as their size, shape, texture, colour, etc.

2. Physical play

Physical play takes place when children do movable activity for example, running, jumping, climbing, crawling, swinging, throwing a ball and so on. Physical play encourages children to develop their muscles, and bones, which are important for their growth.

3. Creative play

Creative play occurs when children express their own ideas and feelings to make something new, for example, a picture, an animal in modelling dough, designing cards and building a house from building blocks, etc.

4. Imaginative play

Imaginative play is pretend play or fantasy play. Children will imagine that they are someone else, an animal/human such as a prince, a rabbit or objects such as a car. Sometime they play like adults when they see their parents work. Attempting to behave like someone else helps him or her to understand more clearly the way other people behave.

5. Manipulation play

Manipulation play involves the skillful using of children's hands. During manipulation play the hands, eyes and brain are being trained to cooperate, to work smoothly together. Children will increase the skillfulness of their hands, when they play with rattles, soft toys and other objects.

6. Social play

Social play occurs when children play together. This type of play allows them to cooperate, to share, and to be honest. On the other hand, it also teaches them that antisocial behaviour, like cheating, leads to isolation and loss of friendship. A child often quarrels and in doing so learn about each other's reactions (Hughes, 2006)

However, each type of play provides different types of children's learning and development. For example, physical play and manipulative play would develop the physical skills of children, while, discovery play, creative play and imaginative play encourages cognitive learning. Also, social play with other people provides emotional learning. When children play, they learn about the world around them and develop physical skills and emotional learning.

Making and playing with TTTA encourages children to develop manipulative play because when children make and play with the toys they will develop hand, eye and brain. Also, playing with the TTT would relate to physical play and social play when participants play with the toys with a member of the family or other people, they will learn sharing, cooperation and develop communication skills. Furthermore, play with the TTT would encourage creativity and imaginative plays when participants decorate the toys and design the rules to play the toys with others.

It is clear that play is very important for children's development, imagination, creativity and adults' learning. For more understanding about play, I will discuss the context about play below.

2.12.2 Contexts for play

A learning environment is a space where the resources, time, and rationales for learning are available to a group of people to nurture, support, and value their learning of a proscribed range of information and ideas (Kanhadilok and Watts, 2012c). As Reiber (2001) points out, learning environments can be social places even when only one person can be found there. The centre of a learning environment is sharp, clear, and focused, but the edges are fuzzy. There are limits to each learning environment, both in what can be learned there and whose learning will be supported most. It is more common to describe a learning environment by the types of resources to be found there, but while the resources are crucial to a learning environment's effectiveness, resources are only as good as the conditions under which one has access to them. In Figure 2.6 below I set out some of the broad framework, in this instance a model for 'learning through play' to happen.

Figure 2.6: The model of two zones of play
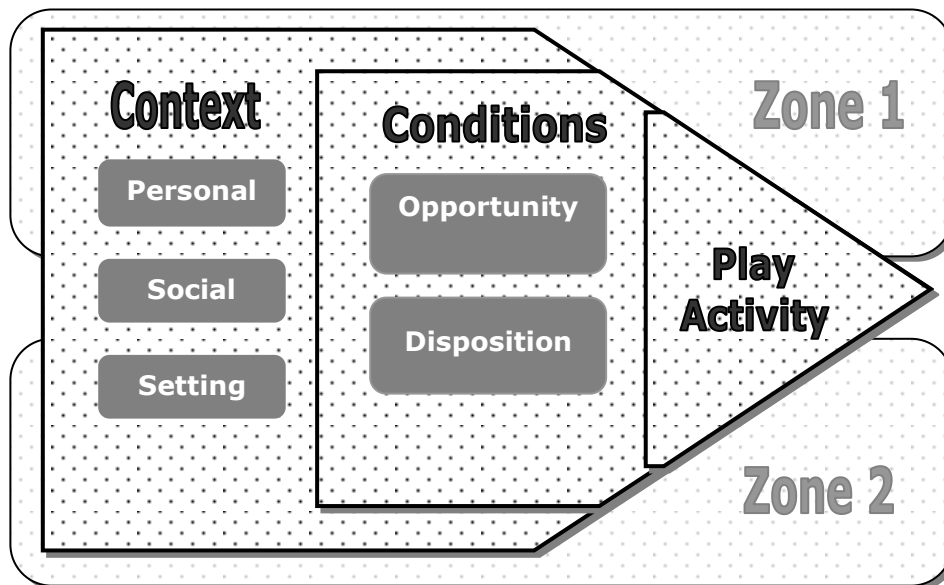
Source: Kanhadilok and Watts (2012c:882)

The two zones represent those environments where play is - and is not - deemed appropriate. Zone 1 is a play zone, and is intended to encompass all of those physical, and virtual, spaces where play can commonly take place, including sporting arenas, parklands, areas of the countryside like woodlands and beaches, youth centres, arcades, playgrounds, theme parks, a comedy show, streets, gardens, bedrooms, game-worlds etcetera. Zone 2 is intended to represent the opposite, a no-play zone, those spaces where play is deemed a distraction, inappropriate, is uninvited, curtailed: a three-lane motorway, a church, a busy construction site, the company board-room, some lecture theatres, classrooms, a funeral, and so on. It is clear even with that distinction there are occasions where some play may be possible, especially where this contravenes conventions, conformity, and causes amusement. (Kanhadilok and Watts, 2012c).

Even when the zone is appropriate, where the people and the setting are right, play may still not take place. As Else (2009) maintains, play is personally directed, trades upon a disposition, a momentary mood and is undertaken for its own rewards. Play must involve pleasure: where there is no pleasure, no fun, no enjoyment, then there is no play. When play becomes tedious, is imposed or required, then it ceases to be play.

When the fun ends, players become disillusioned, frustrated, bored - one can signal an end to play by leaving the play-setting. Moreover, play entails on opportunity for risk – low risk in some settings, high risk in others, for example, walking along the top of a wall, swinging high on a tyre over a river is high risk, appearing foolish playing a game of charades is a low risk situation.

Leading from figure 2.6, *Personal characteristics*, *social relationships* and *particular settings* can be further descriptions of contexts for play. The 'personal' relates to the individual, and his or her tendencies towards play, emotions and playfulness as stated in the section of playfulness. The 'social' entails a person's feelings, beliefs, culture, as these relate to others. People find 'playmates' in a range of different contexts: home, school work, social venues, sports halls, a golf course. The setting is also important, whether playing mixed doubles on a tennis court, 'I-spy' in the family car, *Wii* games in the living room or *Runescape* in the bedroom.

2.12.3 Three dimensions of play

A comprehensive review of literature on play by Rubin, Fein, and Vandenburg (1983) led them to define play three dimensionally, i.e., context, disposition and behaviour. I will follow this line of thinking here:

(1) Context

A learning environment is a space where the resources, time, and reasons are available to a group of people to nurture, support, and value their learning of a limited set of information and ideas. Learning environments are social places even when only one person can be found there. The centre of a learning environment is sharp, clear, and focused, but the edges are very fuzzy. There are limits to each learning environment, both in what can be learned there and whose learning will be supported most. It is most common to describe a learning environment by the types of resources to be found there, but while the resources are crucial to a learning environment's effectiveness, resources are only as good as the conditions under which one has access to them. This thesis will describe together these two contexts: the expectations of learning within a

play-zone. The context of play and the disposition to play (as discussed below), create an atmosphere where play-learning can take place.

(2) Disposition

Even when the zone is appropriate, where the people and the setting are right, play might not take place. As Else (2009) maintains, play is personally directed, trades upon a disposition, a momentary mood and is undertaken for its own rewards. Play must involve pleasure: where there is no pleasure, no fun, no enjoyment, then there is no play. When play becomes tedious, is imposed or required, then it ceases to be play.

(3) Behaviour

 Behaviour in this study is focused on children and adults' behaviour inventory in order to measure playful behaviours. The study focuses on twelve playfulness characteristics of participants and includes Cheerful, Happy, Friendly, Outgoing, Sociable, Spontaneous, Impulsive, Unpredictable, Adventurous, Funny, Active and Energetic. The study done previously about playfulness of visitors in a science museum indicated that most of visitors label themselves as 'funny', 'cheerful' and 'happy'. The highest score related to being friendly. These broad outcomes are consistent with a general portrayal of these young Thai people's behaviour as friendly, happy and funny. Thailand pictures itself as the 'land of smiles' (Thailand Tourist Authority, 2011), where people are happy and funny. When visitors are playful, they have a readiness to learn with the exhibitions and activities in a science museum.

It is to be noted that play is important for childrens' learning and development. Children develop their knowledge, skills, self-regulation, cognitive processing and social development. Play will bring playfulness to players. Playfulness encourages imagination and creativity for children and adults. Play depends on the context and condition of play as stated above. When play occurs, learning will follow. Learning is important for children and adults as stated above. In the next section, I will discuss the learning theory that explains how people learn as shown below.

2.13 Constructivist learning theory

The learning theories of Jean Piaget (1953), Jerome Bruner (1966), Lev Vygotsky (1978) and John Dewey (1944) serve as the foundation of constructivist learning

theory. Constructivism views learning as a process in which the learner actively constructs or builds new ideas or concepts based upon current and past knowledge or experience (Pritchard, 2009).

Constructivism itself has many variations, such as action learning, discovery learning and knowledge building. Regardless of the variety, constructivism promotes a student's free exploration within a given framework or structure. The teacher acts as a facilitator who encourages learners to discover principles for themselves and to construct knowledge by working to solve realistic problems. Aspects of constructivism can be found in self-directed learning, transformational learning, experiential learning, situated cognition, and reflective practice and religious practice (Long, 2006).

Constructivism is generally attributed to Jean Piaget (1944), who articulated mechanisms by which knowledge is internalized by learners. He suggested that through processes of *accommodation* and *assimilation*, individuals construct new knowledge from their experiences. When individuals assimilate, they incorporate the new experience into an already existing framework without changing that framework. This may occur when individuals' experiences are aligned with their internal representations of the world, but may also occur as a failure to change a faulty understanding; for example, they may not notice events, may misunderstand input from others, or may decide that an event is a fluke and is therefore unimportant as information about the world.

In contrast, when individuals' experiences contradict their internal representations, they may change their perceptions of the experiences to fit their internal representations. According to the theory, accommodation is the process of reframing one's mental representation of the external world to fit new experiences. Accommodation can be understood as the mechanism by which failure leads to learning: when we act on the expectation that the world operates in one way and it violates our expectations, we often fail, but by accommodating this new experience and reframing our model of the way the world works, we learn from the experience of failure, or from others' failure (Illeris, 2007:13).

It is important to note that constructivism is not a particular pedagogy. In fact, constructivism is a theory describing how learning happens, regardless of whether learners are using their experiences to understand a lecture or to follow the instructions for building a model airplane. In both cases, the theory of constructivism suggests that learners construct knowledge out of their experiences. However, constructivism is often associated with pedagogic approaches that promote active learning, or learning by doing or 'discovery learning' (Driscoll, 2005).

Constructivist learning in the museum

Black (2006) states that 'Constructivism represents an idealist approaches to the concept of the development of knowledge'. He also points out that 'Where constructivism appears to differ from most other theories lies in its application both to how people learn and to the nature of knowledge itself. If constructivist theory is accepted as central to the nature of museum learning, the curatorial role in developing exhibitions and activities becomes, in principle, one of providing visitors with opportunities to interact and to construct their own meaning' (p.140).

Curators have to seek to communicate the subject matter into an appropriate format for visitors' understanding and gain new knowledge. Also, they can continue to build on what they have already been learned. The subject matter must also be about concept rather than facts, which the aim to build on existing experience to construct new meaning. Visitors will require to understand the 'Whole' as well as of the parts, and the parts must be understood in the context of the whole (Falk and Dierking, 2000).

The National Science museum, Thailand develops the science exhibitions and activities following the constructivist theory. The exhibitions display concept, fact, theory and information about scientific knowledge with the appropriate presentation, for example the label and the relevant pictures encourage visitors to understand the whole of the exhibitions and the interactive exhibitions allow they learn through hands-on learning, while gaining understanding of the parts. When visitors learn all learning points in the gallery in the museum, they will interact and construct their own

meanings of the subject matter that curators provide to them. Also, the capable learning of learners depends on their prior knowledge or their background.

The traditional Thai toy activity is the same as the exhibition concept design. The activity provides environments and resources for family play-learning. The environment includes the Thai technology gallery atmosphere, the traditional Thai toys exhibition with the collections of old toys and the cartoon character of toy playing. The resources comprise the materials to make the toys, the handbook, Explainer and Assistants to support their learning during the activity. The introduction of the activity and the toy exhibition allow participants to learn the whole of the traditional Thai toy concept. When learners learn how to make and play with the toys, they will interact in some parts. If they learn every part of the activity, which are the exhibition, collections, traditional atmosphere, make and play activity, member of the family, Explainer, Assistants, the handbook, and all materials to make the toys, they will construct their own meaning about traditional Thai toys, local wisdom and scientific knowledge that is the whole process of learning.

2.14 Learning through play

Chaiban (2004) points out that learning in children is different from adults because adults have more experience than children. Adults' concept of learning relates to independent, self-direct learning but children are dependent. However, children's readiness to learn is based on physical, mental and social development but adults learn from their need. Learning environments, the sequence of lesson designs and activities are quite different between children and adults.

This research studies family play-learning with TTTA, I conducted research with family groups including children, young adults and adults. The difference of learning in children and adults is beneficial to family play-learning in that TTTA wanted more experienced members of a family (mainly adults) to transfer their knowledge and skills about making and playing with the toys to young members of the family. Adults have more experience, are ready to learn, and have immediate application. This quality is suitable for level one and two action of family play-learning as stated above. So, in

this section I will separate explanation about children learning through play and adults learning through play as presented below.

2.14.1 Children learning through play

Newstead (2011) stated that 'Children learn by playing, become physically healthy by playing, heal emotionally by playing and lots more. In other words, all sorts of good things happen to children because they play' (p.10). Play is the primary benefit for children. The most amount of learning by young children occurs during free play. The nature of children is curiosity which leads them to explore possibilities and test each one. Play with blocks will begin by stacking them. From this simple activity, children learn basic problem solving skills and explore size and shapes. The earliest form of play in childhood is functional play. Through this type of play the child gains confidence in his abilities, which will encourage him to do new things and support gross motor skills as well as logical thinking (Moyles, 1999).

Also, Sinker (2011) describes that play is important for children's development because it is the way that children learn skills that they need for a playfulness and capable adulthood .Following are some of the ways that children learn while playing:

1. Physical skills are developed through movement when children learn to reach, grasp, crawl, run, climb and balance, as well as develop their handling of objects in play.

2. Language skills are learned as a child playing interacts with others. Beginning with cooing games with a parent and evolving to sophisticated levels such as telling stories and jokes. The increasing of ability to use language occurs as the children play, as well, the social skills grow through learning to cooperate, to negotiate, to take turns and play by the rules are all are important skills learned in early games. Also, through imaginative play, a child begins to learn some of the roles and rules of society.

3. Emotional well-being develops through positive experiences. It occurs when children feel successful and capable as they play and they acquire important

ingredients for emotional health. Consistent with Daniel (2011) who states that play is very important for children's leaning and emotional development. Play provides a wide array of benefits that gives a child fun and enjoyment, and also, play develops personality and helps children to realize potential experiences that provide satisfaction and success. Furthermore, play allows children to gain creativity and imagination and helps them to develop speech, reading, thinking, problem solving and fine motor skills. Play is also integral to encouraging children to manage emotions; develop values and understand and explain the world around them (Hughes, 2006).

2.14.2 Play and children's development

Play is an activity, which is essential for children and adolescents development. Many researchers found that 75% of brain development occurs after birth. Play activities can encourage children to both stimulate and influence the development of nerve cells. This process also influences the development of cognitive, affective and motor skills, emotional well-being, creativity, problem solving, language, socialization, personal awareness, and learning ability (Nash, 1997).

Play activity performs the most important role in helping children to be active, make choices and practice the mastery of certain actions. They should have experience with a wide variety of content, for example, art, music, language, science, math, social relations. Because, each content is important for developing a complex and integrated brain. Play makes a link to sensory-motor, cognitive, and social-emotional experiences, it also provides an ideal setting for brain development (Child Development Institute, 2011).

2.14.3 Adult learning through play

By nature, humans are born to play. Playing is instinctive and fundamental to human being's existence. Playing encourages survival through connecting people to other people and to sources of energy and excitement. Play stimulates the brain and body, as well as stimulation of a source of calmness and relaxation. Playfulness encourages people to be inventive, smart, happy, flexible, and resilient. Also, play with fun is an important way to develop the imagination, creativity, problem-solving abilities and mental health. Play is not only for children, but it also important for adults. Play often

makes adults feel really alive and also, play is important to adults' physical and mental health, just as is getting enough sleep, eating well and exercising (Kemp, Smith, Dekover and Segal, 2011).

Play enriches the life of adults, inspiring growth and liveliness. It allows the opportunity for healthy stimulation that adult cannot grain by work or other daily tasks. Play is also the supportive tool to help adults to create new ideas, which can be applied to real-life and challenge. Play can reduce the risk of developing mental impairments because play is an intellectually stimulating activity, which can stimulate the brain, resulting in an increase of cognitive reserves. Play also takes the mind off stressors, giving the body a chance to restore itself. Positive thinking links to good health and decrease the risk of developing mental illness and physical disease (Hughes, 2006).

Physical play activity helps adults to increase energy; strengthens the heart; stimulates endorphins; burns off hormones, sugars, and fats released into the bloodstream as a result of stress; and improve sleep. Furthermore, play can encourage adults to develop social skills through social activities, which strengthen personal ties and community. These activities provide the opportunity to connect with others, develop relationships and practice social skills such as communication, cooperation, and boundary setting (Patterson, 2011).

I agree with Kemp, Smith, Dekover and Segal (2011) that play stimulates the brain and body of adults and play is important to develop the imagination, creativity, and problem-solving of adults especially when they have playfulness. Hughes (2006) and Patterson (2011) have the same idea that play helps adults to reduce stress, increase the energy, stimulate the brain that links to the good health. It is clear that play is important for adults' learning and health.

2.14.4 Principle of adult learning

The Canadian Literacy and Learning Network (2011) described the seven principles of adult learning, which illustrates the difference between children and adults' learning as follows:

1. Adults must want to learn

Adults must want to learn something that relates to them being able to better their life. They will learn effectively only when they have a strong inner motivation to learn a new skill or develop previous experiences or gain a particular type of knowledge to improve their life or family. For example, learning in order to help their children, is a strong motivation for parents as is getting a higher education for a good job.

2. Adults will learn only what they feel they need to learn

Adults always learn something that they want to learn depending on their interest. They are practical in their approach to learning with something that they want to know such as learning something to help them, or something that responds to their interests or answers their questions.

3. Adults learn by doing

Children learn by doing, but active participation is more important for adults. They need to learn by doing to develop their skills and gain a deeper understanding of the relevance of what they learn (Knowles, 1990)

4. Adults learning focuses on problem solving and the problems must be realistic

Children learn skills sequentially. Adults start with problem solving.

5. Experience affects adult learning

Adults have more experience than children. The previous experiences of adult learners will benefit their developmental skills.

6. Adults learn best in an informal situation

Children have to learn to follow the curriculum in the schools. Whereas, adults can learn anywhere and anytime that they feel or they need to know, for example, they can

learn through the mass media or an informal environment such as learning centres, museums, natural parks or the work place.

7. Adults want guidance

They want information as a guide line in the way to learn with self-directed learning that helps them to improve their situation. They want to choose options based on their individual interests.

It was clear that learning through play is important for children and adults' learning because through playing with TTTA, participants (both children and adults) can gain experience and knowledge individually and learn toy making skills from this activity. Also, play provides playfulness. Playfulness encourages people to be inventive, smart, happy, flexible, and resilient. Play with fun is an important way to develop the imagination, ones' creativity, problem-solving abilities and mental health for children and adults as stated above.

As state above TTTA provides playfulness and the opportunity for experiential learning and learning through play. Moreover, TTTA will provide bi-gnostic learning to participants including scientific knowledge (Western science) and local wisdom. In The next section, I will discuss TTT and TTTA for family bi-gnostic learning with the toys activities below.

2.15 Toys and the importance of toys

Before discussing bi-gnostic learning from the TTTA it is important to describe the toys, the background of traditional Thai toys and the importance of traditional Thai toys for bi-gnostic learning. The details of this section are presented below.

Toys

Toys and play are the first steps of learning in children's lives. When children play with toys, it seems represent a real life. Toys are the educational tools, which encourage the development of children (Basal and Zeteroglu, 2011). Stone (1983) point out that toys are not only for playing, but toys are also the tools for playing that

supports children's development in social awareness, imagination, visual motor capabilities and thinking processes. Play is an important activity for children worldwide and often represents a primary and valuable means of learning. Toys are an important part of a child's' life and through play, children can learn about themselves and the world around them (Hartman, 1987).

Oxford Word Power Dictionary (2006) defines toy in the following way: 'Toy means an object that a child can play with especially a model of a real thing such as a car or animals: boxes full of book toys and games' (p.755). Also, MacMillan English Dictionary (2007) defined the word this way: 'Toy means a piece of equipment that you enjoy using'. (p.1587). Sukamol (2005) defines toy is an object or equipment or things that a child can play with and it will help them enjoy and encourage their cognitive and imaginative development (p.10). Toys are play tools, which stimulate emotion and the five senses of children. Also, toys help children to develop their evaluative and practice skills, encourages imagination, speeds up the physical and supports the mental development (Sezer, 2011). Frobose (2008) defines toys as the props of play. They are the objects, equipment or things which individual (Children and adult) will play with that gives them enjoyment and also, enables them to gain knowledge, cognitive learning and imagination. Oravec (2000) defines toys as 'learning instruments', so that children's imagination is stimulated and helps them to develop, both socially and intellectually (p.1). Cappetini (2011) has the view that toys belong to children's culture all over the world. I myself define toys in the following way, 'Toys are objects, tools or playthings that individuals including children and adults can play with. Toys will give players enjoyment and encourage cognitive learning, social learning, physical skills, imagination and creativity.

The importance of toys

Toys are tools used in order to promote the development of a children's imagination and to enrich their dreams (Akin, 2007). If play is the work of the children then toys are the tools of learning. Through toys, children can learn about their world, themselves, and others. Also, toys teach children to: figure out how things work; pick up new ideas; build muscle control and strength; use their imagination; solve problems

and learn to cooperate with others (Child Development Institute, 2010). Toys are important for a child's development. Toys are the materials of play, play is not only an act for children to enjoy themselves, but also to help children to learn many key skills, experiences and concepts. For example: playing with toys allows children to learn and to interact with the environment; improve self-esteem, social skills, intelligence, and problem solving (Hughes, 2006).

Fish (2010) points out that toys help children learn through the developmental stages. When children play with a toy they will learn everything around them and increase their motor skills, toys that encourage them to perform simple tasks are important. For example, building blocks or construction toys are not only fun for children, but also help a child to develop their motor skills and hand-eye coordination. Some toys that allow children to think and gain simple experiences are important. An excellent example is puzzles, which are the great toys to exercise children's minds. Toys that can teach a lesson are especially vital and toys that are a variety of different shapes and colour can provide constant teaching opportunities. Toys also encourage children to develop their creativity. Some simple toys are great tools for cognitive development because they accelerate children to utilise their imaginations. Through interactions with toys, a child also learns about cause and effect. For example, when children play with marbles, they learn that force from one object will cause another object to move. Toys that support interaction with other people are important tools for learning and development of children. Toys such as puppets or simple board games will assist in teaching children social interaction. A child can learn about sharing, communication, taking turns, and engaging in simple teamwork (Hughes, 2006).

Hasson (1984) agrees that some children enjoy playing with the toys by themselves, desiring only occasional interaction or reinforcement from others and while others want and need more interaction and feed-back too. Frederick (1977) points out that toys and play in general, are important for children to grow up and learn about the world around them. A child uses toys and play to discover his/her identity; to foster his/her body to grow strong; to learn cause and effect; to explore relationships; and practice many skills. As Hasson (1984) stated "Good toys can stimulate curiosity and

creativity .Toys that are fun can stimulate the emergence of a child's skills and abilities" (p. 27).

Sama (2011) argued that some toys send messages about violence; such as war toys and guns. Children watch violent shows on the television, these shows may scare them and promote in their behaviour that which is not acceptable such as war and fighting, these programmes, provide negative effects to children. Most experts say that children should not be allowed to play with guns or other violent toys because these toys can be overwhelming to children, and lead them to exhibit violent behaviour. The other example is a play environment clutter-free, which parents and teachers should to be careful of when children play with these toys and playthings. For example, provide a science and nature box with a magnifying glass or toy animals to promote creative play environments. Parents have to make sure modelling clay, sorting toys, puzzles, balls, riding and climbing toys are accessible to encourage healthy child development. Daniel (2011) suggests that toys play an integral part of children's learning processes and a variety of well-chosen toys support each child's individual development. When children grow and develop, their needs will change with each stage and with their differing abilities and interests.

It can be clearly seen that toys are objects, equipment or tools that individuals (Child and adult) can play with. Playing with toys, individuals will gain playfulness and a knowledge of the world around them. Toys also encourage imagination, cognitive, effective, psychomotor and social skills for children. The same as traditional Thai toys (TTT) provide the opportunity to play for children and adults with TTTA. Traditional Thai toys are the tools for learning about the old traditional Thai toys, TTT making process, and bi-gnostic learning. The importance of TTT and how TTT encourage bi-gnostic learning is presented below.

2.16 Traditional Thai toys (TTT)

Before I discuss the importance of TTT and how TTT encourages bi-gnostic learning, I will describe the background of TTT for more understanding about these toys.

2.16.1 The meaning of traditional Thai toys

The Child Institute and Child Foundation (2007) defined traditional Thai toys as meaning a toy that is made from natural materials that are commonly found in that location. The National Science and Technology Development Agency (2006) also defined traditional Thai toys as the objects that children play with and are made from the materials that can easily be found in their locale such as material from nature or waste materials. These toys represent local wisdom, culture and society and they also promote the four functions of happiness: physical, mental, social and spiritual. Saipayak (2004) views that Traditional Thai toys are made from the natural materials from the local environment. Playing with traditional Thai toys relates to nature, tradition and culture. These toys emphasise the relationship between each member of the family when they cooperate to find materials, make and play together, this leads to children gaining love and warmth from their family.

2.16.2 The background of traditional Thai toys

The old traditional toys reflect the sound of laughter, smiling faces and the playfulness of children in the past; this is a memory. Moreover, the small number of toys remaining represent a surrogate from the past through to the present. The old traditional toys are rare to find in today's markets. Most traditional toys are produced by the specialists of traditional toy making, who modify local materials to create the toys. So, the traditional Thai toys are different depending on each location. Traditional Thai toys are the objects of a culture that reflects the way of life of each part of Thailand (Princes Maha Chakri Sirindhorn Anthropology Centre, 2007). More than 300 traditional Thai toys have disappeared from the society (The Nation Newspaper, 2011), coordinator of Rung Aroon Thai Toy Group, Taweesap Namkajornroj (2011) said that "urban lifestyle was replacing the rural ways of life, many Thai toys had already become extinct. Thai children are now addicted to the internet and cell phones. A Thai top and bamboo flying saucer used to be very popular but now they do not attract children and these toys can only be seen at demonstrations and special events" (p.1). However, Namkajornroj (2011) explained that varieties of play would stimulate the development of brain cells, lead to the efficiency of learning and recognisability. Playing with local Thai toys motivates to children's learning, it helps to develop

motor, effective and cognitive skills. These toys also help a child to develop their emotions, connect to society, promote playfulness and reduce stress. Rung Aroon Thai Toys Group's mission is to conserve local toys and continue local wisdom know-how regarding how to make local Thai toys.

Furthermore, the Khon Thao Khon Kae group of toys makers at Baan Pa Daet village in Chaing Rai province, have as their main objective to encourage closer relationships between family members of different generations through toy making; a simple vocation stemming from knowledge and experience passed down from generation to generation. The members of this group are seniors that can express and transfer their knowledge of local history through art and toys. They are proud to be able to help the local community to conserve traditional wisdom. They are also invited to teach local toy making in schools in northern Thailand. Each elder has his or her own special knowledge and techniques for making different type of toys. For example, someone may be skillful at basketry, others like to use their own imagination to create toys in many ideas and appearances using locally available materials such as bamboo, softwood, palm leaves, coconut leaves and so on.

As for, the National Science Museum, Thailand, that promotes scientific knowledge and local wisdom through exhibitions and activities. There is a traditional technology gallery to present science inside Thai local wisdom technology, not only about Thai toys, but it also exhibits other local wisdom, for example Carving Technology, Ceramic Technology, Metallurgy, Wickerwork and Weaving Technology. The traditional Thai toy exhibition is located in the Study Area in the Traditional Technology Gallery inside the Science Museum. This exhibition presents the background of traditional Thai toys, types of toys, how to make toys, how to play with toys, scientific knowledge and local wisdom found inside these toys. The exhibition also exhibits collections of traditional Thai toys to stimulate visitors with the real toys. Moreover, there are traditional Thai toy activities to promote scientific knowledge and local wisdom through the making and playing with the toys. The main concept of this activity is to connect the knowledge from the exhibition, collections, handbooks and activities to the visitors' learning of scientific knowledge and local wisdom as stated

above. It is to be note that TTTs are important for children and adults' bi-gnostic learning. However, TTTs have benefits but also limitations, I will discuss these below.

2.16.3 The benefits and limitations of Traditional Thai toys

Kasetsart University Research and Development Institute (2004) points out that some traditional Thai toys help children to develop their body for example muscles of fingers and wrists when they hold or play with the toys. These toys also promote the development of emotions and social skills when they play with the toys with friends for example this leads to sharing, teamwork and social communication. Furthermore, many kinds of traditional Thai toys encourage scientific skills and scientific knowledge.

The Child Institute and Child Foundation (2007) describes how traditional Thai toys can reduce the problems of the negativity of toys in this present time in five ways as follows:

1. The material of traditional Thai toys made from the natural materials and the objects found around the house. This reduces the harm from the toys' materials, for example, reducing the choice of plastic toys.

(2) Traditional Thai toys are easy to make. Normally, they are made by children and parents or members of the family themselves this leads to saving money to buy the other kinds of toys.

(3) During the making of traditional Thai toys, children, parents and members of family can work together with happiness and warmth.

(4) Traditional Thai toys provide the relationship between children and friends at school.

(5) When people turn back to play with traditional Thai toys, these toys will be returned to the society again, leading to the conservation of traditional Thai toys.

On the other hand, traditional Thai toys have a limitation and problems in this present time. The body of traditional toys, are mostly made from the natural materials such as bamboo, coconut shells, palm leaves and so on which were easy to find in the past, nowadays they are hard to find in the city. Also, these materials are not permanent and damage easily. Moreover, the colour of these toys is not attractive to children, when

compared with the modern toys. Furthermore, some traditional Thai toys may be dangerous because of the body of the toy or the method of playing with the toys, for example, the wooden sling that is used for throwing stones, it is dangerous when children use it as a weapon to fight with their friends or use it carelessly (Kasetsart University Research and Development Institute, 2004).

I believe that the traditional Thai toy (TTT) is unique. It is the made from the local materials from creativity of the specialists of traditional toy making. The traditional Thai toys differ from location to location. So, it is a reflection of the community, culture and the way of life. Traditional Thai toys are rare to see in this present time, so it is important to study and conserve them. Consequently some people and organisations are promoting TTT for Thai people to learn about these old fashioned toys and to stimulate them to conserve TTT and the local wisdom. TTTA in a science museum is one of those organisations who provide information TTT to visitors of science museums so that they can learn about the TTT, Thai culture, local wisdom and the science inside these toys. Also, TTTA will stimulate participants to be aware the value of local wisdom and science. The details of learning about science and local wisdom (bi-gnostic learning) from TTTA I will describe below.

2.16.4 Traditional Thai toys (TTT) for learning of science

Traditional Thai toys are the culmination of local knowledge that has been collected over a long period of time with the aim of providing playfulness and reducing stress of emotion. Moreover, Traditional Thai toys can stimulate learning, knowledge, recognition ,creating and imagining and they also encourage awareness of the value of local wisdom. Traditional Thai toys are made from waste materials or local materials that adults provide to children or children make by themselves to play with. Playing with traditional Thai toys reflects on wisdom, way of life and culture of a community. Moreover, they will encourage a child's development, such as physical, emotional, social and intellectual development. Learning science through traditional Thai toys aims to encourage the learner to seek knowledge through both scientific knowledge and local wisdom (Kanhadilok and Watts, 2012b).

Nearnchalearm (2005) points out that playing with traditional Thai toys helps children to develop both learning processes and science process skills, for example, measuring, observing, predicting, making decisions and inferring. He also describes learning science from a way of life, culture and tradition that relates to the learners will promote attitudes toward science that makes links between thinking processes and the way to seek knowledge, for example: curiosity about knowing the facts a desire for answers; and explanations about the phenomena; attempts to seek the answers; strong concentration while playing with the toys; having a reason for acceptance or refutation of the explanation; finding the relationship between cause and reason; have trust and no bias. These methods support the need of individuals, provide circumspectness and make a plan for each step of playing with the toys and an open mind to accept others view points, lead to the completion of scientific learning as illustrated in figure 2.7 below.

Figure 2.7: The relationship between traditional Thai toys and science learning
Source: Nearnchalearm (2005:7)

Science
- Scientific knowledge
- Science process
- Scientific method
- Creativity

Attitude toward science

Traditional Thai toys
- Playfulness
- Enjoyment
- Awareness
- Impressiveness
- Etc.

Senses
Ears, eyes, nose, tongue and skin
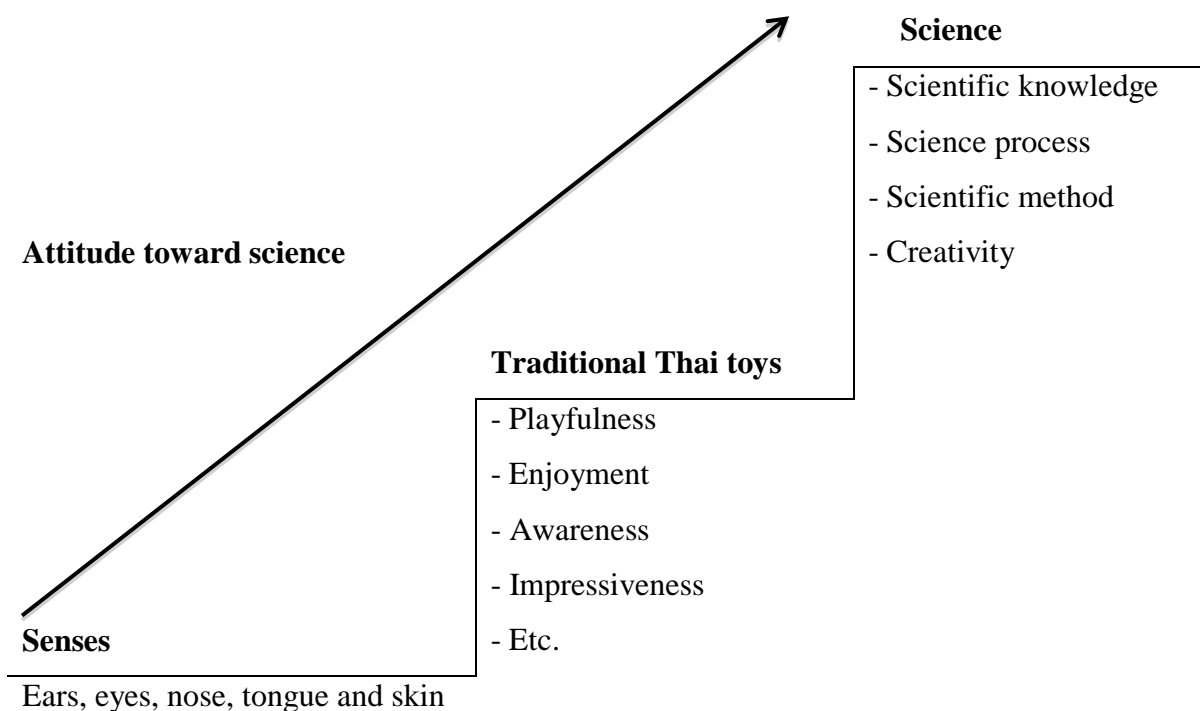
Bringing traditional Thai toys into education will encourage learners' thinking and learning, for example, looking at the problems and trying to find the way to solve them based on previous experience or modifiable experience, this will then, lead to a new experience or the learning a new things. These ideas are called 'creativity.' Traditional Thai toys for learning science also helps learners to discover, create and solve problems as well (National Science and Technology Development Agency, 2006).

It is to be note that these TTTs provide scientific learning for study. So, the details of scientific learning (Western scientific learning) will be presented below.

2.16.5 Western scientific learning through traditional Thai toys

Scientific knowledge, scientific processes and learning skills

Children and adults will learn scientific knowledge from a variety of traditional toys, when they study the exhibition and the collections of toys there, and are informed as to how these toys work with the explanation of the scientific knowledge inside each toy. They will understand these toys and the scientific knowledge more deeply, when they make and play with the toys. For example, the group of toys using springs and the group of spinning toys will allow the participants to learn scientific knowledge about energy; force and motion, friction and inertia. Whereas the group of sound producing toys will encourage learners to learn about the nature of sound. Also, the gravity toys provide the scientific knowledge about the gravity of the Earth (Kanhadilok and Watts, 2012a).

Also, traditional Thai toys will encourage children, young people and adults to develop scientific processing skills while making and playing with the toys in the TTTA. For example, experiment, observation, collection, organisation data, discussion and drawing conclusions. Moreover, this activity provides other learning skill development for the participants such as cognitive, affective and psychomotor skills, which are important for children's development and adults learning (Kanhadilok and Watts, 2013a).

Environment

Traditional Thai toys also allow visitors to learn about environmental science from the materials used in the construction of the toys, which are made from natural materials that disintegrate when they are unused. These toys point out that a toy made from natural materials does not cause environmental problems and are safe for players to play with. Whereas, the industrial toys, which are made from plastic and chemical materials may contribute to global warming, which is a big problem for our planet. In the same way, some modern toys are made from chemical materials to produce fascinating colours. But they may unsafe for children. When, participants are aware and learn about environmental science, they will be concerned about this situation.

2.16.6 Example of Western scientific learning from traditional Thai toy

Case study: Coconut mouse toy

The coconut mouse toy not only provides knowledge of Thai local wisdom, but also, allows children to learn about scientific knowledge beside making and playing with the toys. For example, when the children play with the coconut mouse toy, they can learn about how it works and the scientific knowledge beside the toy. The coconut mouse toy moves from the spring of the elastic band, which covers the wheel and is fixed beside two sides of the coconut shell. When the wheel moves forward from the force of the string, the elastic band twists and the mouse toy runs forward and then the elastic untwists and the coconut mouse toy moves backward. This movement looks like the mouse is running. When children make and play with this toy, they learn how to construct it and do the experiment, also to select the components of the toy and find the best way to make it perfect.

Also, the toy using springs relates to everyday life such as springs in the bed. The springs provide knowledge about energy, for example, when the springs twists, it retains the energy called "Potential Energy" and when the springs untwists, it releases the energy for movement, this is called "Kinetic Energy" Moreover, the movement of the coconut mouse can be related to the energy story such as the source of energy and how energy is used to move vehicles (Sharp, 2004).

However, TTTA not only allows participants to gain scientific learning, but it will provide local wisdom learning to the visitors of the science museum as presented below.

2.16.7 Traditional Thai toys (TTT) for local wisdom learning

Traditional Thai toys represent local wisdom, culture and community. Making and playing with the traditional toys will encourage children to learn about Thai local wisdom. Learning Thai local wisdom through traditional Thai toys will be separated into eight types of local wisdom (adapted from Somkanay, 1992) that I have mentioned in the section of Thai local wisdom above. The details of eight types of Thai local wisdom as presented below:

1) Home and community values

Traditional toys have been developed and played with for hundreds of years. Parents invented and taught their children how to make toys from local materials that were affordable and easily found in nature. There is a relationship between each member of the family when they cooperate to find materials, make and play together, so leading children to gain love and warmth from their family. Also, traditional Thai toys in each part of Thailand are different. They are unique and depend on the local materials, beliefs and culture that vary in each region.

2) Moral, custom and culture

These toys represent local wisdom, culture and society and they are also thought to promote the four 'traditional elements' of happiness: physical, mental, social and spiritual. Playing with traditional Thai toys relates to nature, tradition and culture.

3) Narratives and community stories

Traditional Thai toys can make a link to the telling of stories about history, background and the stories of the community.

4) Art and artifacts

Traditional Thai toys represent the art and artifacts of Thailand. As stated above, these toys are unique, and different in each part of Thailand, they are made by local artists or craftspeople who create these toys from their imagination, beliefs and culture.

5) Local occupations

Some traditional Thai toys relate to local occupation such as the toys from Khon Thao Khon Kae group. They make the toys based on the livelihood of people in the communities. For example, doll models depict people using a mortar to grind rice grains, or a stall vendor, or people working a sawmill, animal-like creatures woven from leaves and models of fishing equipment used in local community. These toys reflect the occupations in the community, which children learn, when they play with the toys.

6) Points of view, beliefs and principles

Some traditional Thai toys reflect a point of view, beliefs and principles. For example, people use small dolls of people and animals, which are made from clay or ceramics to worship 'Prapom'. They believe Prapom is the angel, who protects their house. These toys represent the servant of Prapom.

7) Creativity

Traditional Thai toys derive from the creativity of local artists and craftspeople. They create these toys from observations of nature; collect their ideas from the local environment and materials; from beliefs and culture. Thus, these toys reflect the creativity of people and community. When children make traditional Thai toys, they would create their toys from the integration of the traditional Thai toys.

8) The economics of OTOP.

 OTOP means One Tumbon (Sub-district) One Product, the product from the community's intelligence. The Government promotes this project for all villages to produce their products to raise the economy of the community. Traditional Thai toys are one of OTOP's products from some villages in Thailand.

2.16.8 Example of Thai local wisdom learning from traditional Thai toy

Case study: Coconut mouse toy

Traditional Thai toys came from creative thinking and the innovation of Thai people who create many toys for the young people. Many toys can improve cognitive skills, emotional skills and social skills that are important for child development (Department of Non-formal Education, 2001). Children not only improve important skills from Traditional Thai toys, but they also learn Thai local wisdom, for example home and community, values and ethics, family stories, narrative tales, artefacts, wise people, folklore, creativity and OTOP (Kanhadilok and Watts, 2013b).

For example, the coconut mouse toy allowed children can learn about the Thai local wisdom through making and playing with this toy. For example, Thai culture relating to the relationship in the family. Thai culture emphasises relationships within the family, Thai families are usually large in number. It is not uncommon for at least three generations to live together in one house, for example grandparents, parents and siblings. Grandparents will care for and educate their grandchild when mother and father work on the farm. The older generation will teach Thai culture to their grandchild through stories, the making and playing with toys, the relating of family history. Evening meals are communal, enjoying dinner together as a large family.

Moreover, in the Thai traditional calendar, the first year of the animal cycle is the year of the mouse. Thai tradition holds that when all the animals of the world raced across the jungle to the finish line, the mouse came first, the cow second, then the following animals, the pig last. For this reason the mouse is the first animal in the yearly cycle. Thai and Asian people believe that if the calendar turns to the golden mouse year, they will be wealthy. The animal year cycle represents the relationship between Thai people and the animals in their life such mouse, cow, snake, goat, chicken, etc. (Boonlert, 2011).

On the other hand, the farmers believe that mice are pests, not least because mice always eat and destroy products in their farms. It is not that farmers believe the mice are dirty; their belief is that these rodents will always eat the good products on the

farms. That said, many traps have been created to rid themselves of the nuisance of mice. Then, from mousetrap to food, when the farmers get the mice in the trap, they are killed and prepared as food. The special mouse dish in Thailand is 'mouse curry'.

As stated above, it is to be noted that TTTA will provide local wisdom learning to participants. For example the coconut mouse toys mentioned above will provide the local wisdom about home and community values; morals, customs and culture; narratives and community stories; points of view, beliefs and principles, and the economics of OTOP. Actually, the TTT gallery displays several kinds of TTT. Each TTT came from a different place in Thailand. So, they are unique and provide different local wisdom knowledge inside them. Thus, participants can learn more in the traditional Thai toys gallery and the other traditional technology exhibitions in the traditional technology gallery that relates to each toy.

It is clear that TTTA will allow participants to learn scientific knowledge and local wisdom. This is consistent with the purpose of this research which is to simulate science museum's visitors to learn 'bi-gnostic knowledge' including scientific learning and local wisdom from TTTA.

2.17 Bi-gnostic learning and the values of Traditional Thai toys
Bi-gnostic learning means that two knowledge systems are operative in one person, or at least that one person can operate in two cultures. I see that recognising two or more cultures in individuals and society is beneficial. Being bi-gnosis is being able to see the same situation through both Thai and Western eyes, and then having the choice of which way to respond. Having more than one form of knowledge is a personal and community resource that gives more choices in action and thought, therefore more freedom.

2.17.1 Example of bi-gnostic
1) OTOP Gold merchants
The National Science Museum, Thailand features a Traditional Thai Technology gallery, one of six major galleries, in this case designed specifically to inspire learning about the

relationship between scientific knowledge and Thai local wisdom (The National Science Museum, 2007). One part of the gallery houses particular exhibits of metallurgy, including aspects of the moulding of metal that illustrates, for instance, the 'lost-wax process'. This process is one used to make sculptures of the Buddha, make complex and intricate ornaments of silver and gold. Some aspects of the process have been transferred over a thousand years, for example, evidence of ancient lost-wax processes can be found in Ban Chiang village, Udantani Province, the north-east of Thailand.

Intricate works can be achieved by this method, primarily depending on the carver's skills. The basic technique begins with a wax model of the finished piece. Wax is easy to work with and inexpensive, and allows the sculptor to create a unique wax pattern of his or her very own. The wax model is covered by rubber latex that hardens. The wax is then heated and allowed to flow from the rubber mould and that then allows molten metal to be poured in to form a copy of the delicate wax shape. In Thailand, such intricate silverware is called 'Tom', where Tom means to 'put into'. In modern industrial uses, the process is called investment casting.

Figure 2.8: OTOP Gold merchants

Sources: National Science Museum, Thailand (2007:18)

While Tom silver and gold-ware are beautiful and famous world-wide, the artisans in Thailand have clearly gained technological skills from western countries to develop their technology for the production of better goods, greater quantity and quality. With Tom

gold, for example, craftsmen pour the molten gold into pattern lines that can go quite deep from the surface of the product. Here an important technique is to use mercury paint on the surface before painting on the gold and producing the colour black (made from copper, lead and silver melted together) and used for producing the black line of the pattern. Why mercury? Because mercury helps absorb the gold into the line design. Thai people have gained knowledge of such technology from production methods in western countries.

Within the Thai economy, Wua Lai Village has now become a community famous for its traditional silverware, helping to conserve the nation's artistic and cultural heritage. The art of silverware began in the region in the distant past when our forefathers made silver bowls and trays to use in religious ceremonies. The rhythmic sound of hammer on metal has been heard within Ban Wua Lai province for more than 200 years. One silversmith, Phrathan Bunlom, for example, was taught how to make silverware by his parents, this knowledge was passed from generation to generation within communities. In their book (2010), The Office of Small and Medium Enterprise Promotion (OSMEP) say,

> 'The silversmiths of Ban Wua Lai remain true to their traditions while adapting their skills and designs to the changing times, proudly bringing the ancient art of metal-working into the 21st Century'.

One of the OSMEP stories concerns Somsri Pewon, a third generation silversmith who recalls watching her parents and grandparents shaping and decorating raised patterns on silver bowls. Each silversmith retains the family's trade secrets and, in her school breaks, Somsri helped work alongside other family members to etch designs on the silverware. She is an advocate of progress, and argues that current production must respond to shifts in trend and fashion, with modern tools and techniques helping to develop the work. But to what extent do the new methods and old cultures intermix? While the new generation of young workers must be good at using new technology, says Somsri, they must also fully embrace tradition and heritage for the designs they use (OSMEP, 2010).

2) Indigo dyeing

The second example is the indigo dyeing technology that is exhibited in the traditional technology gallery. This technology explains western science in parallel with local

knowledge through the process of indigo dyeing.

In Thailand, communities like to use indigo dye on everyday clothes because its colour proves to be so durable. The dye can be obtained locally and processed from raw materials. The actual process of indigo dyeing is rather challenging and complicated, using a cold fermented vat technology. Because the indigo dye itself is not soluble in water, it must undergo chemical change to be dissolved. The preparation begins with soaking fresh indigo leaves for one day. Formulae differ from village to village and the artisan must know the right age of the indigo leaves to be collected. The freshness of the leaf is deemed highly important. The moment to collect the leaves is at dawn before the morning dew evaporates. The fresh leaves must be immersed in water immediately after picking, and left in the water for just the right time. Not too long or too short. The leaves are removed from the water when the colour becomes bluish-green, lime water is added to it and the solution changes to yellow. This yellow water is stirred for a few minutes, the bubbles change from clear to blue. Fast stirring makes the bubbles disappear, then the water become dark blue. Left over night, then the brown liquid which has risen to the top is poured off, with the indigo paste remaining at the bottom of the vat. The paste is kept in a clay pot. It can be kept for two to three years by adding ash water to keep it moist.

The preparation of the indigo bath starts from mixing the indigo paste with ash water, and stirring it twice a day in the morning and evening for fifteen to twenty days until the indigo bath becomes yellow. Then the dyeing starts. After the first dyeing, the indigo bath can be reused by adding more indigo paste and ash water. This is left at least six hours until the indigo bath becomes yellow again, and the dyeing process can begin once more.

The initial soaking of the indigo leaves does not to directly obtain the colour solution. Rather, this process allows two chemical substances in the leaves themselves to interact with each other and become soluble in the water. However, when this blue solution is exposed to the air and oxidized it becomes insoluble and cannot attach to the fibers of the textile, and so can be washed off. Experienced artisans know that the blue indigo solution is not for dyeing. It needs to undergo a fermentation process using

an ash solution. At this stage the artisans have to adjust the acidity and alkaline condition of the solution using their own expertise and observation (without scientific equipment). Then, the solution will turn from blue to yellow, which is the right condition for the dye to attach strongly to the fibres of the materials. When the submerged fabric is removed from the yellow dye solution, the indigo quickly combines with oxygen in the air and reverts to its insoluble form. The more often the textile is dipped in the solution, the deeper the colour becomes, and a deep blue hue would need at least 6-20 repetitions of this cold dye process (National Science Museum, Thailand, 2007)

Thai village artisans claim that indigo dye attaches so strongly this way that the colour lasts the life of the material. Good quality production, they say, must result in a long-lasting, bright, clear, clean colour no matter how deep or light is the hue. Inexperienced or unscrupulous producers of indigo dyed textiles usually do not (or choose not to) understand these processes, or they tend to rush the process. Making indigo dyed textiles is an art as much as a science (Tinnaluck, 2005)

Figure 2.9: Indigo dyed textile

Sources: National Science Museum, Thailand (2007:40)

3) Other examples

It is not only OTOP Gold merchants and indigo dyed textiles that explain bi-gnosis and the benefit of bi-gnostic learning, but in Thailand many projects use bi-gnosis to support and develop the processes and products of each community. I will summarise the example of bi-gnostic projects in Thailand in table 2.4.

Table 2.4: The example of bi-gnostic projects in Thailand

Project	Location (Province)	Local wisdom	Western science and technology
1.Improvement of Rice varieties	- Pijit	Agriculture, rice farming technique	-A technique to germinate rice grain without husk, - Knowledge about regaining the hybrid vigour of hybrid rice
2. Creative rice products	-Pathumthani - Ayutthaya - Bangkok	Ceremonial and traditional food and drink from young rice	-Food manufacturing - Food science
3. Herbal uses and integrated/organic farming	- Rayong	Herbal medicine, integrated and traditional organic farming	-Food safety - GMP standard - Production of plant hormone - Fertilization - Insect repellents - Organic farming
4. Soil Replenishing: From Sky to Earth project	- Burirum	Agriculture	- Agriculture - Soil

Project	Location (Province)	Local wisdom	Western science and technology
5. Traditional/folk medicine system and local healers	- Chiang Rai	Traditional/folk medicine	-Scientific procedures in how knowledge is created and documents - Medicine and pharmacology - Plant taxonomy
6. Indigo dyed textiles of Mae Theeta	- Sakon Nakhon	Handicraft- indigo dyed cotton Mudmee textile	-Research on chemical process of the indigo dye.
7. From weed to innovative furniture	- Pathunthani	Handicraft/weaving of natural fibre	- Research in chemistry to deal with the problems of mould - Research on fibre strength for furniture manufacturing

Source: Adapted from Tinnaluck (2005: 223-305)

These are small examples of bi-gnosis that have been used in each community. According to the Social Investment Fund Project (1998-2002) that was launched in all villages across Thailand, with the national scheme to provide a fund of one million baht to each village to develop their own products (OTOP), to promote the economy of the community and revive the economy of Thailand. So, there has been many projects that develop the community's products through local wisdom as well as science and technology. It is to be noted that bi-gnosis is very important for Thai people in each community and for sustainable development of the country.

However, bi-gnosis has been studied in many countries, for example, Nadasdy (1999) studied cases where Aboriginal people participated with government scientists in resource management and environmental impact assessment studies. Nadasdy's study

revealed that, 'TEK (Traditional ecological knowledge) was used by government scientists to avoid a two-way integration of two knowledge systems and to reinforce a Western cultural bias that controlled decision making over local land and animal issues' (p.289). It was clear that western science and local knowledge could be bridged. Moreover, Garroutte (1999) published a paper entitled *American Indian Science Education: The second Step* which provided a synthesis of the contrasting assumptions in Western scientific and American traditional thought systems, and the importance of keeping these two models of inquiry separate when designing an indigenous-based science curriculum.

It was to be noted that bi-gnosis is that of two both knowledge systems developed together in parallel, and that connect only where individuals see fit. The connection between the two forms of knowledge depends on the purpose at hand, the problems to be solved, the time and place and the conceptual challenges to be met. These are not peculiar to Thailand or the relationship between Thai local wisdom and western modern science but there have been numerous studies on indigenous knowledge and science, not least Maori people in New Zealand, Aboriginal tribes in Australia, Native American tribes in Canada. Nevertheless, the connections were shaped by the place, the people, their customs and traditions and their economic necessities (Akenhead, 2011).

2.17.2 Bi-gnostic learning and traditional Thai toy activities

The bi-gnostic strategy of traditional toy activity is making visitors aware of different cultures ways to describe and live with nature. Each culture has different content and values. In term of values, both scientific values and the values of local wisdom are made explicit in the TTTA. For example, these toys do not depend on electricity and are made from local materials and with the support of local wisdom, are suitable for sustainable development in Thailand. On the other hand, when visitors learn about force, energy and biology, they become aware of the power of science and technology which can explain a wide range of mechanisms. For example, the scientific concept of energy is enormously important for mankind because it advances human constructions and understanding that power changes in the world (Kanhadilok and Watts, 2013b).

On the other hand, the value of local wisdom emphasises harmony with nature (Aikenhead, 2006). Thai local wisdom is a way of life, knowledge that tries to make people aware of life and adapt them to nature. For example, the coconut mouse toy is made from coconut shell, a wooden wheel, string and an elastic band. These materials are 'close to nature', can be found easily, they are hand-made, construction is straightforward. This toy-making encourages children's creativity so that, when children and adults make and decorate a coconut mouse toy, they often create other animals, for example, coconut turtles, coconut beetles, coconut cars, etc. (Kanhadilok and Watts, 2012c).

There are two profound limitations on scientific knowledge. First, science is limited by its focus on selected attributes to the exclusion of others. This is a choice made by scientists not a limitation imposed upon science by physical reality. Second, the advancement of science and science education often competes with national interest in maintaining the integrity of traditional culture. It would, however, be mistaken to infer that my discussion is 'soft' on superstition, or that science is being reduced to an aspect of cultural relativism. In this kind of work it is necessary to ask about the balance between these two interests, science and local culture. While I am encouraging bi-gnosis, the degree or kind of bi-gnosis is clearly affected by characteristics in the two systems and the relationship between them. I do not advocate the 'infusion', 'assimilation' or 'incorporation' of one knowledge system within the other, nor the 'integration' or 'blending' of the two knowledge systems. I do not support a 'middle path', a consensus approach: working away until something mutually acceptable is found.

Bi-gnosis seeks understanding from both sides of the issue, deriving a clear understanding from both local wisdom and Western science that can work side-by-side. I tend towards Article 8J of the UN Convention on Biodiversity (United Nation, 1992) which reads:

> 'Respect, preserve, and maintain knowledge, innovations, and practices of Indigenous communities and lifestyles relevant for the sustainable use of biological diversity. And promote their wider application with the approval of such holders of such practices. Encourage the equitable sharing of benefits from the uses of such knowledge and practices' (p.149).

Traditional Thai Toy Activity is consistent with this Article because this activity aims to encourage people who visit science museums to learn how local wisdom parallels Western science and to promote awareness of and conservation of Thai local wisdom that is the practices of indigenous communities and the lifestyle of Thai people. Also, this activity allows participants to make traditional Thai toys form environmental materials in the community. These toys do not contribute to environmental problems, which cause the extinction of biodiversity. TTTA can bio-degrade, disintegrate into nature when they are unused. Traditional Thai Toy Activity provides Thai local wisdom learning and awareness of the value of Thai local wisdom for people into two sections:

(1) Community way of life: Real life; Everyday experiences; Community; Resources; Local wisdom and OTOP.

(2) Tradition and culture: Tradition, Culture, Belief, Religion, etc.

Traditional Thai toy activity also encourages participants to learn Western science about physics, biology and environmental science for children, young people and adults in science museums from the exhibition, collection of the traditional Thai toy and Explainers. Also, TTTA provides scientific knowledge, scientific concepts and attitudes toward science and skills development: scientific processes, cognitive, effective and psychomotor skills, making and playing with the traditional Thai toy, parallels Thai local wisdom. Moreover, local toys can encourage science education from the use of traditional Thai wisdom for children and adults to learn science. This is a small example. In the same way, when we consider the local agriculture, medicine wisdom or the traditional food, the scientific knowledge can encourage us to support sustainable development and sufficiency.

Bi-gnostic learning from the TTTA is also consistent with the National Education Act 1999, amended in 2002, section 8 that provides that educational provision that shall be based on: '(i) lifelong education for all; (ii) all segments of society participating in the provision of education; (iii) continuous development of the bodies of knowledge and learning processes'. Moreover, this activity follows the aim of education in section 6 of the Act 1999, where it states "Education shall aim for the full development of Thai

people in all aspects: physical and mental health; intellect; knowledge; morality; integrity; and desirable way of life so as to able to live in harmony with other people" (Office of the National Education Commission, 2002:7).

Conclusion

This review of literature explains the background of my study, my interests and the importance of family play-learning through informal education with the TTTA at a science museum.

A Science museum is an informal educational environment for visitors to learn scientific knowledge, tradition, culture and local wisdom from the exhibitions and all activities. The biggest visitor group to a science museum is a family group who visits the museum with inter-generational members of the family. This research is interested and focuses on family groups who participate with the traditional Thai toys activity (TTTA) with the aim to study family play-learning with the TTTA. The review literature above provides more understanding for me about how family learning in the museum that will relate to family play-learning that I am interested in. Also, that review literature gives me confidence to research through providing TTT for learning bi-gnostic knowledge including scientific learning and local wisdom to visitors of science museum. Also, the literature points out the importance of traditional Thai toys, experience learning and learning through play, they also encourage my perception to research about learning through making and playing with the TTTA. These review literatures also guide me on how to conduct this research and all research methods to use. So, the research methodology of family play-learning through informal education with the TTTA at a science museum will be presented in Chapter 3 as stated below.

CHAPTER 3
RESEARCH METHODOLOGY

3.1 Introduction

The main objective of this chapter is to explain the research methodology including that in the pilot study and its effect to make changes to the methods that are employed in the main study. Furthermore, this chapter also will describe the aims of the study: the research focus and decision of the methods; the target audience; research design; limitations of this study; sampling of the study; method of data collection; triangulation; and gaining access and data analysis procedures. This chapter also addresses the validity and reliability of this research; ethical issues; biases, errors and the quality of data and the pilot study. The details of all research methodology will be presented below.

3.2 The aims of the study

The aims of this study are:

1. to develop family play-learning through make and play activities with traditional Thai toys at the National Science Museum, Thailand.

2. to isolate and describe the factors that encourage family play-learning by using traditional Thai toys.

3. to study family play-learning outcomes through make and play activities with traditional Thai toys.

4. to explore the nature and impact of traditional Thai culture and local wisdom, and Western modern science (bi-gnostic learning).

3.3 Research focus and determination of methods

This research focuses on family groups, who visit the Science Museum and voluntarily participate with the TTTA. The main focus of the research places emphasis on four points of the study as follows;

    1. How family play-learning and inter-generation learning

    2. The family learning outcomes after participating in the TTTA

3. Family learning about bi-gnostic learning (Western modern science and Thai local wisdom)

4. The factors that encourage family play-learning

In order to find out the answers to these four foci, I decided to use multi-method research to study family play-learning with TTTA at a science museum. After reviewing the literature regarding the methods and methodologies used in educational research to collect data and follow the aims of my study, I determined the methods and research design for the project. I also considered the suitable tools for answering the research questions, sample groups, time, resources and access to the sources of data. The pilot study was conducted with three groups of people including children, teenagers and adults, who participated with TTTA at the Science Museum in June 2011. Then, I reported the results of the pilot study to my supervisors and after discussions with them, I considered the various results emerging from the pilot study, I modified the sample of the study, the semi-structure questions for the interview, added the family play-learning observations and reordered the structure of conducting data again for the main study. I will discuss the pilot study later in this chapter.

3.4 Target audience for the findings

The findings of in-depth analysis of a particular family play-learning with TTTA at the Science Museum could be of interest to researchers, educators, activity and exhibition designers, curators and family visitors and all those involved in the field of science education, science museum education and Thai local wisdom and potentially elsewhere. This research is an initial research about family play-learning and bi-gnostic learning. I anticipate that this research will benefit the museum organisation and pedagogy of science in the science museum and school of science in Thailand and elsewhere; I will discuss this more in chapter 5.

3.5 Research design

The planning and design research can appear to be a linear process, with the researcher moving from articulating the study purpose to establishing evaluation objectives or questions to choosing research methods (Diamond, Luke and Uttal, 2009). The

approach in this research is mainly 'naturalistic research' in that is it is carried out in the natural setting, which is a science museum and the purposive sampling is chosen to explore family play-learning occurring in the real situation that families commonly visit science museum and voluntarily join the TTTA. Designing the naturalistic research begins with identifying the problem and research purpose; deciding the focus of the study; identifying the research questions; selecting the research design and instrumentation; addressing validity and reliability; ethical issues; approaching data analysis and interpretation (Cohen, Manion and Morrison, 2011).

The objective of the study, discussed in the Chapter one, focuses on four research questions:

1. What family play-learning and learning outcomes can be achieved through traditional Thai toy activities in a science museum?

2. To what extent do traditional Thai toy activities influence family bi-gnostic learning?

3. How does learning with traditional Thai toys affect the relationship between participants' character and engagement, the environment and resources?

4. Can the model hypothesis of family play-learning through traditional Thai toy activities effectively be used to monitor family play-learning?

This research applies multi-methods where there is a substantial element of qualitative data collection as well as a substantial element of descriptive quantitative data collection in the same research project. The multi-methods design in this research focuses on sequential explanatory design. The character of this designing is the collection and analysis of numerical quantitative data followed by the collection and analysis of descriptive qualitative data. (Robson, 2011).

The first and second questions focus on family play-learning, bi-gnostic learning and learning outcomes from the activities that are the individuals' experiences. The third and fourth questions explore the factors that encourage family play-learning with TTTA at a science museum. To achieve the purpose of research and answer all questions of the study, I have adopted a multi-method design to conduct research as

stated above. The quantitative method is used to explain and interpret the findings of family play-learning outcomes, their playfulness character and the families' motivation for learning at home. The qualitative method is used to explore family play-learning, playfulness character, engagement with the activity and bi-gnostic learning.

I chose a descriptive quantitative method because it is a suitable approach which helps in understanding the factors or variables that explain or relate to an outcome and helps the researcher best understand and explain the problem (Creswell, 2003). However, one disadvantage of the descriptive quantitative approach is some lack of the explanatory power when compared with the qualitative method that provides fine detail of finding data. This research does not use the experimental method but it focuses in the survey approach.

The survey approach design provides a descriptive quantitative or numerical description of trends, attitudes, or opinions of the population by studying a sample of the population; it also includes cross-sectional and longitudinal studies using questionnaires or structured interviews of data collections, with the intent of generalizing from a sample to a population (Creswell, 2003). In this research I applied questionnaires to study family play-learning outcomes because the questionnaire is suitable to study family learning outcomes after participating with TTTA, playfulness character, the feedback of families' motivation for learning at home, and the analytical data from the toy learning outcomes questionnaire is used to isolate and describe factors that encourage family play-learning with TTTA at a science museum.

The qualitative methods (Diamond, Luke and Uttal, 2009) emphasise deeper understanding over how well they can be generalised for a larger population. These methods allow the researcher to examine individual cases or events in depth and detail. Qualitative methods also utilize direct quotation, open-ended narrative, detailed reporting of events, and behavioural observation. They are also effective as a way of understanding complex phenomena that cannot be easily summarised into discrete categories (p.45). However, Brannen (2005) points out that qualitative research does

not use numbers as the quantitative research does. It is simplistic and counter-examples exist. In this research, I applied participant observation to observe and explore how families play-learning, the playful behaviour of participants during the activity and how they engage with the activity. The semi-structured interview was used to ask the family about how they learn scientific knowledge and local wisdom (bi-gnostic learning) after TTTA.

3.6 Limitation of the study

The research has been limited with family play-learning through using traditional Thai toy activities in the Science Museum at the National Science Museum, Thailand. This research will retain the data from the Science Museum side only. The participants are limited to 88 families and include adults, young people and children. Also, the data will be kept from the families who come to visit the Science Museum and enroll voluntarily to participate with TTTA in the activity area. Also, this sample represents only one group of middle class families who voluntarily joined the TTTA in a science museum. They do not represent all levels of Thai society. Furthermore, all research instruments were provided to participants who volunteered to join the activity and to voluntarily answer the questions on the questionnaires and during an interview. So, it is possible that some respondents may not have returned their responses to the researcher, especially, families' motivation of learning at home questionnaires that participants had to send their feedback about family's motivation with the TTTA back.

Although, this study is concerned with family play-learning and family learning outcomes from the activity and the factors, which encourage family play- learning in a science museum. This research does not place emphasis directly on the scientific learning from the curriculum but focuses on modern science in everyday lives, society, traditional Thai culture and local wisdom.

3.7 Sampling

The sample size and the sampling strategy will have a major effect on the interpretation of the study results. Bias in sampling or too small a sample will skew the research findings and they may misrepresent what is generally true of the public at

large. The sample size depends on the purpose and the methods of the study. Quantitative methods require larger sample sizes than the qualitative methods because quantitative approaches emphasis generalized results from a sample of strategically selected people. Whereas, the aim of the qualitative method is a better understanding of a particular phenomenon within a particular group of people. The norm of this method is small sample size (Diamond, Luke and Uttal, 2009). This research uses the purposive sampling method to sample the family groups in a science museum. Purposive sampling involves several types of research including the aim to achieve representativeness, to make comparisons, to focus on specifics, unique issues or cases, to generate theory through the gradual accumulation of data from different sources (Cohen, Manion and Morrison, 2011). The purposive sampling is suitable for family group samples in a science museum because the research focuses on the family group and they voluntarily participate with the TTTA which is a unique activity.

The purposive sampling sample in this thesis emphasises the family group and includes three levels of age from Erikson's (1950) stage of development: 1) children between 10- 12 years, 2) teenagers between 13- 20 years and 3) adults over 20 years (Chaffer and Kipp, 2010). This research separates purposive sampling into two groups: (1) family sample group outside the TTTA and (2) family sample group inside the TTTA:

3.7.1 The family group outside the TTTA

The family groups outside the TTTA are separated into two groups:

1. The sample group of the family for the playfulness character questionnaire (Stage 1)

For this sample the family groups are asked voluntarily to complete the playfulness character questionnaire at the introduction area in the science museum. The population of this study are all the families who visited a science museum on February 2012 (136 families with 342 people) and the sample of this study consisted of 93 families (179 people following the sample size of Krejcie and Morgan (1970)) with children 10 years and over to complete the questionnaire.

2. The sample group of families for bi-gnostic interview (Stage 3)

Some people of the family were sampled to answer the bi-gnostic semi-structured interview with random sampling. The study used 5 children, 5 teenagers and 5 adults as the sample and also, the 5 staff of the TTTA including the Explainer and four Assistants were interviewed too. These samples represented all the age groups of the participants and staff. The total sample of this research was 20 people following the sample size of the interview that was about 10-30 interviewees (Thomson, 2011).

3.7.2 The family group inside the TTTA (Stage 2)

This sample included all families (children, teenagers and adults) who volunteered to participate with the TTTA (88 families, 212 people). All family groups were observed with the participant observation method through the three instruments: family play-learning observation, playfulness observation and engagement observation. Especially, families that had a child at least 10 years or over, 51 families, 125 people. All the members of these families had to complete the Toy Learning Outcomes Questionnaire (TLOQ) and the head of each these family groups had to complete the families' motivation of learning at home questionnaires to find out about the learning motivation of the family when they returned home.

3.8 Methods of data collection

Multi- methods were used to fulfill the aims of the study, three concurrent methods of data collection included questionnaires, participant observations and semi-structured interviews which were used to study family play-learning with TTTA at a science museum. In this research, these methods were separated into seven tools of study in three stages of data collection as in the Table 3.1 following:

Table 3.1: Stages of data collection

Stage of data collection	Research instruments
Stage 1 (Family groups out of the TTTA)	(1) Playfulness character questionnaire
Stage 2 (Family groups during the TTTA)	(2) Toy learning outcomes questionnaire (3) Family play-learning observation, (4) Playfulness observation, (5) Engagement observation,
Stage 3 (Family groups out of the TTTA and after TTTA)	(6) Semi structured bi-gnostic learning interview, (7) Families' motivation of learning at home questionnaire

The strategy of these three methods and the details of each tool for collecting data of family play-learning is as follows.

3.8.1 Questionnaires

This research employs questionnaires to study families' playfulness characteristics and their learning outcomes after the families participated with TTTA. A questionnaire is used widely and is useful to collect descriptive survey information, providing a relative sample and straightforward approach to the study of attitudes, values, beliefs and motives and for being able to be administered without the presence of the researcher. The data of a questionnaire is often numerical data and the data is usually comparatively straightforward to analyse (Cohen, Manion and Morrison, 2011).

Robson (2011) states that questionnaire-based surveys would provide both advantages and disadvantages. He points out that the advantages of the questionnaire are that they can to be adapted to collect generalised information from a large number of the population. They can be extremely beneficial in providing large amounts of standardised data at relatively low cost, in a short period of time and allow anonymity when sensitive areas are involved. Also, the questionnaires allow respondents freely to

answer questions in their own time or at their own pace. When compared with the interviews or observations, the results of these instruments may depend on personal appearance, mood or conduct of the interviewers or observers, whereas, this is not present, when a questionnaire is answered. Another advantage of a questionnaire is that it can guarantee confidentiality and gain more truthful response than other tools (Burns, 2000). Also, the results of the questionnaire are simply a matter of processing the data using computer analysis.

In contrast, the questionnaires also provide disadvantages to researcher; for example the results of data depend on the character of respondents (e.g. their memory, knowledge, motivation, experience and personality). Respondents may not necessarily report their attitudes, beliefs, etc. accurately, for example they may answer in a way that shows them in a good light (Robson, 2011). This is consistent with Burns (2000), who points out that the problem of a questionnaire is the ambiguities in, and the questionnaire questions may not be detected. The small sample size of the respondents may not allow generalisation to the larger population.

Selection of appropriate type of questionnaires

Cohen, Manion and Morrison (2011) point out that there is a large range of types of questionnaire. The appropriate type of questionnaire for each researcher depends on the sample rule of the survey's design, for example the larger the size of the sample may indicate the use of a more structured, closed and numerical questionnaire, whereas, a smaller sized sample will use less structured, open and word-based questionnaires. Researchers can select several types of questionnaire, from the highly structured to unstructured. Researchers have to design the questionnaires depending on their situation and then questionnaires need to be piloted and refined before conducting the research using the questionnaires. There are three types of questionnaires: structured, semi-structured and unstructured. *The structured questionnaire* uses a pattern of clearly structured, sequenced and focused questions, – often using closed questions to collect and make comparison of the results. *The unstructured questionnaire* applies opened-end questions to invite respondents to write what they think for their answers in the questionnaire. Between structured and

unstructured questionnaire, it is the *semi-structured questionnaire* that provide a series of questions, statements or items to ask the respondents and the respondents are asked to give their comment in the way that they think best. There is a clear structure, sequence and focus, but the format is open-ended for respondents to give answers in their own words (Robson, 2011).

This research mainly applies to structured questionnaires with closed questions to collect and make comparison of the data. The last section of the questionnaire uses open-ended questions to explore respondents' answers and their personal perceptions. This research provides three questionnaires for collecting data of family play-learning with the TTTA; **(1) playfulness questionnaire, (2) Toy learning outcomes questionnaire and (3) Families' motivation of learning at home questionnaire.** These questionnaires use four types of questions to gather data: (1) *Dichotomous questions* to ask respondents' gender, (2) *Multiple choice questions* are used to ask their education and some answers, (3) *Rating scale*s are used to find out about family play-learning and their learning outcomes from TTTA, and (4) *Open-ended questions* are used to capture their perception after participating with TTTA and participants' ages.

Most of the questions in these questionnaires use a Likert style rating scale (Oppenheim, 2001) to gather the numerical data in the questionnaire but I have adapted the five ranges of responses of the Likert scale (1=strongly disagree, 2=disagree, 3=uncertain, 4= agree and 5=strongly agree) into four ranges of answers, for example 1=Nothing, 2=Little, 3= Some and 4= A lot. I cut the middle range of the scale out because the purpose of the questionnaire needs respondents to determine the size of their opinion or thinking, as either positive or negative and either most or less. The descriptive analysis of these questionnaires conveys the meaning of numerical data to make comparisons and initiate discussion.

1) Playfulness questionnaire

The playfulness questionnaire (PQ) was adapted from Barnett (2006) (the Young Adult Playfulness questionnaire) (see Appendix 1). It is a self-reporting instrument

that aims to find out about a persons' character of playfulness. This questionnaire design uses four rating scales to describe their playfulness character using twelve types of playfulness characteristics including Cheerful, Happy, Friendly, Outgoing, Sociable, Spontaneous, Impulsive, Unpredictable, Adventurous, Funny, Active and Energetic. Respondents voluntarily complete this questionnaire at the Reception Area in a science museum.

2) Toy learning outcomes questionnaire

The toy learning outcomes questionnaire (TLOQ) was adapted from Generic Learning Outcomes (GLO) of school students at the workshops in the museum, based upon the work of the Research Centre of Museums and Galleries at the University of Leicester (Hooper-Greenhill, 2007) (see Appendix 2). This is the main questionnaire of the research, finding out about family learning-outcomes from TTTA. The main characteristic of this survey is that it comprises four rating scales to ask about their opinion with the toys and opinions of their learning from TTTA. It includes seven themes and 33 items as follows: 1) Knowledge and understanding (4 items), 2) Skills (5 items), 3) Attitude and values (5 items), 4) Enjoyment , inspiration and creativity (4 items) and 5) Action, behaviour and progression (5 items), 6) Science learning (6 items) and 7) Attitude towards Thai local wisdom (4 items). The last section of this questionnaire was designed to explore the facilities that encourage family play-learning, including environments and resources for learning and, the open-ended questions were used for participants to write their perceptions about this activity at the end of the questionnaire.

3) Families' motivation of learning at home questionnaire

This questionnaire aims to explore the families' motivation of learning at home (FMLHQ) after they joined the TTTA. This questionnaire asks for the last level of family play-learning (adapted from Bandura, 1986,2005) that participant observation cannot observe during the activity about learners' motivations, for example adaptation and improvement to their daily life. This questionnaire provides multiple choices of behaviour of adults and children's motivation after learning with TTTA, for example, they can choose to teach other people to make the traditional Thai toys; adapt to their

work or study; tell others about the TTTA or show others how to make the toys, make the toys themselves again, give the toys to other people or do nothing at all (see Appendix 3).

Validity and reliability in questionnaires

Validity

This research makes provision of competent colleagues at a science museum to review and critisise all of the questionnaires before completion, to ensure they are valid for use as a sample. Also, the three questionnaires (PQ, TLOQ and FMLHQ) as stated above were originally in the English language. They have had to be translated to the Thai language for the Thai family groups. As for the content validity, these questionnaires were sent to three science education experts in the National Science Museum, Thailand, who are familiar with the purpose of the survey and have expertise in the English language to translate the English language to Thai language and from Thai language to English language to ensure these questionnaires were translated accurately. After that, three science education experts provided comments for me to consider about the different meanings of the language with some phrases words, for example, 'Clowns around', 'Jokes/teases', 'Funny' and 'Humorous' in the playfulness questionnaire, all use the same word when being translated into Thai language. Experts suggested cutting out 'Clowns around', 'Jokes/teases and 'Humorous' and leave only the word "funny" to represent the characteristics of this comedic group. Then I refined all questionnaires and sent them back to them until they considered them acceptable.

Reliability

Three questionnaires (PQ, TLOQ and FMLHQ) were given to 15 people, that represented family groups including 5 children, 5 teenagers and 5 adult visitors to read, and ask for their comments to find out the reliability of the pilot study. They made some comments about some confusing questions for me to consider. I improved the perplexing questions before using the revised questionnaire to conduct a pilot study with the sample 30 people in three groups. After the pilot study, I analysed the reliability of these questionnaires with SPSS programme and then analysised the

reliability of the results again. The results of some questions (Characters) of the playfulness questionnaire were below the standard of reliability. So, I made changes to the meaning of those characteristics for an easier understanding, for example impulsive, outgoing and, adventurous and had 30 visitors complete them. Then I analysed the reliability of those questions again until they reached an acceptable reliability standard before using them in the main study.

3.8.2 Observations

Observation is a method to observe and note systematically, people, events, behaviour, settings, artifacts, routines, etc. Observation as a research tool provides an opportunity for the investigator to gain 'live' data from naturally occurring social situations (Cohen, Manion and Morrison, 2011). Observations (Morrison, 1993: 80) enable the researcher to gain data on the:

  1) physical setting (e.g. the physical environment and its organisation);

  2) human setting (e.g. the organisation of people, the characteristic and makeup of the group or individuals being observed, for instance, gender, class);

  3) interactional setting (e.g. the interactions that are taking place, formal, informal, planned, unplanned, verbal, non-verbal, etc.);

  4) programme setting (e.g. the resources and their organisation, pedagogic styles, curricula and their organisation).

Observations are the most straightforward means of a better understanding of the nature of visitor interactions in informal environments. Diamond, Luke and Uttal (2009) describe five types of observation tools that can be used to study visitors' behaviour in informal environments: (1) counting, (2) tracking movements, (3) basic observations, (4) detailed, more systematic observation and (5) participant observations.

Selection of the appropriate type of observation method

This research applies participant observation to find out about family play-learning with TTTA in a science museum that is a programme in an informal setting as stated above. The participant observation might be useful in a small project, with small

groups, for events/processes that take a reasonably short time, for frequent events and for activities that are accessible to observe (Robson, 2011).

On the other hand, participant observation may face the risk of bias. For example, reactivity; participants may change their behaviour if someone is observing them. They may feel more anxious or try harder in class. The validity of the construct depends on the decision of observers for judgment of the observable evidence, for example the difference between a relaxed smile, a nervous smile, friendly smile or a hostile smile. Are these labels for valid indication of that behaviour? (Diamond, Luke and Uttal, 2009).

This research used participant observation to observe a families' playfulness character, their engagement with the TTTA and family play-learning with the TTTA at a science museum. As stated above, observations enable one to gain live data on the physical setting (environment and resources), human setting, interactional setting (informal) and programme setting, they are consistent with the TTTA at a science museum, that is a programme set by humans in the physical setting, a science museum's environment; that is an informal environment for learning. Moreover, participant observations are useful for a small group, short time events and the activities that are accessible to observe. TTTA is a bi-gnostic activity that allows small groups of participants per session to learn scientific knowledge and local wisdom through make and play activities with the toys in a one hour period.

In the TTTA, there are five staff members to organise the activities, including one Explainer and four Assistants to help two groups of participants. I am a participant observer of the toy activities, as an Assistant in one group of the activity. Not only a researcher must be a participant of the observers, but all staff in the TTTA have to observe and take note of the participants' behaviour during the TTTA. This research employs three participant observations to obtain descriptive data of family play-learning through Playfulness observation, Engagement observation and Family play-learning observation.

1) Playfulness observation

The playfulness observation (PO) is adapted from the study by Lieberman (1977) (Playfulness: Its Relationship to Imagination and Creativity). The playfulness observation aims to observe playfulness behaviour of the participants during their engagement with the TTTA. We observed playing and non-playing people and recorded their behaviour by taking note through Leiberman's (1977) categories and sub-categories. These codes, categories and sub-categories are used to discuss the results of participant playfulness with the TTTA. The code, categories and sub-categories of playfulness observation data is presented in Table 3.2 below:

Table 3.2: Code, categories and sub-categories in analysis of playfulness observation

Code	Category	Sub-category
P 1.0	**Physical spontaneity**	
P 1.1		• Facial expressions of enjoyment
P 1.2		• Makes the toy enthusiastically
P 1.3		• Plays with the toys exuberantly
S 2.0	**Social spontaneity**	
S 2.1		• Accepts the invitation to play
S 2.2		• Plays with other people happily
S 2.3		• Talks and discusses with other people
S 2.4		• Shares the materials to make toys with other people
C 3.0	**Cognitive spontaneity**	
C 3.1		• Enthusiasm in following the activities
C 3.2		• Completing the activities in making the toys themselves
C 3.3		• Decorating the toys
A 4.0	**Manifest joy**	
A 4.1		• Interest
A 4.2		• Fascination
A 4.3		• Curiosity

M 5.0	**A sense of humour**	
M 5.1		• Smiles
M 5.2		• Laughs
M 5.3		• Exaggerated gestures about the toys.
EC 6.0	**Expression and conversation**	(Verbal/explains, asks questions, answers questions, expresses like/dislike or any family's conversation, etc.) Present in the conversation form.

Source: Adapted from Lieberman (1997:12)

2) Engagement observation

The engagement observation in this study was adapted from the four components of learning set out (Learning environment, learning goals, learning activity and learning method) by Hawryszkiewycz (2007) and divided into five engagement code schedules because the purpose of this observation was to explore participants' engagement behaviour during participating in the TTTA and also, these codes, categories and sub-categories would relate to the other instruments. So, the results may support the others. The five main coding schedules of this observation were a guideline to observe participant engagement' behaviour as illustrated in Table 3.3 below.

Table 3.3: Code, categories and sub-categories in analysis of engagement observation

Code	Category	Sub-category
EA 1.0	**Engagement with the activity**	
EA 1.1		• Explores the goals and ideas of the activity
EA 1.2		• Observes the activity strongly and is involved
EA 1.3		• Succeeds in the goals of the activity
LA 2.0	**Learning from the activity**	
LA 2.1		• Follows the activity
LA 2.2		• Asks questions

LA 2.3		• Answers the questions
LA 2.4		• Teaches other people to make the toys
IG 3.0	**Involvement in their group**	
IG 3.1		• Shares the materials or tools with others
IG 3.2		• Helps others to make the toys
IG 3.3		• Plays with the toys with other people
IG 3.4		• Talks or discusses with others
EER 4.0	**Engagement with environment and resources**	
EER 4.1		• Explores the exhibition
EER 4.2		• Plays with the collection of the toys
EER 4.3		• Cooperates with the Explainer and Assistants
EER 4.4		• Interested in the toys handbook
EER 4.5		• Interested in the toy that they made in the TTTA
EC 5.0	**Expression and conversation**	(Verbal/explain, asks questions, answers questions, expresses like/dislike or any family's conversation, etc.) Present in the conversation form.

Source: Adapted from Hawryszkiewycz (2007:5)

3) Family play-learning observation

The family play-learning observation (FPLO) was adapted from Bandura's (2005), four levels of family learning. The purpose of this observation was to observe how family play-learning or how inter-generational learning was obtained through make and play activities with the toys in the science museum. This observation provided five

behaviour coding schedules as a guide line to observe family play-learning behaviour as shown in Table 3.4 below.

Table 3.4: Code, categories and sub-categories in the analysis of family play-learning observation

Code	Category	Sub-category
A 1.0	**Attention**	
A 1.1		• Adults watched and listened to the information and the method to make the toys
A 1.2		• Adults responded to the Explainer and Assistants
A 1.3		• Adults can follow the steps to make the toys
A 1.4		• Children and teenagers were fascinated by the toys
R 2.0	**Retention**	
R 2.1		• Adults guided their children about how to make the toys
R 2.2		• Children and teenagers watched and listened about how to make the toys from adults
R 2.3		• Children and teenagers responded to the adults
R 2.4		Children and teenagers can follow the steps to make the toys
MR 3.0	**Motor reproduction**	
MR 3.1		• Children and teenagers recognised and followed the making processes
MR 3.2		• Children and teenagers completed construction of the toys by themselves
MR 3.3		• Adults watched their children make the toys

MR 3.4		• Adults completed and decorated their toys again
M 4.0	**Motivation**	
M 4.1		• Repeat making of the toy again
M 4.2		• Play with other toys
M 4.3		• Other
EC 5.0	**Expression and conversation**	(Verbal/explain, ask question, answer question, express like/dislike or any family's conversation, etc.) Present in the conversation form.

Source: Adapted from Bandura (2005:18)

In level 4, motivation; some behaviours were hard to observe during the activity, for example observation of adaptation and improvement through participation in TTTA, to their work or study, whether they told about the TTTA or gave the toys to others. To find out about this behaviour of family play-learning, I designed a Families' motivation of learning at home questionnaire, to gain more insights about this level.

Also, as a participant observer, I made conversation with participants about how their families play-learning with TTTA through short questions during the activity to gain more family play-learning data. The results of all observations and the data from the short questions during the observation are presented in Chapter 4.

Validity and reliability in observations

Validity

Three observations (PO, EO and FPLO) in this study were originally in the English language. They were sent to three science education experts in the National Science Museum, Thailand. These educators are experts in the English language and science education in the science museum as stated above. They translated the observation codes from the English language to the Thai language and from Thai language to English language and they also reviewed and commented on the observation schedule until it was satisfactory for them. Then these observations were used in the pilot study and after the pilot study I made changes by adding some behaviour that occurred

during the pilot study that was not in the codes guide and adapted some codes for easier observation. In each observation, we use the same observation schedule and the same code guide to observe participants to ensure the validity of observations.

Reliability

The same for the questionnaires, three observations (PO, EO and FPLO) were analysed for reliability. First of all, I managed a meeting with all the staff of the TTTA and discussed the content reliability of those observations. The agenda of this meeting was to have the same understanding of each behaviour code, to measure the same thing in the same way. When each staff member uses these coding schemes to observe the situation, these coding schemes will provide a consistent interpretation. Not only before the activity, but every day after the activity a staff meeting was convened to discuss the results from the staffs' observation field notes to ensure reliability of the data.

Also, observations were used to observe a small family group before the main study. After the initial use, the staff made comments about the observation codes. I discussed with them the behaviour of each family group. I also compared and contrasted their individual observations with the same family group. Then I made changes to the specific codes that I and all staff agreed were reliable to use for the observation of family groups before conducting the main study.

3.8.3 Interview

The use of interviews in research, makes for a move away from seeing human subjects as simply being open to manipulation and data thus generated as somehow external to individuals: to the direction of regarding knowledge as being generated between people, often through conversation (Kvale, 1996; Diamond, Luke and Uttal, 2009: 409). Interviews can apply to one interviewee or they can involve groups of participants. Interviews usually provide conversation to gain personal information, knowledge, attitudes or opinions from a list of prepared questions asked to each participant in the same manner. The purpose of each type of interview depends on how

the findings can be anlysed and contain the interpretation of the data (Diamond, Luke and Uttal, 2009).

Selection of the appropriate type of interview method

Diamond, Luke and Uttal (2009) divide interviewing for learning in the informal environment into three types: (1) structured interviews, (2) semi-structured, and (3) informal conversational interviews (unstructured interview).

This research puts emphasis on the semi-structured interview to find out about families' bi-gnostic learning. The semi-structured interviews are between the structured interview and unstructured interview. *Structured interviews* provide the questions and response categories determined in advance, responses are fixed and respondents choose answers from among these fixed responses. Whereas, *unstructured interviews* offer questions that emerge from the immediate context and are asked in the natural course of things. There is no determination of question topic or wording. *Semi-structured interviews* provide the open-ended questions that allow respondents to give their own answers following the sequence of the question. All interviewees are asked the same basic questions in the same order (Burns, 2000).

The strengths of semi-structured interview is that respondents' answer to the same questions increase the ability to compare if all responses and the answers are complete for each person on the topic question in the interview. Also, this method reduces interviewer effects and bias when research uses several interviewers and they facilitate organisation and analysis of the data. On the other hand, semi-structured interviews provide a small degree of flexibility in relating the interview to particular individuals and circumstances. Standardised wording of the questions may contain a limited naturalness and relevance of questions and respondents' answers (Cohen, Manion and Morrison, 2011). According to the literature above, this research shows that semi-structured interviews are applicable for the design of bi-gnostic interviews as follows.

Bi-gnostic interview

I applied semi-structured interviews as a design for bi-gnostic interviews (BGI) in order to find out about families' bi-gnostic learning including scientific knowledge and local wisdom through the TTTA. Bi-gnostic interviews contain ten open-ended questions about how participants' learn of science and local wisdom (see Appendix 4). The series of questions and codes are divided into three parts as shown in Table 3.5 below.

Table 3.5: Code, categories and sub-categories in analysis of bi-gnostic interviews

Code	Category	Sub-category
ATW 1.0	**Awareness towards Western modern science**	
ATW 1.1		• More understanding about scientific knowledge
ATW 1.2		• Inspiration to study more science
ATW 1.3		• The importance of scientific knowledge
ATT 2.0	**Awareness of traditional Thai culture and local wisdom**	
ATT 2.1		• More understanding about traditional Thai culture and local wisdom
ATT 2.2		• Inspiration to study more traditional Thai culture and local wisdom
ATT 2.3		• The importance of traditional Thai culture and local wisdom
ATT 2.4		• Conservation of traditional Thai culture and local wisdom

IR 3.0	**The importance and relationship between Western science and traditional Thai culture and local wisdom**	
IR 3.1		• The importance between scientific knowledge and traditional Thai culture and local wisdom
IR 3.2		• The relationship between scientific knowledge and traditional Thai culture and local wisdom
IR 3.3		• The development of both, scientific knowledge and traditional Thai culture and local wisdom

Source: Adapted from National Science Museum, Thailand (2007:2)

I conducted face-to-face interviews with 20 people including 5 children, 5 teenagers, 5 adult participants and 5 staffs after the TTTA. I recorded these interview conversations using a digital recorder, in the prepared area near the study area of TTTA that is fairly quiet place and also allows interviewees to see their families during the interview. After listening to the data from these interviews I transcribed it into text file before sending to other staff members for their approval of the transcription and then I sent it to be translated into English by the experts of the NSM.

Validity and reliability in interview

Validity

As stated in the validity of the questionnaires, the semi-structured interview is also reviewed and commented on by competent colleagues before making changes and using with the participants. Also, another group of experts, who are familiar with this area and have expertise in the English language, were used to translate the original English questions of bi-gnostic interview into the Thai language for Thai speaking participants. Then, these questions were asked in the pilot study and after the pilot

study, I made changes by cutting out some unnecessary questions before use in the main study.

For the data collecting, I used the same interview questions in the same order with only one interviewer to ask interviewees after TTTA. I wanted to make sure the data were obtained in the same manner and the possibility of bias was reduced.

Also, the transcribing of the interviews was originally in the Thai language, so, it had to be translated into the English language. The researcher used these experts to translate and prove the accuracy of the interview's transcription before presenting the research.

Reliability

The fifteen questions in the bi-gnostic interview were given to 9 people that represented family groups they included 3 children, 3 teenagers and 3 adult visitors, who were asked to read and give their comments in order to assess reliability before the pilot study. Their comments were that "some questions are confusing" and "some questions are difficult for children". I considered their comments and rewrote the questions again before using them to conduct a pilot study with a sample of 9 people. After the pilot study, I found some questions were almost the same; so, as this was boring and took up time I cut these questions out, thus reducing 15 questions to 10 questions. So, consequently the questionnaire looked more compact and easier to understand for interviewees, especially children. Then, the researcher gave the new set of questions to colleagues to proof read again before using for the main study.

The researcher provided three staff members (researcher's colleagues) to proof-read the transcription of the interviews to check the reliability of the content of the conversation. I also asked them to read a sample of transcripts and to select the transcripts that followed the theme of the interview, so that the themes emerging were qualitative. Then, it was translated into the English language by the three experts as stated above.

3.9 Triangulation

I also used triangulation; that is the use of two or more methods to collect data in the study of human behaviour. Triangular techniques attempt to map out or explain more about the participants' behaviour that occurred in the study by analysis from more than one standpoint with both quantitative and qualitative data (Cohen, Manion and Morrison, 2011). For This research, I used investigator triangulation that made use of more than one observer to be engaged in observing participants' behavior during the activity. The results from each observer were used to compare and contrast. This study also used methodological triangulation that used different methods for the same objective of the study (Cohen, Manion and Morrison, 2011). It is to be noted that different methods in this study included three questionnaires, three observations and one interview were used to study family play-learning through make and play activity with the TTTA at a science museum. If the results of each method used to make comparisons and contrasts are different, then the researcher could have confidence in the results when the different method provided the same results, for example if the data of the questionnaires corresponded to the results of the observations and interviews. The triangulation of results also enhanced validity and reliability of the researcher's results. Moreover, the data in this study were without researcher bias issues here that had to do with subjectivity of interpretation and measures taken to ensure trustworthiness of the clear 'instrument'.

The mixing of data from quantitative and qualitative methods provides a better understanding of the problem than if either data set had been used alone. Creswell and Clark (2007) state that there are three ways in which mixing occurs: (1) merging or converging the two datasets by actually bringing them together, (2) connecting the two datasets by having one build on the other, and (3) embedding one dataset within the other so that one type of data provides a supportive role for the other dataset (p.7).

Each method of study will be thoroughly discussed again in Chapter 4. The numeric results from the quantitative method will be analysed and presented with simple graphical displays in Chapter 4 and the finding of each research instrument will make comparison and contrast in Chapter 5.

3.10 Data collection and gaining access

The collection of the pilot study data took place in June 2011 and the main study data were collect in February 2012 at the study area in the traditional technology gallery at the National Science Museum, Thailand (NSM). Before conducting the pilot study, I sent a letter to the president of NSM asking for permission to conduct both studies. As a science educator I have worked regularly in this area for more ten years, so access to this activity area is not difficult. I planned with the activity's staff the dates of collecting data and the details of both studies before conducting them via a computer conference. The activity's staff meeting was arranged again before the commencement date there was one week for the preparation of materials, exhibitions, the activity area and especially the understanding by all the staff. I explained the purpose of these studies and the purpose of all the instruments for gaining accuracy during the using of each method. Families are the target group of this research. Normally, a large number of family groups visit the science museum on the weekends and they volunteered to participate in the TTTA and cooperated to complete the questionnaires and answer the questions of the interview.

3.11 Data analysis procedures

The processing of analysing data should be considered in the evaluation phase of research strategy. Circumspect thinking through a data analysis approach will help the researcher to easily manage analysis of the data that is needed (Diamond, Luke and Uttal, 2009). Quantitative analysis provides the numerical data, the analysis most often involves the use of tables, graphs and statistical methods to summarise and describe the results. Numerical analysis can be performed using software, for example, the Statistical Package for Social Science (SPSS) that applies the statistical formulae and carries out computations (Bruns, 2000).

The qualitative data analysis will most likely involve descriptive texts using direct quotes, verbatim descriptions, drawings, photographs and other material during a presentation. The evaluation of research often applies both quantitative and qualitative data analysis and presentation. The analysis of data may be comprised of both descriptive text and statistical procedures (Diamond, Luke and Uttal, 2009).

The strategy of each method for collecting and analyzing of the data will be described with the questions of the research as illustrated in Table 3.6 below.

Table 3.6: Methods of collecting data and data anlysis

Research questions	Methods used for data collection	Analysis
1.What family play-learning and learning outcomes can be achieved through traditional Thai toy activities in a science museum?	***Descriptive Quantitative data*** - Playfulness questionnaire - Toy learning outcomes questionnaire - Families motivation of learning at home questionnaire	- Numerical analysis - Content analysis
	Interpretative Qualitative data -Family play-learning observation - Playfulness observation - Engagement observation -Photographic evidence	-Interpretative analysis -Documentary analysis - Photographic analysis
2. To what extent do traditional Thai toy activities influence family bi-gnostic learning?	***Descriptive Qualitative data*** - Bi-gnostic interview	- Content analysis
3. How does learning with traditional Thai toys affect the relationship between participants' character and engagement, the environment and resources?	***Descriptive Quantitative data*** - Playfulness questionnaire - Toy learning outcomes questionnaire - Families motivation of learning at home questionnaire	- Numerical analysis - Content analysis
	Interpretative Qualitative data	-Interpretative analysis
4. Can the model hypothesis of family play-learning through traditional Thai toy activities effectively be used to monitor family play-learning?	- Family play learning observation - Playfulness observation - Engagement observation - Photographic evidence	-Documentary analysis - Photographic analysis

3.11.1 Numerical analysis

The key concepts of numerical analysis include scales of data, parametric and non-parametric data, descriptive and inferential statistics, dependent and independent variables (Cohen, Manion and Morrison, 2011). This research focuses on descriptive statistics. Descriptive statistics are used to present the distribution of the sample or population across a range of variables, and to provide summary measures of the characteristics of such distribution. The measures of descriptive data include frequency counts (may be represented with percentages), measures of central tendency (such as mode, median and mean, depending on the level of measurement), and measures of dispersion of the distribution (such as inter-quartile range and standard deviation) (Blaikie, 2001).

Numerical data analysis in this research employed descriptive statistics to analyse the data from three questionnaires. The analysis of these statistics focused on frequency counts (percentages), measuring the central tendency, emphasizing the mean, measuring the dispersion of the distribution with standard deviation and measuring reliability. To avoid bias of comparison of the mean between each variable, I used Independent-Samples t-test to compare the mean of each variable between genders and used One – Way ANOVA analysis to compare the mean of each variable between age groups. Data analyses were performed using computer software (the Statistical Package for Social Science Programme (SPSS). All tests were considered to be significant at p-value less than 0.05.

3.11.2 Content analysis

Content analysis is a systematic *coding and categorising method*, used to explore large amounts of textual information includes trends and patterns of word used, their frequency, and their relationship with the structure and dialogue of communication (Grbich, 2007).

Coding and categorising methods

A code is simply a name or label that the researcher refers to in the text from the data collection that contains an idea, opinion or information. Cohen, Manion and Morrison

(2011) define coding as the translation of questions responses and respondents information to specific categories for the purpose of analysis. Coding is the ascription of a category label to pieces of data, that are either decided in advance or in response to the data that have been collected (p.559).

This research employs coding and categorising methods to analyse the contents of the answers from the open-ended questions from the comments of the participants in the last part of the toy learning outcomes questionnaire, the results from the three observations and the answers from the semi-structured interview.

3.11.3 Interpretative analysis

The purpose of interpretative analysis is to explore how participants make sense of their personal and social world. This analysis focuses on the meaning of particular experiences, events and states hold for participants. The approach of this analysis is phenomenological, involving detailed examination of the participants' life-world; it attempts to explore personal experience and is considered with an individual's personal perception or account of an object or event. This analysis is required in order to make sense of that other personal world through the process of interpretative activity. The interpretation process involves two stages: 1) the participants are trying to make sense of their world, and 2) researchers are trying to make sense of the participants trying to make sense of their world (Smith and Eatough, 2006).

According to Smith and Osborn (2007), interpretative analysis is employed in in-depth qualitative analysis, which has commitment to the person as a cognitive, linguistic, affective and physical being and assumes a chain of connection between people' talk and their thinking and emotional stage. Researchers have to interpret people's mental and emotional state from what they say.

In this research, I used interpretative analysis to analyse participants' behaviour from playfulness observation, engagement observation and family play-learning observation to investigate their feelings, thinking and emotions when participating in TTTA.

3.11.4 Documentary analysis and photographic analysis

The documentary research in education might be the primary documents by publication or individuals, for example, written documents, books or textbooks; reports or proceedings; newspapers or magazines, and personal documents such as diaries, notes, letters and autobiographies or whatever, although the term is extended to include non-written documents such as films and television programmes, pictures, drawings and photographs (Robson, 2011). This research uses photographic analysis of the TTTA as the evidence for documentary analysis. Photographs are extremely useful documentary resources for social research. Photographs can be used both as data and to represent the outcomes of the investigation. As data, photographs can provide a means other than written documents. They are also a richer access to the people, places and practices being the studied. By presenting the data in a visual from, researchers can provide the depth and nuance of insight that is hard to achieve with text only, to their readers. Photographic data analysis can provide guided insights and characterization (Gibson and Brown, 2009).

The social sciences generally use three types of visual imagery as evidentiary materials in inquiry and argument: photographs, videos and graphics. As stated above, this research used photographs as evidence to explain the persons' behaviour and their emotions when participating in TTTA. Photographs or images play an integral role in research processes and can be useful in a number of ways, for example, images can be produced by participants as data; images are useful to elicit or provoke other data; images can be used for feedback and documentation of the research process and images are useful as a mode of interpretation or representation (Weber, 2008: 47).

Bohnsack (2008) stated that photographic analysis should be considered the interpretation and explanation of the information that is inside the photographs or images to gain more understanding. Photographs are implicated in all signs or meaning when studying behaviour in social situations of a setting for example expressions through gestures or the expression of faces. Researchers should analyse the meaning of the images including people, places and atmosphere and make interpretations of the text to explain signs or meanings of the photographs following

the methodological device. Photographs provide the personal insights as well as a personal record and social relationship. The analysis may use questions "what" and "how" to analyse events, behaviour or emotions of people in the images to gain a deeper understanding from them (Grady, 2008).

As stated above photographs are the data of participants, useful for feedback and documentation of the research process and useful for interpretation or representation data and could combine with other data as a triangulation research method. This research used photographic analysis to anlyse the photographs of TTTA at a science museum. These photographs include the atmosphere of the activity; the exhibition and the collections of the traditional Thai toys; participants' behaviour during their involvement in TTTA and the working of the Explainer and the staffs. These images can support the findings of the questionnaires, observations and interviews. All selected photographs will be presented in Chapter 4.

3.12 Validity and Reliability

Validity and reliability are important for the evaluation stage of research (Diamond, Luke and Uttal, 2009).

3.12.1 Validity

Validity is an important key to effective research. If a piece of research is invalid then it is worthless. Validity is thus a requirement for both quantitative and qualitative in naturalistic research (Cohen, Manion and Morrison, 2011: 179). Validity refers to the fact that the research tools being developed are accurate and appropriate and they provide what the researchers are trying to investigate. Validity can demonstrate the particular instruments in fact measures, following the purpose of measuring and accurately represents the description and explanation data or theory (Burns, 2000). In the quantitative data use, validity might be improved through careful sampling, appropriate instrumentation and appropriate statistical treatments of data. Quantitative research provides the measuring of standard error and which has to be acknowledged. Whereas, qualitative data validity might be presented through the honesty of the participants, extensive and intense/fertile and the scope of the data achieved. Qualitative data focuses on subjectivity of respondents, opinions, attitudes and

perspectives which together contribute to a degree of bias (Cohen, Manion and Morrison, 2011).

According to Burns (2000), there are several types of validity:

1) Content validity

Content validity concerns the questions in the instruments. The researcher must ensure that the elements of the main issue that are covered in the research are both a fair representation of the wider issues under investigation (and their weighting) and that the elements chosen for the research sample are themselves addressed in depth and breadth (Cohen, Manion and Morrison, 2011:188). The conducting of this research follows the procedures that are state above in the methodology of data collection with the participants in the completion of the questionnaires, the observations during the activity and the conducting of the interviews after the activity. Three types of data were gained from different sources that followed the objectives of the study, provided fair representation of the wide results and covered the investigation. The results from each method can support the others with comparisons so as to determine their veracity.

2) Internal validity

Internal validity concerns the credibility and plausibility of the research including the methodology and findings. Researchers must ensure that the findings can describe the phenomena being researched (Robson, 2011). The results from the quantitative research were obtained from the three types of questionnaires and the qualitative research through three observations and one family interview. They were developed and confirmed by a consensus between the researcher and the science educators who are experts in the learning of science in a science museum concerning the credibility of data collection. Also, this research is a naturalistic research. However, all of the phenomena during the conducting of the research are about the nature of science museum activities and about the nature of visitors who volunteer to join the activities. Thus, the finding of this research from the real time and real situations in the science museum activity can explain the phenomena being researched.

3) External validity

External validity refers to the degree of results that can be transferred to the wider population, cases, settings, times or situations, i.e. to the transferability of the findings (Cohen, Manion and Morrison, 2011:186). The conclusions of the research can be transferred to other contexts. The provision of clear, rich and detailed descriptions can make comparisons with other groups, participants and settings appropriate for transferability (Lincoln and Guba, 1985; Merriam, 1988). Some parts of the results in this research were presented to the public through posters and presentations to many conferences and they were also submitted to the relevant journals worldwide to exemplify their external validity.

3.12.2 Reliability

Reliability is a measure of how consistent a method is. A reliable method measures the same thing, usually in the same way, each time it is used (Diamond, Luke and Uttal, 2009:46). Reliability in the quantitative research focuses on consistency, dependability, and replicability over time, over instruments and over the groups of respondents and it deals with precision and accuracy. The reliability in this research was concerned about the research situation (context, conditions); the factors that affect participants, research and the method; and the instruments for collecting data themselves (Cohen, Manion and Morrison, 2011). This research uses computing reliability coefficients with the SPSS programme to determine reliability of the questionnaires. The quantitative method uses computing reliability to estimate the internal consistency method through the Cronbach' coefficient alpha on SPSS (Burns, 2000). Qualitative research does not emphasis replication, refining, comparing or validating constructs, but it strives to obtain real data in natural situations through observations or interviews. Reliability in the qualitative research must consider the suitability between the data that is being recorded and what is actually occurring in the natural setting during the collecting of data that covers the accuracy and comprehensiveness (Bogdan and Biklen, 1992).

The Validity and reliability that I addressed above were the guidelines for researcher to consider the quality of this research. Validity helped researcher to develop accurate

and appropriate tools for investigation and reliability to measure consistency of the method in the same thing, same way and same time that would provide the accuracy and comprehensiveness of the data. When I consider all validity and reliability as stated above during the development of research tools and the collecting of data, they provided me with the confidence to conduct quality research.

3.13 Biases, errors and quality of data

The role of researchers in qualitative research should be concerned about experiences, assumptions, values, personal backgrounds and their biases, such as gender, history, culture, and socioeconomic status that might shape their collecting and interpretation of data during a study (Cresswell, 2004). In this study, I tried to remove biases and errors as stated above, at all stages of data collection and interpretation. All questionnaires were analysed through computer software (the Statistical Package for Social Science programme (SPSS) that applies to the statistical formulae) to find out numerical data without bias and reduce bias of comparison of the data of all variables. The observations of the activities are clear and faithful because the researcher's team was concerned about the validity and reliability during the observation. After observations each day, I and all staff working on the activity (as participant observers) discussed any pertinent issues requiring further clarification thus ensuring the results of all the observations were precise. Also, I followed the validity and reliability guide to conduct interpretative analysis after data collecting in order to shape the quality of data. Before the interviews, I detailed descriptions of the interviews, settings and other relevant information that related to the questions, and during the interviews I asked the questions clearly and unambiguously to all interviewees and tried to ensure the transcription of the answers from the participants (Robson, 2011).

Also, in my reporting, I used narrative received from participants using their own words without researcher bias. I thought constantly about the bias and error of the study to ensure that this research would have quality and value.

3.14 Ethical Issues

Ethical considerations are important when carrying out research involving people. Ethics are a vital part of any research and there is a potential for harm, stress and anxiety, and a myriad other negative consequences for research participants (Robson, 2011). According to the British Educational Research Association's (2011) the revised ethical guidelines for educational research, states research must have responsibilities four issues: (1) Responsibilities to the participants including voluntarily informed consent; openness and disclosure; the right to withdraw; children, vulnerable young people and vulnerable adults; incentives; damage arising from participation in the research; privacy, (2) Responsibilities to the sponsors of the research, (3) Responsibilities to the community of educational researchers and (4) Responsibilities to educational professionals, policy makers, the general public, intelligent ownership and relationship with host institutions.

According to the Brunel University Research Ethics Committee (2010) any research that involves human participants to be carried out on Brunel University campus requires ethical approval. Ethical requirements are observed during the research designing, conducting, recording and reporting research that involves human participants. Primary importance of research study must ensure the dignity, rights, safety and well being of research participants. All research will have some degree of potential risk /or benefit. General responsibilities of the researcher are to protect the life, health, privacy and dignity of the human research participants. No one was forced to take part in the research and no one was put at risk. It was made clear to participants that they could withdraw their participation at any time without penalty. Researchers have to consider their responsibilities, risk assessments; safety; providing adequate information to the participant; voluntary participation and informed consent.

I was concerned about the ethical issues in each stage of conducting the research. I presented the research plan to the Brunel University Research Ethics Committee for consideration and the making of necessary changes. During the conducting of the research, I was always concerned about the dignity, rights, safety and well being of participants. I had to ensure that no harm or injury would be caused to them during the

research and also the participants would be anonymous. Before conducting the research study in the TTTA and out of the TTTA, participants were given a general introduction about the researcher, research approaches and the purpose of the study. Also, I explained the benefits of the research findings to the participants and provided them an assurance that their responses would be anonymous and confidential and any of their personal information would not be disclosed, including at the stage of the publication of the findings. The participants included children, teenagers and adults; they understood the purpose of this activity and this research. They are voluntary participants in the activities and involvement in the research approaches.

As for the interviews, I took the necessary care to get the participants' informed consent for each interview. I explained why they were chosen for the interview and how the sharing of their experiences would help the improvement of the science museum education. I also explained to each interviewee that their name and their personal information would not be disclosed in any form. I allowed all of them the opportunity to see the transcripts of their interview if they wanted. I obtained all the candidates' oral consent for digital recording and field-notes. The conversation from digital recording would be transcribed to verbatim data and field-notes used to find out the meaning of their facial expressions and body language during the interview.

Although, the responsibility of the participants and organisations were made clear. Any information of candidates would not be disclosed in this study or in any other form. The reporting of my study would be true and would not cause damage, stress, embarrassment or loss of self-esteem as the details of the participants would remain confidential.

3.15 The pilot study

Before conducting the main study I carried out a pilot study in June 2011 in the activity area at the traditional technology gallery that is the same area of the main study as stated above. The purpose of the pilot study was to provide a method of training and experience in the quantitative and qualitative data collection. For The quantitative data collection, I devised questionnaires for the participants and practiced

the numeric data analysis with the SPSS programme. It also provided me the opportunity to try out the qualitative data collection through observation and interview techniques using semi-structured questions, field-note taking, devising observational schedules, determining pre-coded categories, practice of interviewing by the use of digital recording and transcribing of the data. According to Robson (2011), some methods and techniques necessarily involve piloting such as in the development of a structured questionnaire or a direct observation instrument. An experiment or survey should be piloted on a small scale in virtually all circumstances (p. 405). Pilot studies helped me to refine data collection with both content of the data and research methods. It also helped me to improve the quality of data from all instruments of the research and the levels of all participants.

3.15.1 Sample of the pilot study

The sample in the pilot study was 30 participants including children (age 10-12 years), teenagers (age 13-20 years) and adults (age over 20 years), who volunteered to join the TTTA at the activity area in the traditional technology gallery at the science museum during June 2011. In the pilot study I did not emphasis the family group, I only tried to find out the results from the participants all of ages at the TTTA. After I conducted the pilot study, I found that 80% of participants who joined the TTTA were family groups. Then I observed how they learnt, I found interesting things about family play-learning in TTTA. Consequently, the sample in the main study will focus on the family group that is defined as one or more adults participating in the TTTA with either a single child or several children or teenagers.

3.15.2 The instruments and stages of the pilot study
The instruments of the pilot study

The pilot study employed three questionnaires and one observation to collect data from participants of all ages at the TTTA. The first one was the fascinating toy questionnaire (FTQ) and aims to find out the most fascinating toys to use in the TTTA. The second questionnaire was the "Playfulness Questionnaire" (FQ). This questionnaire I sought to find out the character of the participants. The last questionnaire was the "Toy Learning Outcomes Questionnaire about interest in toys"

(TLOQ). The TLOQ has the purpose to find out about visitors' learning outcomes including seven topics and two sets of questions about the environment and resources in the TTTA as stated in the methods and data collection. TLOQ was separated into two phases, the first phase used TLOQ1 conducted immediately after the TTTA and the second phase using TLOQ2 following up how participants learn at home, three to four weeks after joining the activity the responses of which were posted back.

As for the observation, the engagement observation schedule (EOS) was used to observe the behavior of participants and emphasised observation of three interactions; (1) meaning full interaction, (2) intentional interaction and (3) effective interaction, when participants engaged with the TTTA at the beginning and the end of the activity.

3.15.3 Findings of the pilot study

The data from the fascinating toys questionnaire indicated that most of the participants were interested in the group of toys using springs including the coconut mouse toy and the paper caterpillar toy. They gave the reasons that those toys can move, are easy to make, beautiful, could be taken home and rarer to find than other toys. For this reason, I chose the group of toys using springs as the tools for studying family play-learning.

The evidence from the playfulness questionnaire data shows that most of the **children and teenagers** defined themselves as **friendly**, **happy** and **cheerfu**l respectively. The nature of Thai children is generally friendly and happy. They are happy to make friends, open minded and optimistic. Also, they are always happy and cheerful. Whereas, the **adult** participants described themselves as **happy, friendly** and **cheerful** respectively. It was clear that the playfulness characters of participants including children, teenagers and adults were similar. They are **happy, friendly and cheerful**.

The engagement observation schedule data showed that most of the participants engaged with the TTTA. They have curiosity and enthusiasm to learn to make and play with the toys in the TTTA. Most of the participants intended to join the activity because they were interested in the toys that they made in the activity and they wanted to keep the toys that they had made themselves.

The Toy learning outcomes questionnaire data indicated that most of the participants were interested in the toys that they made in the TTTA. Participants gained learning outcomes from TTTA between 'Some' and 'A lot'. These are positive results that participants seem to have gained from TTTA. The strongest responses of the children and teenagers were towards 'Action, behaviour and progress' and 'enjoyment, inspiration and creativity'. Whereas, the adults showed the strongest responses toward 'Attitude towards Thai wisdom' and 'Attitude and values". Most of the participants concluded that the environment and resources in this activity are the most conducive and appropriate for learning.

However, it is must be noted that the above results were obtained from a small sample size, they are not representative of all participants in the National Science Museum, Thailand. To obtain more accurate results, the main study would have to be conducted with a larger sample group.

Conclusion

This research follows naturalistic research that was carried out at the Science Museum with the purposive sample that is family groups who voluntarily joined the Traditional Thai toys activity (TTTA). As stated above the purpose of this research was to study family play-learning with TTTA at a science museum, the outcomes of family play-learning and family bi-gnostic leaning. The methodology of this research followed the aims and the questions of the study to investigate family play-learning, bi-gnostic learning and the factors that support family play-learning. This research employed multi-methods with both quantitative and qualitative methods to conduct this research including three questionnaires, three observations and one interview. The questionnaires applied structured questionnaires with closed questions to collect and make comparison of the data. The questionnaires in this study included a Playfulness questionnaire, Toy learning outcomes questionnaire and Families 'motivation of learning at home questionnaire. The qualitative methods employed participant observation to find out about, family's playfulness, family's engagement and family play-learning and the interview was used to find out about family bi-gnostic learning. All tools of this study were used to try out the validity and reliability before being used

to conduct the main study. As stated above, a pilot study is useful to improve the methodology and all tools of the study. The results of a pilot study also allows me to make changes, cut unnecessary things and add some related tools to find out in more details answers to the research question. The consequences of the sample in the main study changed, the title of the research changed from *"Learning science in an informal environment: Using traditional Thai toys in the National Science Museum, Thailand"* to *"Family play-learning through informal education: make and play activities with traditional Thai toy activities at a science museum"* which allowed for more understanding about the purpose and the content of the thesis. After conducting the main research, the data analysis and the findings of this research will be presented in Chapter 4 below.

CHAPTER 4
DATA ANALYSIS AND FINDINGS

"On many occasions even though the activities were actually full other families wanted to join in. The staff of the TTTA had to provide a 'queue card' to control the order" (Explainer).

4.1 Introduction

Data analysis is an important phase of a research project because the data in their raw form do not speak for themselves. The messages stay hidden and need careful testing out (Robson, 2011). After having collected the data for this research project, the stage of analysis and interpretation has been reached. So, I have divided the data analysis of this study into two parts to include the analysis of both quantitative and qualitative data in order to answer the questions of the research project as follows:

1) Quantitative data analysis includes the analysis of the results of the three questionnaires:

      1.1 The playfulness questionnaire

      1.2 The toy learning outcomes questionnaire

      1.3 The families' motivation of learning at home questionnaire

2) Qualitative data analysis, this analysis is separated into three sections and subsections as follows:

      2.1 The results of three observations:

         2.1.1 Playfulness observation

         2.1.2 Engagement observation

         2.1.3 Family play-learning observation

      2.2 The bi-gnostic interview

      2.3 Documentary analysis from the photographs

After data analysis, the finding of these data will be discussed and made conclusions in Chapter 5.

4.2 Quantitative data analysis

In this research, quantitative data analysis focused on numerical analysis. The numerical analysis in this study emphasised descriptive statistics and did not provide co-relational statistics. The measures of the descriptive data in this study included frequency counts (displays with percentages), measures of central tendency (presented with mode, median and mean), and measures of dispersion of the distribution (presented by standard deviation). I used the Statistical Package for the Social Science Programme (SPSS) and applied statistical formulae including descriptive statistics to describe demographic characteristics, Independent - t-test to compare the differences of two independent groups and One – Way ANOVA to compare the differences among multiple independent groups. All tests were considered to be significant at *p*-value less than 0.05.

4.2.1 Playfulness questionnaire

The playfulness questionnaire (PQ) was adapted from Barnett (2006) (the Young Adult Playfulness Questionnaire) (see Appendix 1). On February 2012 the playfulness questionnaire was conducted face-to-face with 93 families chosen from 136 families 342 people, with children 10 years and over, both teenagers and adults, these 93 families consisted in total of 179 people who were visiting the Science Museum. The questionnaire was administered to them in the science museum's Reception Area on the first floor. The purpose of this survey was to study the characteristics that relate to the 'playfulness' of families, including children, teenagers and adult members. The first part of the questionnaire was straightforward and aimed at collecting the personal background of respondents. The second part sought to explore the playfulness of family members. Details of the respondents and the resulting list are shown in Figures AP5.1-5.6 (see Appendix 5).

Results

The background of participant data shows the number in each of the three age groups: adults, teenagers and children (36.8%, 33.5% and 29.6% respectively). Adults are the biggest group in the TTTA. The ratio of male to female is 45.3% and 54.7%. The

education of participants ranged from primary school to master's degree. The highest percentage of participants' education was a bachelor's degree (31.3%).

The results from PQ also showed that most participants described themselves on the positive side. Most participants characterised themselves through the playfulness characteristics as **Friendly**, **Happy** and **Cheerful** respectively as shown in Figure AP 5.4 (see Appendix 5). The responses of children, teenagers and adults were not significantly different in the characteristics of Cheerful ($p = 0.13$), Happy ($p = 0.27$), Friendly ($p = 0.54$), Outgoing ($p = 0.15$), Sociable ($p = 0.07$), Spontaneous ($p = 0.90$), Impulsive ($p = 0.87$), Active ($p = 0.67$) and Energetic ($p = 0.89$), however the three age groups did show a significant difference in Unpredictable ($p = 0.01$), Adventurous ($p = 0.00$) and Funny characteristics ($p = 0.00$). The results indicated that children and teenagers labelled themselves as more unpredictable, adventurous and funny than adults did.

When compared by gender, male and female were not significantly different in the eleven characteristics of playfulness: Cheerful ($p = 0.30$), Happy ($p = 0.13$), Friendly ($p = 0.17$), Outgoing ($p = 0.58$), Sociable ($p = 0.09$), Spontaneous ($p = 0.23$), Impulsive ($p = 0.67$), Unpredictable $p = 0.61$), Funny $p = 0.08$), Active ($p = 0.26$) and Energetic ($p = 0.62$), but both groups were significantly different in the Adventurous characteristic ($p = 0.00$). Males reported themselves more adventurous than females did, as illustrated in Figure AP 5.5 and 5.6 (see Appendix 5).

Playfulness questionnaire summary

The evidence from the playfulness questionnaire data indicates that most respondents described themselves as closest to the playfulness characteristics of **Friendly**, **Happy** and **Cheerful**. When separated, the analysis of the playfulness characteristic of children, teenagers and adults, the results showed both similarities and differences. Three levels of respondents: children, teenagers and adults described their playfulness characteristic to be no different in 9 characteristics (Cheerful, Happy, Friendly, Outgoing, Sociable, Spontaneous, Impulsive, Active and Energetic) but the three characteristics where the three group were different included Unpredictable, Adventurous and Funny. Children and teenagers seem to be more unpredictable, adventurous and funny than adults.

Also, the responses of males and females showed no difference in 11 characteristics except that on the adventurous characteristic males labelled themselves as being more adventurous, than females.

4.2.2 Toy learning outcomes questionnaire (TLOQ)

The Toy Learning Outcomes Questionnaire was adapted from Generic Learning Outcomes (GLO) of school students at the workshops in the museum, based upon the work of the Research Centre of Museums and Galleries at the University of Leicester (Hooper-Greenhill, 2007) (see Appendix 2). TLOQ was conducted in February 2012 among 51 families, with children aged 10 years and over, 125 people (from a total of 88 families, 212 people) who visited the science museum, and who volunteered to participate with TTTA at the Science Museum. TLOQ was given to participants to complete after participating in the TTTA. The first part of the questionnaire deals with the background of respondents. The second section sought to find out visitors' interest in toys and toy learning outcomes as stated in Chapter 3. The purpose of the third part was to find out how environments and resources in the TTTA area were conducive and appropriate for participants' learning, and the final section of this questionnaire was designed to explore participants' comments about the activity with the open-end questions. The resulting list is shown below.

The results of the toy learning outcomes questionnaire, (TLOQ) in Figure AP 6.1 - 6.4 and Table 6.1, Appendix 6 shows the background of the participants. Adults form the biggest group in the TTTA (51.2%). The mean age of adults' is 39.31 years and the highest percentages of adults' ages lie between 31-40 years (46.9%), second highest between 41-50 years (31.3%). Children (28.8%) outnumbered teenagers (20%). There are more females (62%) overall than males (38%). The educational achievements of participants range from primary school to a doctorial degree. Bachelor degrees (40%) are the most numerous for adults and teenagers, whereas – unsurprisingly - basic primary school (36%) shows the highest percentages of education in the children's group.

The first part of the toy learning outcomes questionnaire data indicated that the biggest group of participants were adults with a mean age of 39.31years and a high percentage

of this group lies between 31-40 years. Children outnumbered teenagers; and females more than males. The educational achievements of participants were between primary school and a doctorial degree. Bachelor degrees were numerous for adults and teenagers, while, primary school illustrates the highest percentage of education in the children's groups.

Most participants labelled themselves as being very playful characters. The three age groups were significantly different ($p = 0.00$). Responses of the teenager group showed that they were more playful than children and adult groups. However, There were no significant differences between male and female's responses ($p = 0.58$) as illustrated in Figures AP6.5 and 6.6 in Appendix 6.

The results also indicated that children, teenagers and adults were significantly different in frequency of play with the toys ($p = 0.02$). The responses of children and teenager groups showed that they more usually played with the toys than the adult group. Whereas, males and females were not significantly different in their frequency of playing with the toys ($p = 0.14$) as shown in Appendix 6, Figure AP 6.7-6.8.

The top three favourite toys were traditional Thai toys (21.6%), dolls (12.8%) and all toys in general (10%) respectively, as illustrated in Figure AP 6.9 in Appendix 6. There was no significant difference of feeling very interested when playing the toys among children, teenagers and adults ($p = 0.80$). Males and females had no significant difference of feeling very interested when playing with the toys. The three age groups responded that they had no significant difference in toys in the TTTA ($p = 0.80$). Also, males responses to the TTTA's toys did not differ from females as shown in Figures AP 6.10-6.13 in Appendix 6.

The second part of the toy learning outcomes indicated that most participants defined themselves as closest to the playfulness characteristic. When compared by age, teenagers labelled themselves the most playful, children and adults as follows respectively. Males and females showed no significant differences in the playfulness characteristic. The results also indicated that children and teenagers usually played

with the toys more than adults did. However, when compared by gender, males and females showed no significant difference about frequency of play with the toys. Traditional Thai toys were the most favourite toys for the majority of participants. The second choice was dolls and the third was all toys. The data also indicated that three age groups showed no significant difference of feeling very interested when playing with the toys. Children, teenagers and adults responded about the toys that they made in the TTTA as very fascinated by both male and female.

The main purpose of the TLOQ was to investigate seven outcomes of learning from TTTA as shown below. The results from TLOQ in Figure AP6.28 and AP6.29 in Appendix 6 are positive results and show that all participants gained learning outcomes from the TTTA ranging from *'Some'* to *'A lot'*. The highest responses were in the **'Attitude toward Thai wisdom'** and **'Scientific learning'**. The others ('Skills', 'Enjoyment, inspiration and creativity', 'Action, behaviour and progression', 'Attitude and values') are similar. The last is 'Knowledge and understanding' which provide some of learning outcomes.

There was no significant difference of responses among children, teenager and adult groups in six themes of learning: Knowledge and understanding ($p = 0.79$), Skills ($p = 0.74$), Attitude and value ($p = 0.43$), Enjoyment, inspiration and creativity ($p = 0.81$), Action, behaviour and progression *($p = 0.36$)*, and Attitude to Thai local wisdom ($p = 0.09$). However, Scientific learning was significantly different among these three groups ($p = 0.02$). Males and females were not significantly different in all themes of learning (Knowledge and understanding ($p = 0.41$), Skills ($p = 0.11$), Attitude and value ($p = 0.93$), Enjoyment, inspiration and creativity (p = 0.64), Action, behaviour and progression ($p = 0.87$), Scientific learning *($p = 0.92$)* and attitude to Thai local wisdom ($p = 0.60$). The details of investigating the seven outcomes of learning from TTTA are as follows:

(1) Knowledge and understanding
The results in Figures AP 6.14-6.15 in Appendix 6 show that participants seem to have gained knowledge and understanding ranging from 'Some' to 'A lot'. Perhaps

unsurprisingly, the highest responses were toward '***Learning how to make and play with the toys'***. These data illustrate that most participants did learn how to make and play with the toys, following the objective of the research. The data also show that most participants gained understanding about the toys and that the toys helped them make links and relationships between other things. The lowest of these responses indicates only that the toys gave them specific kinds of information.

Table 4.1: Comparison between participants' ages, and the highest and lowest responses of knowledge and understanding gained from TTTA

Ages group	Highest response	Lowest response
Children	They learnt how to make and play with the toys.	The toys gave them specific information.
Teenager	They understood the toys.	They found that the toys made links and showed relationships between other things.
Adult	They learnt how to make and play with the toys.	They found that the toys made links and showed relationships between other things.

Also, the data from the comments of participants indicated that most participants did gain scientific knowledge and local wisdom, in ways that they could adapt to their daily lives. In general, adults asked that science museums provide more activities like the TTTA for children to learn, and some suggested that this kind of activity should find its way into the school curriculum. For example, some of the respondents said:

Woman F24: I like this activity very much because it makes children happy, gains more knowledge and understanding.

Girl F36: I have never seen this activity before and I gained new knowledge myself.

(2) Skills

The result of TLOQ about the skills of the participants in Figures AP 6.16-17 in Appendix 6 show that participants gained from the TTTA between 'Some' and 'A lot'.

Participants gained communication skills the most and the lowest responses were toward the new emotional skills. Most respondents also developed physical, intellectual and social skills. Participants in the TTTA had to communicate with the members of their family, with the Explainers and Assistants when they guided the activities, and learn how to make and play with the toys. So, they recognized that they could develop communication skills. Children also developed physical skills, not the least being hand and eye-coordination. Most participants responded that they gained the new skills by making and playing with the traditional Thai toys because they had to complete the toy themselves.

Table 4.2: Comparison between participants' ages, and the highest and lowest responses about the skills developed from TTTA

Ages group	Highest response	Lowest response
Children	They gained intellectual skills and they learnt new communication skills.	They learnt new emotional skills.
Teenager	They gained intellectual skills and they achieved new physical skills.	They learnt new emotional skills
Adult	They learnt new communication skills.	They learnt new emotional skills.

Also, the data from the comments of participants indicated that TTTA encouraged participants to develop their skills, especially children who developed handicraft skills by making the toys. They also realised that they developed social and communication skills when they discussed and played with the toys with other people. Some of participants commented that:

Man F35: This is a good activity that allows children to make the toys themselves.
           This activity should to continue.
Woman F25: I am very interested that my son (7 years old) can make the toys himself.

(3) Attitude and values

The attitude and values outcomes from TLOQ in Figures AP 6.18-19 in Appendix 6 show that *the highest responses were toward participants who gained positive attitudes and they had awareness towards the values of the TTTA.* Most of them thought that the toys helped them enjoy their family interactions. They gained confidence from the toy activities and it changed their feelings about playing with the toys. In particular, they developed more positive attitudes towards TTTA. On the other hand, the lowest responses indicate that some thought the TTTA simply changed their attitude toward other people. One of the participants commented that:

Woman F2: I was more interested in the idea of conserving local wisdom because examples are increasingly rare to find at present.

Table 4.3: Comparisons between participants' ages, and the highest and lowest responses of attitude and values gained from TTTA

Ages group	Highest response	Lowest response
Children	They gained positive attitudes from TTTA.	They changed their opinions or attitudes towards other people.
Teenager	The toys helped them enjoy their families and their friends.	The toys changed their feelings and perceptions about playing with toys.
Adult	They gained gain positive attitudes from TTTA.	They changed their opinions or attitudes towards other people.

(4) Enjoyment, inspiration and creativity

The results from TLOQ in Appendix 6, Figures AP6.20-21 indicated that participants felt they gained enjoyment, inspiration and creativity from the TTTA. *The highest responses were towards participants who had fun when they played with the toys.* Most of them thought that the toys prompted them to be creative and the toys made them pleasantly surprised. Even the lowest responses indicate that some of them think that toys provided inspiration for innovative thoughts. One of the purposes of the TTTA was to provide 'opportunities for playfulness' for the participants. The analysis

of this data indicates that participants did feel playful - that is, again, consistent with the purpose of the study.

Table 4.4: Comparison between participants' ages, and the highest and lowest responses of enjoyment, inspiration and creativity gained from TTTA

Ages group	Highest response	Lowest response
Children	They thought that the toys prompted them to be creative.	They gained innovative thoughts after joining TTTA.
Teenager	They had fun after participating in TTTA.	The toys surprised them and the toys prompted them to be creative.
Adult	They had fun after participating in TTTA.	The toys surprised them.

The comments of the participants indicated that most families enjoyed the activity. They were happy to make and play with the toys both in the family group and with other people. Some of participants commented that:

Boy F10: I like this activity because I can make new toys anytime that I join the activity.

Woman F46: I appreciate this activity. It helped me manage with making the toys and they are funny.

Girl F27: I want to visit NSM again because I enjoyed making and touching the toys. I liked the paper caterpillar toy.

(5) Action, behaviour and progression
The TLOQ data about action, behaviour and the progression of the participants in Appendix 6, Figure AP6.22-23 show what participants gained from the TTTA. ***The highest responses were towards participants who understood the intentions of the toy maker***. Most of them also believed that the toys helped them to be interested in playing with other toys and they understood why people love to make and play with the toys. They also felt independent from the everyday pressures of study or work

when they joined the TTTA. Even the lowest responses indicate that some of them thought that making and playing with the toys changed their behaviour.

Table 4.5: Comparison between participants' ages, and the highest and lowest responses of action, behaviour and progression developed from TTTA

Ages group	Highest response	Lowest response
Children	They understood the intentions of the toy maker	Making and playing with the toys changed their behaviour.
Teenager	Toys helped them to be interested in playing with other toys	They understood why people love to make and play with toys.
Adult	They understood why the people love to make and play with toys.	Making and playing with the toys changed their behaviour and they felt more independent from study or working when they played with the toys.

Moreover, they commented that making and playing with the toys changed their behaviour, for example they felt they could freely to show their emotions to other people.

Woman F29: My son played with other children; something that he has never been known to do before. Normally, he is very shy.

(6) Scientific learning

The results of the scientific learning outcomes in Appendix 6, Figures AP 6.24-25 illustrate that *the highest responses came from participants who gained scientific learning*. Most participants wanted to return to learn scientific knowledge at science museum again because making and playing with the toys in TTTA inspired them to do this. Most of them also had fun learning science in TTTA. They understood the science involved in the toys and thus understood science better than before. Most of them also gained scientific skills from the TTTA. The lowest responses came from

participants who thought that making and playing with the toys inspired them towards being scientist. One of participants wrote that:

Woman F44: I gained scientific knowledge from the activity. I can take this knowledge home to teach children there.

Table 4.6: Comparison between participants' ages, and the highest and lowest responses of the scientific learning gained from TTTA

Ages group	Highest response	Lowest response
Children	They understood the science involved with toys.	TTTA inspired them to be scientist
Teenager	They had fun learning science through TTTA.	TTTA inspired them to be scientist
Adult	TTTA inspired them to go to the Science Museum again.	They understood the science involved with the toys.

(7) Attitude towards Thai local wisdom

The TLOQ results about attitudes towards Thai local wisdom in Appendix 6, Figures AP 6.26-27 show that most participants have strong and positive attitudes towards Thai local wisdom. The highest responses indicate that *most participants think that making and playing with the toys in the TTTA inspired them to conserve Thai local wisdom*. Most of them also believe that the toys helped them understand more about Thai local wisdom, and they thought that making and playing with the toys in TTTA inspired them to study this further. The lowest responses indicate that some of participants had fun learning Thai local wisdom.

Table 4.7: Comparison between participants' ages, and the highest and lowest responses of attitudes towards Thai local wisdom gained from TTTA

Ages group	Highest response	Lowest response
Children	Making and playing with these toys inspired them to conserve Thai local wisdom.	They had fun learning Thai local wisdom by making and playing with these toys.
Teenager	Making and playing with these toys inspired them to conserve Thai local wisdom.	They had fun learning Thai local wisdom by making and playing with these toys and Making and playing with these toys inspired them to study Thai local wisdom further
Adult	Making and playing with these toys inspired them to conserve Thai local wisdom.	They had fun learning Thai local wisdom by making and playing with these toys

The comments from participants indicated that they learned about Thai local wisdom including Thai culture and traditional Thai toys from the TTTA. They preferred the aspect about conserving local wisdom because examples are increasingly rare to find at present. An example of their comments appears below.

Man F5: This activity helps children to learn about the toys from the past and helped them realise that they are rare to find at present. It is a good activity to conserve traditional Thai toys.

Woman F15: This activity should continue because it can encourage children to recognise the materials, toys and how to make them. It also protects the making of traditional Thai toys.

Woman F49: I gained knowledge about Thai local wisdom and traditional Thai toys, and also, I will protect Thai local wisdom.

(8) Environments in the TTTA

The toy learning outcomes questionnaire (TLOQ) data about the environment in the TTTA in Appendix 6, Figures AP 6.30-31 show that all environments of the TTTA helped participants to learn with TTTA 'a lot'. The highest responses were in regard to the collection of the old traditional Thai toys. The second was the exhibition, and the lowest responses in respect to the lighting and sound in the TTTA respectively.

Table 4.8: Comparison between participants' ages, and the highest and lowest responses of environments in the TTTA

Ages group	Highest response	Lowest response
Children	They thought the exhibition and collections of toys helped them to learn with TTTA.	The lighting and sound in the TTTA
Teenager	They thought the lighting and sound in the TTTA helped them to learn with TTTA.	The collections of toys
Adult	They thought the collections of toys helped them to learn with TTTA.	The lighting and sound in the TTTA

(9) Resources

Toy learning outcomes questionnaire (TLOQ) data about the environment in the TTTA in Appendix 6, Figures AP 6.32-33show that participants also responded 'A lot' to the resources in the activity that were appropriate to their learning with TTTA. The highest responses focussed in the direction of the Explainer, second were the Assistants and the materials provided to make the toys, third was the toy handbook. The lowest responses focussed on the toy that they actually made in TTTA, the one they made themselves and their play efforts.

Table 4.9: Comparison between participants' ages, and the highest and lowest responses of resources in the TTTA

Ages group	Highest response	Lowest response
Children	They thought that the Explainer, Assistants and the toy handbook helped them to learn with TTTA.	The materials to make the toys and the toys that they made in TTTA
Teenager	They thought that the Explainer helped them to learn with TTTA.	The toys that they made in TTTA
Adult	They thought that the materials to make the toys helped them to learn with TTTA.	The toys that they made in TTTA

(10) Comparison between environments and resources for learning in TTTA

In Appendix 6, Figures AP 6.34-35 illustrates the comparison between environments and resources for learning in TTTA. The results indicated that all participants (children, teenagers and adults) thought that the *resources encouraged their learning with TTTA more than the environments*.

Toy learning outcomes questionnaire summary

The results of TLOQ indicated that families gained learning outcomes from the TTTA. They appear to have learned most in relation to both **'local Thai wisdom' and 'scientific knowledge'** when compared with the other themes of learning. This is largely consistent with the purpose of the study. Children, teenagers and adults gained learning outcomes not differently through 6 theme of learning (knowledge and understanding, skills, attitude and value, enjoyment, inspiration and creativity, action, behaviour and progression, and attitude toward Thai local wisdom) from the TTTA but they were different in the theme of science learning. Also, the responses of males and females towards all seven themes of learning were not different.

The evidence from analysis of this questionnaire also indicated that participants developed skills, actions, behaviour and made progress from this activity and that TTTA stimulated knowledge, understanding, attitudes, values, enjoyment, inspiration

and creativity within the family. Also, the environment and resources in the TTTA encouraged participants to learn within TTTA.

4.2.3 Families' motivation of learning at home questionnaire (FMLHQ)

The families' motivation of learning at home questionnaire is a small questionnaire that aimed at exploring the families' motivation for learning once they left the TTTA. This 'post activity' questionnaire asks for the last step of family play-learning (adapted from Bandura, 2005), 'Motivation: that the learners will try to take what they have learned from the setting and repeat, adapt and improve on what they have been doing'. The purpose of the questionnaire was to support the observation data of family play-learning, for example, would they make the toys again; would they give the toys to other people; would they teach other people to make the traditional Thai toy; or would they adapt the tasks within their own work or study. This questionnaire provides the multiple choices of adults and children's motivation after learning with TTTA. In all, 51 questionnaires were provided to families and just over half of respondents (28 families) completed the questionnaires and returned them to the researcher.

The results of FMLQ in Appendix 7, Figure AP 7.1 shows that the highest responses were that 'they would talk about the TTTA and would teach others how to make the toys (72.5%); the second was that 'participants would make the toys again' (66.6%). The third level of responses were that 'they gave the toys to other people' (61%), and fourthly 'they taught others to make the toys' (55%). The lowest responses were toward 'the idea of adapting the toys to their work or study' (33.3%). The comparison data between adults and children with teenagers indicated that adults wanted to teach other people to make the toys (56.2%) more than children and teenagers (44%). Also, adults wanted to make the toys again (72%) more than did children and teenagers (61%). On the other hand, both children and teenagers (78%) wanted to talk about the TTTA to other people, more so than the adults did (67.2%). Adults, children and teenagers wanted to adapt TTTA to their work or study (33.3%) and give the toys to other people (61.1%) to an equal degree.

The analysis of this questionnaire also assumed that most participants had motivation from the TTTA because they could repeat the making of the toys again, thought about how to adapt the toys to their work or study and had an idea to improve the toys.

4.3 Qualitative data analysis

In this research, qualitative data analysis has focused on content analysis. This includes the coding of behaviour, the conversations during the activity and the answers to the interviews. I used thematic coding and categorising methods to translate the questions responses and respondents' information from the observations and the 'bignostic interview'. Interpretative analysis is used to explore and interpret the behaviour of the participants during the TTTA. Also, the documentary analysis uses photographs of the TTTA as evidence for analysing the TTTA, including a sense of the busy atmosphere of the activity; the exhibition and the collections of the traditional Thai toys; participants' behaviour during participating with TTTA and the working of the Explainer and Assistants. These images can support the finding of those questionnaires, observations and interviews. The details of qualitative data analysis are as follows.

4.3.1The observations

Observation was one of the three primary instruments for collecting data in my study. Through participant observation of the TTTA, my aim has been to answer research question one: 'What family play-learning and learning outcomes can be achieved through traditional Thai toy activities in a science museum?' and research question two: 'How does learning with traditional Thai toys affect the relationship between the participants' character and engagement, the environment and resources?' by finding out how during family play-learning, the families engaged with the TTTA and their playfulness characteristics. Four members of the staff of the TTTA and myself were the participant observers: one member of staff was an Explainer and three members of staff and myself as the researcher were the Assistants to the groups of participants. After meeting to ensure the precision of all codes of the observations, we had to observe and note participants' obvious behaviour during the TTTA, including expressions of their feeling and behaviour to gain descriptive data of their playfulness,

their engagement in the activity and evidence of family play-learning through the TTTA.

All observations were made in February 2012 with the 88 families (212 people: male 84 people and female 128 people) including all children, teenagers and adults in the family groups who agreed to participate in the TTTA at the science museum that day. The details and the results of all observations are as follows.

4.3.1.1 Playfulness observation

Presentation and analysis of data from the playfulness observation field notes

The codes, categories and sub-categories in the analysis of playfulness observation applied from Leiberman's (1977) categories are shown in Chapter 3, Table 3.2. I have analysed the results through these categories to allow the TTTA team and myself to note patterns and themes. The results of the 'playfulness observations' is illustrated below.

1. Physical spontaneity

1.1 Facial expressions of enjoyment

Most participants engaged easily with the toy activities, exploring until they understood what each part did and how it worked. Their behaviour showed repetition of the movements and actions, clear facial enjoyment, often playing with some of the toys for extended periods until the allotted time was up. Some progressed to the next toy with equal enjoyment, for as long as the time allowed. Some adults said that

Woman F27: My children liked these toys, when they played with the toys in the exhibition, they enjoyed laughing and smiling when the toys were working. They had never seen those toys before. They also pulled me in to join in the activity.

Some young participants said:

Boy F85: This toy (coconut mouse toy) always makes me laugh and smile when I play with it. It looks so funny.

However, some young participants had nervous looks on their faces because they could not understand how to make their toy. So, they asked the adults or the Assistants and tried to make the toys themselves until they completed them. Then their faces cleared and they showed enjoyment instead of anxiety. Some adult participants showed their normal impassive faces when participating in the TTTA but they did join in the activities, asking questions and following the process of the activities.

1.2 Make the toy enthusiastically

Participants showed enthusiasm in making the toys for different reasons. Adults made the toys enthusiastically so as to be able to teach their children. Whereas, children and teenagers were enthusiastic to make the toys for their own selfsatisfaction and wanting to play with their toys or give the toys to other people. For example young participants said:

Girl F21: I will give this toy to my brother.
Boy F63: I will do everything to finish the toy. (he then laughed)

Some adult participants expressed:
Woman F29: I have never seen my son so enthusiastic about something like this. I
              think he likes to play with this toy very much.

Younger participants had difficulty in binding the string when making the coconut mouse toy, not least because of their limited physical skills, for example, hand-eye coordination. Older members or the Explainers demonstrated the skills involved and gave them learning and construction assistance. Making the flying birds was more difficult, than for example, the spring-toys activities, because producing the wickerwork flying birds required more skills, such as weaving the body of the flying bird and managing to actually complete it.

On the other hand, some children did not fully join in the activities and did not listen to the Explainer or the adults. They made the toy in their own way, completely

misunderstanding how to do it, until they literally could not complete the toys, then an Assistant helped them to finalise the construction.

Also, some children were less enthusiastic to join in the activities and made the toy slowly because it (the flying bird toy) was difficult for them. Their parents and Assistants guided and helped them. Once the toy was finished, these children's expressions changed to expressions of excitement as they began to play with their toys. Small children said:

Girl F23: Mom, this toy is too hard for me to make, please help me. I want to play with it.

1.3 Plays with the toys playfully

Participants were fascinated by the exhibition and the collection of the old toys in the first part of the activity area. They enjoyed exploring and learning from the exhibition and having fun with the collection of the toys. Some of them had never encountered these before, so they engaged with these toys until they knew how they worked.

The TTTA began with an introduction to the activity by the Explainer and a demonstration of how to play with some of the collection of old toys and to make the toys of the TTTA. Then, participants had to make the toy by themselves. Participants look busy and purposeful when they selected the materials to make the toys and they made the toys exuberantly with their family. Adults in the group guided their children to make the toys, most children made the toys carefully, following the adults guidance. Some children showed the adults how to make the toys. When the toys were complete, all members of the family joined together and played happily with the toys. The highlight of this activity was actually playing with the toys, with individuals saying, for example,

Boy F25: I will walk with the coconut mouse toy, as though it is my pet. I will give this toy to my sister.

Boy F70: I will name the paper caterpillar toy 'Bobby'. (Then he carried the toy with him everywhere in the museum, like his friend).

Adult participants said:

Woman F15: These toys (coconut mouse toys) are funny. Your toy is running like it's dancing, but my toy is running like a real mouse.

(then she laughed)

Conversation within Family 10

Dad: Hi son, do you want to race the flying bird toy with me? The first to fall to the ground is the winner.

Children: Sure dad, my toy will be the winner because it flies so fast.

Figure 4.1: Photographs of physical spontaneity

Sources: Traditional Thai toy activities at the National Science Museum, Thailand (February 2012)

2. Social spontaneity

2.1 Accepting the invitation to play

Participants exhibited the most playfulness when they demonstrated their toys to friends. Some explored and played with the toys by themselves, then invited friends and family over to play with them and to talk about the toys: when they found them worthy of note, they would call over and involve others in play, talking animatedly about the toys, and how they work:

Conversation1:

Girl F21: Your toy runs smoothly, but mine is not smooth. Could I try your toy?

Boy F22: Yes, you can. Could I look at your toy?

Girl F21: It walks smoothly and fast. I like it.

Boy F20: I see, your toy has a problem with the wheel, it is too tight. I will adjust it for
you.

Also, the coconut mouse toys and paper caterpillar toys consist of wheel. They allow children and adults to be competitive with their toys, so there were soon invitations to race the toys between family members and also with other families - and talk:

Conversation2:

Boy F29: Would you like to race the coconut mice?

Girl F28: Yes, of course. I think my toy is the fastest.

Girl F27: Yes, sure. This is the start line and that is the finish.

Boy F29: Are you ready? One…two…three

2.2 Play with other people happily

Participants always played with the toys with members of their family. They enjoyed talking, making and playing with the toys with their families. Children made new friends in the TTTA, they enjoyed inviting their friends to play with the collection of the toys and they played happily with these toys together. Children also played with other people's toys and exchanged the toys they were playing with They were willing to share the toys with others. Moreover, children asked to play with the Explainer's toys. Adults always played with their children but some adults played with other children or adults in another family. Some of their conversation:

Conversation3:

Boy F42: I think my toy can run faster than your toy. (And he laughs)

Boy F43: I don't think so. Could we race our toys?

Boy F42: Yes, of course.

Conversation4:

Girl F11: Your coconut mouse toy looks like a ladybug. Could I see your toy?

BoyF12: Yes, you can play with my toy. I think your toy looks like the face of a lady,
       doesn't it?

Girl F11: Yes, of course. I wanted to make it as a doll. You can take a look and play
       with her.

2.3 Talk and discussion with other people

Participants took pride in their achievements, and met new people, the other previously unknown participants at the gallery. They not only played with the toys with members of their own family but also with other people in other family groups. They interacted through the activities and through stories with other people, with the Explainer and the Assistants. Interesting, was the adult-adult talk about the toys with other families, about their children (for example children's education), their welfare or behaviour in their home and so on. Some conversations were as follows:

Conversation5:

Woman F62: How about your child? I saw he enjoyed those toys.

Woman F63: Um...well, he liked this activity so much and he liked the toys he made
       by himself today. He told me that the toys were funny and lovely, especially,
       when he made them himself. How about your daughter?

Woman F62: The same as your son, she obviously liked her coconut mouse toy. She
       drew it as her cat because she loves cats. I think she enjoyed this activity.
       Look at the way they play together.

2.4 Share the materials to make toys with other people

In the section of toy making, participants shared the materials and tools to make the toys with other people. They were willing to join in making the toys with their group. Some participants helped other people to select suitable materials to make the toys. Adult participants especially, guided children to learn how to make the toys and provided help until their child (or others) understood the toy making process. Not only adults, but also children or teenager participants who finished early; (perhaps they had had previous experience of the toys) provided help to the younger people or adults or their new friends. They also helped other participants with similar problems

or warned them in advance of problems to come, inviting their new friends to play together after the activity. Some conversation:

Conversation6: Family 24

Mother: Watch me son, you have to fold the paper like this, follow the line of the paper (paper caterpillar toy).

Son: I'm confused. I will be careful and follow the line.

Mother: Well done, my boy. Keep going.

Conversation 7:

Boy F24: Why doesn't my coconut mouse run?

Boy F25: I know how to fix it. Let's see. There is a problem with the string and the wheel. I will show you how to fix it, so next time you can do it yourself.

Boy F24: Thank you so much. I think I understand this problem.

Figure 4.2: Photograph of social spontaneity

Sources: Traditional Thai toy activities at the National Science Museum, Thailand (February 2012)

3. Cognitive spontaneity

3.1 Enthusiasm in following the activities

The participants showed considerable enthusiasm in following the activities led by the museum's Explainers. Most listened and watched the presentation and the demonstration of the process of toy making; some asked questions. Most showed enthusiasm, especially the adult participants who clearly intended to follow the Explainer until they understood all the process, principally because they wanted to teach their children.

Most teenage participants could follow the activity and help the adults to show the younger children how to make the toys. Some small children could not follow some of the steps to make the toy, especially the 'flying bird' that they had to weave from palm leaves. In this instance, they had to wait for the adults to teach them. They stayed enthusiastic because they wanted to play with the toys. Some expressions and conversation are:

Conversation8

Man F42: Please demonstrate slowly and repeat the previous step again.

Explainer: I am sorry, I was too fast. I will slow down.

Man F42: Thank you so much.

However, some non-involved people (young children) showed low enthusiasm to follow the activity. They constructed the toy slowly making many mistakes, until the adults in the family finished then showed them the process, guided and helped them to make the toy. Also, some children were too shy to ask the question of the adults or Assistants until the Assistants asked them about the problem and assisted them. Some young participants said:

Girl F3: I don't want to make this toy. It is difficult. Mom, please make it for me. I am hungry.

Boy F1: It is difficult to fold the paper to make this toy (paper caterpillar). I cannot do it but I will try to fold it until it is wrinkly.

3.2 Completing the activities in making the toys themselves

The aim of this activity was for participants to make the toys themselves to learn how to make them accurately. Most teenagers and adults could complete the toys themselves but some small children (6-9 years) needed adult help to complete them. One of the reasons that participants had enthusiasm for completing the activities in making the toys themselves was that they wanted to have these toys, typically quite rare to find in a normal market. Some of their expression and conversation:

Girl F56: I was so proud when I made this toy myself and I will teach others how to do it.

Girl F39: Mom...Dad, This is my toy. I made it by myself. I think it is so beautiful.

Conversation 9: Family 19

Granddaughter: Grandpa...Grandma, look at this, this is my mouse. I made it.

Grandfather: Well done little girl, I am so proud of you.

Grandmother: Very good, girl.

From the team's observations, we found that, when participants could make the toys themselves, recognise how to make running repairs on them and understand how they worked. They could connect to other toys that use the same principles, for example, the coconut mouse and paper caterpillar toy.

3.3 Decorating the toys

After participants completed the toys, they were then allowed to imaginatively decorate them'. For example, many enjoyed colouring the body of the coconut mouse, drawing a face, hair, tail, shirt or skirt for the toy. Some wrote their name inside the body of the coconut mice or named them Mighty Mouse or Ladybug. Some used colour and made fanciful tails, experimented with pulling and pushing the string to move the wheel until it worked. Some expression and conversation:

Girl F7: It was fun when I decorated this toy. This is 'ladybug.' Mom, take a look. It has a black dot and dot...dot…dot like a real ladybug.

Girl F6: My toy is so beautiful. I drew the dress for it. It looks similar to my doll.

Boy F10: Dad, this is a pig. I put a red and pink colour as skin. It looks so fat with a
short tail (and laughs).

Conversation 10: Family 51

Older sister: Look at this, 'my toy'. It is a rabbit I added the long ears and big teeth to
it. It is so funny.

Younger brother: I don't think so. It looks like a monster rather than a rabbit
(and laughs).

Older sister: Look at your toy. It looks like a dirty mouse and disgusting
(and laughs too).

The results from our observations showed that young children had greater imagination
when decorating the toys than teenagers and adults. Children spent a considerable
amount time creating the toys, relating these to their experience, for example, the
mouse, ladybug, rabbit, pig or bear, etc. Teenagers also showed imagination in
decorating the toys but a rather limited creativity in comparison to the younger
children. From our observation, most of them created the coconut mouse toys to look
like a mouse and spent a shorter time than children to colour and draw the toys. As for
the adult participants, most of them spent the shortest time in decorating the toys.
Some of them drew only eyes, ears, nose, mouth and moustache.

Figure 4.3: Photographs of cognitive spontaneity

Sources: Traditional Thai toy activities at the National Science Museum, Thailand
(February 2012)

4. Manifest joy

4.1 Interest

Within the traditional toy collections we observed interest, fascination and curiosity. Participants were clearly interested in the information and pictures of the toys, enjoyed the cartoon characters in the graphics panels, and playing with the exhibition toys. Participants played repeatedly with these and there was clearly evident enjoyment when the toys moved or made a sound. Some children said:

Girl F17: I have never made the flying bird toy before, this is the first traditional Thai toy in my life and I want to play with it with my family.

Some adults reminisced:

Woman F26: I remember that I used to play with this toy with my parents. I'm going to take the flying bird toy back home to my son.

That said, not all of the participants could be designated as playful. A few signalled slight boredom with the activity and showed relatively low levels of interest. A number of these were young men, visiting the Science Museum with their family, who seemed reserved and unwilling to participate in the TTTA with the younger children. Some said:

Man F35: It is a child's activity. I have made these toys before. It's a waste of time.

As for the younger participants, there were some small examples of frustration. Some showed negative feelings when they could not follow the steps in the toy-making process, such as winding the string or bending the bamboo sticks. They wanted to make the toys themselves but could not manage this alone. In moments of moodiness some young children said

Girl F43: I cannot make it. It is too difficult for me.

As I noted earlier, when play becomes tedious, when players become frustrated or disillusioned, when the fun ends, then it ceases to be play.

4.2 Fascination

The TTTA fascinated participants sufficiently to join the activity through the toys. Our observations found that, when families found this activity area, most participants (children, teenagers and adults) showed interest. Some of their expressions were:

Woman F40: I like the cartoons in the exhibition. This boy wears an old fashion dress and the old hairstyle. He is very handsome with the smiley face. I love him.

Man F35: Some of these toys, I played with when I was young but these toys I have never seen before. Look at this, son, let's play together.

Boy F38: This toy can make a sound like a bird. These toys sound like cicadas. This is a wooden frog. I think it sounds like a frog (then, he plays with this toy). Yes, exactly, this is the sound of a frog (and laughs).

Little boy F2: They're funny, I like these toys, I want one but where can I get one?

Our observations found that children, teenagers and adults were equally fascinated by all parts of the TTTA. Families who visited the traditional Thai technology gallery preferred to participate in the TTTA.

4.3 Curiosity

Participants showed their curiosity by asking for information about the traditional toys and had enthusiasm to learn. Some adults and teenagers asked the questions of the Explainer, some played and replayed with the collection of the old toys until the allotted time expired. Children always asked questions of the adults, the Explainer and the Assistants about 'How do we play with these toys?', 'How do these toys work?' and 'Where can we get these toys.' Some children asked the Explainer:

Boy F10: Could we change the material to make this toy?

Boy F20: Could we change the coconut mouse toy to other creatures?

Girl F10: Why is the wheel of the paper caterpillar toy different from the coconut mouse toy's wheel?

Girl F31: Why are some toys in the same group such as the sound group made from different materials? Why are they different figures?

Figure 4.4: Photographs of manifest joy

Sources: Traditional Thai toy activities at the National Science Museum, Thailand (February 2012)

5. A sense of humour

5.1Smile, 5.3 Laughter and 5.3 Exaggeration about the toys

One of the missions of the NSM was to provide playful learning to all visitors. The TTTA followed this mission through by putting some jokes, trick actions with the toys, or by the Explainer's funny expressions during the activity to create a playful atmosphere for the participants. The Explainers were successful in encouraging playfulness, and motivating participants through laughter. The participants enjoyed the process, they smiled or laughed, especially when they decorated and finished the toys, they took pride in their creations.

Conversation 11: Family 22

Son: Dad, Why you don't you put more decoration on the toys than this? There is only a face. I can't identify that what this creature is. Look at my toy. This is a bear. This is its face, brown hair and short tail. It is so pretty. What do you think?

Dad: I am too lazy to decorate it. I just follow the toy's design (and laughs).

I think your toy looks almost like a bear. You have to put the pop-up ears in this area then, I think it may look more like a bear than it does now.

Son: Good idea, I will do it.

Conversation 12: Family 38

Some children made exaggerated remarks about their toys to their friends and family:

Older brother: My toy is so cool. This is a robot. It is smarter than your toy.

Sister: Really, I think it looks more like a television rather than a robot (and laughs).

Look at this. This is a mighty mouse with the big eyes, big ears and big body. It is very powerful.

Older brother: Overstated, I think it is only a coconut shell toy (and laughs).

Sister: But I finished it faster than you (and smiles).

Figure 4.5: Photographs of a sense of humour

Sources: Traditional Thai toy activities at the National Science Museum, Thailand (February 2012)

4.3.1.2 Engagement observation

Engagement Observation Results

Table 3.3 in Chapter 3 presents the codes, categories and sub-categories of engagement observation adapted from Hawryszkiewycz (2007). The results of the engagement observations are similar to the results of the playfulness observation. So, I summarised the results of this observation through tables to present the behaviour of the participants during their participation with the TTTA following the categories of the engagement observation. The summary resulting from the engagement observations are shown in Table 4.2 below.

Table 4.10: the results of Engagement Observation

Category of observation	Results of engagementt observation
1. Engagement with the activity	Participants engaged enthusiastically with the TTTA. They explored the goals and the ideas of the toy making. They also showed curiosity and enthusiasm to learn the story of traditional Thai toys and the scientific knowledge and local wisdom inside the toys from the TTTA. They understood the purpose and idea of the activities. They could follow the process of the toy making and succeeded in the goals of the activities by making the toys themselves. *Example of expression and conversation* Boy F81: Mom…my toy is completed. I will decorate it to look like a tank. *Conversation1: Family 41* Girl: Here it is… mom. I have completed my toy. It looks lovely. Mother: I think you forget to put the tail on your mouse, didn't you? Girl: Oh…yes mom. I think someone bit it. (and laughs)

2.Learning from the activity	Participants could follow the activities led by an Explainer. They asked questions of the Explainer and Assistants when they did not understand the process of the TTTA and they could answer the questions asked of them by the Explainer and the Assistants. Most adults, teenagers and some children could help other people to make and play with the toys. Most participants could make and play with the toys by themselves, and gain knowledge and skills from the activities. *Example of conversations* *Conversation 2: (introduction)* Explainer: This question, I would to ask the children. Parents please do not help them. What is the body of this coconut mouse make from? Children: Coconut shell. (Many of children) Explainer: Well done. Do you know…what is inside the coconut shell? Children: (They think)….water….and something white. Oh…yes…coconut milk. (Some children) *Conversation 3: Family 20* Son: Dad…why does my paper caterpillar toy run backwards? Dad: Do you remember? The Explainer said if your toys moved backwards, you have to swop the side of string at the wheel. Son: Yes, I see. Let me change it.
3.Involvement in their group	Participants got involved in their group and with their families in the TTTA. They shared materials and tools to make the toys with other people, helped others to make the toys, played with the toys with their family and others and shared ideas about the toys with their family and other people in their group.

	Example of expression and conversations **Boy F12:** Mom…dad…let's race the coconut mouse toys. *Conversation 4: Family 38* Brother (teenager): Could I help you sister? I have watched you for a long time. Do you have a problem? Sister: Yes…I can't thread the elastic band through the hole in the middle of the wheel. Brother (teenager): Don't worry. Look at me, thread the elastic band is like this, you have to do it carefully. *Conversation5:* **Explainer:** What do you think about your toy? Girl F5: It is my pet. Tomorrow I will take it to school with me and I want to show it to my friends, my new pet.
4. Engagement with environment and resources	Participants engaged in learning with the exhibition of the traditional Thai toys and played with the collection of old toys. They cooperated enthusiastically with the Explainer and Assistants in the TTTA. They were also interested in the toys handbook that they received from taking part in the activity and were interested in making and playing with the toys that they made in the TTTA. They engaged with all the environments and the resources in the TTTA. *Example of expressions and conversations* Man F35: Look at this…boy. This picture explains the sound from the toys that you are playing with. Woman F51: I like these cartoons. They are playful characters...so captivating.

Conversation 6: Family51

Son: How do I play with the wooden frog

Dad: You have to scrape the wooden stick on the back of the frog? Like this…

Son: Fantastic…dad. How does it work?

Dad: (Read the graphic panel) When you scrape the wooden stick at the back of the wooden frog, the sound will echo inside the stomach of frog and this makes the louder sound.

Conversation7: Family 62

Girl: Mom…I like this book.

Mom: Let me take a look. Yes. There are many details about these toys and pictures.

Girl: Assistant please am I allow me to take this book back home.

Assistant: Yes, sure. I think you (mom) may have to help your daughter learn from this book because some parts of the book talk about scientific principles. It may be difficult for your daughter.

Mom: Thank you so much.

Figure 4.6: Photographs of engagement learning with TTTA

Sources: Traditional Thai toy activities at the National Science Museum, Thailand (February 2012)

Engagement observation summary

The evidence from the engagement observation data and photographs indicate that participants engaged enthusiastically with the TTTA. They understood the purpose and the idea of the activities and succeeded in the goals of the activities through making the toys themselves. They learned from the activities, gained knowledge about science and Thai local wisdom and acquired skills from the activities. They were also involved in their group with family and other people by sharing, helping others, playing with others and having discussions in their groups. Participants also engaged with the environment: the exhibition and the collection of toys, and engaged with all the resources of TTTA: the Explainer, Assistants, materials to make the toys, the toy handbook and the toys that they made in TTTA.

4.3.1.3 Family play-learning observation

From the family play-learning observation (FPLO) adapted from Bandura's (2005) work, I have sought to identify examples of family play-learning level as shown below.

(i)   Level 1 actions: Where one member of the family group initiates a task and acts as a role model. He or she gains the attention of the others as they watch the task unfold

(ii)   Level 2 action: Where another member of the family then begin tasks of their own, guided by the better, more accomplished, more experienced members of the group

(iii)   Level 3 action: Where the 'learner' members of the family gain achievement in their tasks supported by, but largely independent of, their family role models

(iv)   Level 4 action: where learners will try to take what they have learned from the setting and then repeat, adapt and improve on what they have been doing.

Presentation and analysis of data from family play-learning observation field notes

The codes, categories and sub-categories in the analysis of the playfulness observation were illustrated in the Table 3.4 in Chapter 3. I adapted Bandura's (2005) work (family learning actions) into codes, categories and sub-categories in the analysis of family play-learning observation results. These categories required the researcher and the staff of the TTTA to take field-note patterns and themes of the family play-learning observation data during participation in the TTTA. Also, the conversation observed between the participants through short questions asked during the activities will be presented at all levels of the action. The key points of family play-learning observation codes, categories and sub-categories and all results of this observation and conversation are shown below.

1. Attention

'Level 1 action: Where one of the family group initiates a task and acts as a role model. He or she gains the attention of the others as they watch the task unfold'

The observation data showe that most adults in the family groups were interested in the TTTA. They invited their children to join the toy activities to gain knowledge and skills about the toys, scientific knowledge and local wisdom as stated above. Family play-learning began with the exhibition and the collections of old toys. Adults in the family group helped their children to construct knowledge through explaining the

information in the exhibition to them. Also, they guided their children to play with the toys, explained how to accurately play with the toys and how the toys work.

The evidence from the participant observation showed that adults in the family groups enthusiastically learnt the processes of making the toys. They intently watched and listened to all the information about the TTTA and could follow the steps to make the toys. They engaged with the Explainer and the Assistants through questioning when they did not understand some part of the activities. Our observations indicate that most teenagers could follow the steps to make the toys but most children had to wait for the adults to teach them.

However, adults had to learn to make the toys before teaching their children. First, the toys that were provided in the TTTA are rare to see in this day and age. Some adults may have never seen and never constructed them before. This was a new experience for them. Also, these toys have unique steps in their construction. For example, the flying bird, participants have to learn how to weave the palm leaf into a bird-like figure before combining this with a pole. A second example is the paper caterpillar, that begins by folding the paper to make the body of the toy. Thus, adults had to understand things clearly before teaching others.

Second, some families had small children participating in this activity. These children could not follow the processes to make the toys given by the Explainer. However, adults are the main teachers in this group who help children construct and play with the toys.

Conversation of level 1: Attention
Question 1: (For adult)
Observer: What do you think about this activity? (Exhibition, traditional toys, activity and the toy that you made today)
Answer:
Man F17: I think TTTA is very good activity for children, adults and family. The
exhibition provides explanations about science and the local wisdom

related to the traditional toys. The collections of the old toys are rare to find these days and they help me and my children gain more understanding about the toys and how to play with them.

Woman F33: I think children can learn science and local wisdom from this activity. These toys are rare to see nowadays. This is a good opportunity for him to learn Thai culture. As for me, I learned more about science and local wisdom in here. I also learned new skills to make and play with the traditional toys. Also, this activity can bring members of the family together to learn the activity. This activity encourages closer relationships in the family.

Question 2: (For adult)

Observer: Did you learn how to make this toy and how?

Answer:

Man F21: The Explainer and Assistants helped me a lot to learn how to make the toys.

Woman F66: I think the guidebook is very good because it shows steps and details on how to make the toy. I can refresh my understanding by reading this book.

Question 3: (For adult)

Observer: Could you teach your children how to make the toy and how?

Answer:

Woman F38: Yes, I can teach my children to make the toys, but sometimes I forget some steps needed. The Assistants will help me to recognise them.

Woman F44: Oh…at home, I don't have much time for my children. In this activity, I can guide them in making the toys and we have enjoyed playing with the toy together. It is a good time for family.

Figure 4.7: Photograph of level 1 action of family play-learning: Attention

Sources: Traditional Thai toy activities at the National Science Museum, Thailand (February 2012)

2. Retention

'Level 2 action: Where other members of the family begin tasks of their own, guided by the better, more accomplished, more experienced members of the group'.

The observation in this level shows that after adults and young adults understood the process of making the toys, they immediately showed their children how to make the toys step by step using the Explainer's method. They watched their children until they believed that they really understood the methods for constructing the toys, then they allowed their children to make the toys themselves. A woman from family 32 stated that *Children learned from her guidance. She just helped them sometimes.*

On the other hand, some children and teenagers guided and helped the adults to make and play with the toys because they had joined in this activity before when they had

visited the museum with school tours. Most children and some teenagers tended to watch, listen and respond enthusiastically to the adults. Most of them had an eagerness to achieve the toys by their own abilities. So, they tended to conscientiously follow the process demonstrated by the adults to make the toys . When they had a problem, they did not hesitate to ask the adults to repeat the toy-making process again until they understood and ensured that they could make it alone. Some small children, though, did not look and listen to their parents because they complained that it was too difficult for them. They wanted the adults to make the toys for them.

The data from the short questions indicated that most adults felt happy when they helped their children. Also, most children were happy when the adults guided and helped them make and play with the toys. They thought family play-learning was very good, it supported the relationship between all members of the family. Some adults, though, were nervous, when their children did not understand their guidance. They wanted their children to learn to make the toy by themselves.

Conversation of level 2: Retention

Question 1: (For adult)

Observer: How did your children learn to make the toy?

Answer:

Woman F32: They learned with my assistance. I just helped them in some parts of the construction.

Woman F42: My child is a teenager, she could learn from the Explainer but in some parts I guided her.

Question 2: (For adult)

Observer: How did you feel when you helped your children and how about your children's feelings?

Answer:

Man F28: I was happy to teach my son to make the toy. I hope he can make the toys by himself at home. He was so happy to make the toy today.

Woman F50: I tried to help my boy but he sometimes didn't understand me.

Question 3: (For adult)

Observer: What did you think about family play-learning?

Answer:

Woman F50: I think family-play- learning is very good for my family because I can learn about the toys and my children can learn from me. We enjoyed playing with the toys. We had a exuberant time learning about the toys and gained scientific knowledge and local wisdom. It was a great time for the family.

Woman F32: Today three generations of my family joined in the activities. There was grandmother, us (parents) and my children. I was happy when my mother told me about this toy. She helped me teach the children.

Question 4: (For Children and teenager)

Observer: How did you feel when your family (father, mother, grandfather, grandmother, aunt and uncle) helped you how to make this toy?

Answer:

Boy F22: I felt good when my father assisted me in making the toys. He helped me and told me something about this toy that I had never known before. The toys are very exciting, I love them.

Girl F19: Today, I joined the TTTA with my grandfather and grandmother. They helped me to make and play with the toys. They told me that they had made this toy when they were young and they told me the story of the relationship of the toys to Thai culture.

Question 5: (For Children and teenager)

Observer: Can you make the toy and how?

Answer:

Boy F14: Yes, my mom showed me how to make the toy then I understood how to make it, it was not difficult.

Girl F28: Yes, my father was clever to help me to make the toy and he played with the toy very well. I liked to play with him.

Figure 4.8: Photograph of level 2 action of family play-learning: Retention

Sources: Traditional Thai toy activities at the National Science Museum, Thailand (February 2012)

3. Motor reproduction

'Level 3 action: Where the 'learner' members of the family achieve their tasks supported by, but largely independent of, their family role models'.

Observation data indicated that children and some teenagers learned the method of making the toys from adults. They aimed to learn the steps of toy making guided by

the adults. Most of them were able follow the steps until they could complete the toys themselves. Some of them did not understand some steps of the process, so they asked for guidance and help form the adults or the Explainer and Assistants. One participant said that *she understood the method to make the toys. She thought she could make the toys by herself without help from the adults.*

Some young children could not make the toys alone, so the adults had to watch and provide suggestions or give them continuously until the toys were completed.

Most of them could complete the construction of the toys themselves. They also aimed to decorate the toys using their imagination. Some of them proudly showed the toys to the other members of their family or to the Explainer and Assistants.

In this level, adults watched their children make the toys. When they were sure that their children could make the toys alone, they allowed them to do so. Then they returned to their own toys to reconstruct them after they had used them to teach their children. They spent some time beautifying them, so their toys clearly contrasted with the children's toys. Both the children and the teenagers' toys had a variety of decoration.

They spent a lot of time creatively decorating their toys. Most of them created the coconut mouse as some kind of animal, for example a ladybug, buffalo, cat, turtle or dinosaur. As for the paper caterpillar toys, they thought they *looked like snakes or dragons.*

The data from the short questions which were asked of children and teenagers during the TTTA showed that most children and teenagers could make the toys themselves after adults' showed them how. Also, they were very proud to make the toys alone. They think the toys that they made were interesting and exciting because these toys could move like real animals. They also said that *they had never seen these toys before. This was the first time for them to make the traditional toys.*

Conversation of level 3: Motor reproduction

Question 1: (For Children and teenager)

Observer: Could you make the toy by yourself, independent of your families' guidance and how?

Answer:

Boy F61: Yes, I understood how to make and fix the toy by myself. I was able to help my brother make and fix his when it didn't work.

Girl F86: Yes, I could do it. I will make it again to prove my understanding. When I go back home, I will teach my sister to make it.

Question 2: (For Children and teenager)

Observer: What do you think your toy looks like?

Answer:

Coconut mouse toy

Girl F6: I think it looks like a ladybug.

Boy F13: My toy looks like a buffalo.

Girl F16: This is a cat.

Girl F20: I made a turtle.

Paper caterpillar toy

Girl F27: It looks like a snake.

Girl F28: I think it is a dragon.

Boy F79: My toy looks like a caterpillar.

Flying bird toy

Girl F43: I made fish swimming.

Boy F50: This is a bird flying.

Question 3: (For Children and teenager)

Observer: What do you think about this toy?

Answer:

Boy F2: I think it is very interesting.

Girl F36: It can move, it's like an animal, I love it.

Question 4: (For Children and teenager)

Observer: How did you feel when you finished making the toy by yourself?

Answer:

Girl F32: I was so proud when I made the toy by myself and my parents were pound as well.

Boy F60: It was the first time for me to make this toy, I was so happy.

Boy F70: I was proud when I made this toy today because it protects Thai local wisdom.

Figure 4.9: Photograph of level 3 action of family play-learning: Motor reproduction

Sources: Traditional Thai toy activities at the National Science Museum, Thailand (February 2012)

4. Motivation

'Indications of Level 4 action: that the learners will try to take what they have learned from the setting and repeat, adapt and improve on what they have been doing'.

In this level, monitoring of the participants revealed some of their actions, for example repeating or playing with other toys. Some of their behaviour such as adaptation or improvement, were difficult to observe during the activity. So, I used the family's

motivation of learning at home questionnaire to investigate all behaviours in this level again to gain more data when the families went back home.

The analysis of the observation data showed that some participants including children, teenagers and adults asked the Explainer for the materials to make the toys again. Some of them wanted to repeat making them to give to their friends or other people at school or the workplace. Some of them wanted to teach the process of toy making to other people in their home.

After completing the toys, most participants wanted to play with other toys. I observed that they went to the collection of toys to choose other toys to play with in the exhibition area. They were also interested in the traditional Thai toys and looked for other kinds of these toys to play with.

The data from the short questions asked of the participants during the TTTA showed that some participants gained their motivation about the traditional Thai toys after participating in the TTTA and that they wanted to:

- Take the toys to give to other members of the family

- Take the toys to school to make together with their friends

- Talk about the TTTA to the other members of the family, friends, teachers or others people

- Play with the toys with other members of the family at home.

- Adapt them to their work (Teacher teaches students)

- Adapt them to their study (Student make project)

Conversation of level 4: Motivation

Question 1: (For Children and teenager)

Observer: If you had materials to make the toy, would you want to make this toy again?

Answer:

Boy F33: Yes, I would like to make the toy again for my brother and we will play with the toys together.

Little boy F47: No, because some toys are too difficult for young children to make alone.

Question 2: (For Children, teenagers and adults)

Observer: When you go back home what will you do about this toy or this activity today?

Children and teenagers' answer:

Girl F5: I will talk about it to other people.

Boy F13: I will take this toy to others at home.

Girl F17: I will make this toy again because you gave me the materials to do so.

Boy F24: I will play with the toy with other people at home.

Girl F34: I will take this toy to school and play with it with my friends and teachers.

Adults' answer:

Woman F21: I will talk about this activity and this toy to others.

Woman F33: I will teach others how to make the toy.

Woman F39: I will play with the toy with my children at home.

Woman F46: I will take this toy to teach my students at school.

Figure 4.10: Photograph of level 4 action of family play-learning: Motivation

Sources: Traditional Thai toy activities at the National Science Museum, Thailand (February 2012)

Family play-learning observation summary

The evidence from family play-learning observation data and photographs indicated that family play-learning behaviour follows Bandura's (2005) social cognitive learning theory (family learning) that the   more experienced members of a family (adults) learn the activity from others (Explainer) and impart this experience of learning to younger members as learners of the family. After the learners learn this experience, they can complete the task alone that is (make and play with the toys). The last level indicates that most participants had motivation to learn more about the toys activities at home. However, the finding has interesting results in that that the experienced members of the family are not only adults, but are also children or teenagers who can teach and help the adults as learners in the family because they (the younger members) gained experience when they previously visited the museum and joined in these activities. It is to be noted that the family play-learning process does not only flow downward from adults to children but can also be an upward learning process.

4.3.2 The bi-gnostic interview

The bi-gnostic interview aims at contributing answers to the second research question: To what extent do traditional Thai toy activities influence family bi-gnostic learning? The data from this interview helped support the results of TLOQ in the section science learning' and 'attitudes towards local wisdom'. This interview was used in order to obtain deeper insights into the topic which is being investigated. I focused my attention on collecting more detailed information from the volunteer family group participants (children, teenagers and adults) and the staff of the TTTA. The qualitative analysis of the data of this interview was carried out using the three major categories of interview questions which focused on: (1) awareness of modern Western science, (2) awareness of traditional Thai culture and local wisdom, and (3) the important relationship between Western science and traditional Thai culture and local wisdom. The categories were induced from the interview data and the interview questions (Mile and Huberman, 1994). After having read the interview transcripts several times and checking my field notes, I developed a preliminary list of codes, categories and sub-categories drawn out from categories used for the analysis of the bi-gnostic interview. The main codes, categories and sub-categories are shown in Table 3.5 in Chapter 3. The bi-gnostic interview was used to conduct an interview in February 2012 There were 20 people consisting of 5 children, 5 teenagers, 5 adults participants and 5 staff (Gender breakdown; 9 males and 11 females; education: Primary school 5 people, Secondary school 2 people, High school 3 people, Bachelors' degree 7 people and master's degree 3 people) they were chosen after they had participated in the TTTA.

Presentation and analysis of data from bi-gnostic interview

The codes, categories and sub-categories of bi-gnostic interview follows three major themes of interview with ten questions of bi-gnostic learning from the TTTA about the learning of science and local wisdom. The relevant transcript data, which evolved from the answers given by the participants and staff of TTTA, also reflects the theoretical background of the study and the research questions. Also, the common threads and differences will be highlighted during the analysis of the results. The key points of the bi-gnostic interview's codes, categories, sub-categories, the answers to the interview questions and the conversations were as follows:

Table 4.11: The results of bi-gnostic interview

Topic	Results of bi-gnostic interview
1. Awareness of Western modern science	All of participants had awareness of Western modern science. They strongly agreed that the TTTA encouraged them to learn more about scientific knowledge after they joined the activities. They thought that the TTTA inspired them to study more about science. They also believed that scientific knowledge is very important to study because scientific knowledge supports the development of the country and scientific knowledge can explain nature's phenomena and everything around them.
	1.1 More understanding about scientific knowledge **Example of expressions:** "The Explainer helped me to learn about the science inside the toys. Also, the exhibition and the collection of these toys gave me more understanding about scientific knowledge. The toys handbook provided much knowledge about these toys and the relevant scientific knowledge. I liked the cartoons in the handbook and the exhibition." (INT 6/ATW1.1) "I think that not only children gained more understanding about science from this activity, but also, we the (parents) learned more science from this toy. I have never known this before because I graduated with an Art degree. I was surprised that a little toy could teach science. I think my children gained more understanding about science from the Explainer, the facilities in this area and from me because I helped them to learn following the Explainers' lead." (INT 4/ATW1.1)

	1.2 Inspiration to study more science
	Example of expressions:
	"This activity motivated our family to learn science from the toys. My children liked this activity very much because they could make the toys by themselves and learn science from the inside of the toys." (INT 9/ATW1.2)
	"We tried to encourage participants to learn science from the TTTA. I think they gained more knowledge about the science inside these toys. I believe that many children will be inspired to learn science and also, their parents will be aware of the scientific knowledge around their children. Then, adults will encourage their children to learn science. As for me, when I lead this activity, I think, I want to learn more about science in many areas because it will benefit my career." (INT 19/ATW1.2)
	1.3 The importance of scientific knowledge
	Example of expressions:
	"Science is one of the main subjects that I have to study. I think, it is important because scientific knowledge helps us to develop our country." (INT 10/ATW1.3)
	"Science and technology help us to understand everything around us because science is around everybody." (INT 2/ATW1.3)
	"I think it is very important for children and adults learning, because scientific knowledge can help people to understand many things around them and lessen their misunderstandings. For example, many people in Thailand are overwhelmed with supernatural beliefs. I think, scientific knowledge can explain these phenomena. As for me,

	I teach my children about reasoning and cause and effect that are the basics of science." (INT 13/ATW1.3)
2. Awareness of traditional Thai culture and local wisdom	All of interviewees had an awareness of the importance of traditional Thai culture and local wisdom. They strongly agreed that TTTA encouraged them to learn more about traditional Thai toys, traditional Thai culture and local wisdom after their participation in the activities. Most of them thought that the TTTA inspired them to study more about traditional Thai culture and local wisdom because TTTA are very interesting activities including the unique exhibition, the rare toys, the enthusiastic Explainer and the friendly Assistants that encouraged participants' learning. For these reasons, they also thought that the traditional Thai culture and local wisdom are very important for learning and for conserving for the next generation.
	2.1 More understanding about traditional Thai culture and local wisdom **Example of expressions:** "I was very interested in these toys. Many of the toys, I had never seen before and this was the first time for me to make the traditional toys. It was not difficult but also not easy because the making of the toys employed a unique method. For example, on this day, I made the flying bird where I had to learn how to weave the palm leaves using the traditional method and combining them with the string. Then, I gained some scientific knowledge about gravity and friction. The Explainer helped me to understand traditional Thai culture and local wisdom because she talked about traditional Thai culture and local wisdom relating it to wickerwork toys." (INT 11/ATT2.1)

"I and my children have learnt more about local wisdom. The first thing, we found in this area, was a beautiful exhibition and many traditional toys as well. I had seen some of the local toys but I had never seen so many old toys displayed there. They are rare to find nowadays but the science museum collects them. I think, it is useful for young children to learn about traditional toys and ancient Thai culture. The Explainer, was very good, she explained the activities very clearly. My children and I gained understanding and we were playful with her during the activities. The Assistants willingly helped us to make the toys. They are lovely." (INT 7/ATT2.1)

2.2 Inspiration to study more traditional Thai culture and local wisdom

Example of expressions:

"Traditional Thai toys are rare to find and the TTTA taught me about science and local wisdom something I couldn't find in any other place. The Explainer introduced me to the knowledge and understanding of traditional toys and Thai playthings from the past. The activity inspired me to study more about Thai culture and local wisdom." (INT 5/ATT2.2)

"I think the TTTA are good activities that can encourage participants to learn more about local wisdom and Thai culture from the toy making process. This was a good opportunity for children and young people to learn Thai culture and local wisdom which most of them had never known before. If these activities are put into the curriculum of the schools, it will be very good. I think many children would be more aware about local wisdom and they would be inspired to do further study." (INT 3/ATT2.2)

	2.3 The importance of traditional Thai culture and local wisdom
	Example of expressions:
	"I think traditional Thai culture and local wisdom were created by ancient Thais over a long period of time. They collected their knowledge and experience for many years and transferred it from generation to generation. This is a good thing. I think it is very important." (INT 4/ATT2.3)
	"One of the purposes of this activity, was for our visitors to gain awareness about traditional Thai culture and local wisdom from the TTTA. Yes, it is very important for Thai society because nowadays, many Thai people do not recognise traditional Thai culture and local wisdom because of the influence of Western modern science. Especially, the younger generation, who are very unaware of their own culture. This is a good opportunity to introduce them to this knowledge." (INT 17/ATT2.3)
	2.4 Conservation of traditional Thai culture and local wisdom
	Example of expressions:
	"It is the same reason as the previous answer because traditional Thai culture and local wisdom have a value in and of themselves. They are hard to find and some of them are lost to us. I think we have to conserve them which means we should conserve traditional Thai culture and local wisdom. " (INT 6/ATT2.4)
	"Traditional Thai culture and local wisdom is very important for Thai society because nowadays, other cultures could overwhelm our culture, if we do not conserve it will be lost or become mixed with other cultures. Then it would not be a true Thai culture. The TTTA is a good media with which to teach people to conserve traditional Thai culture and local wisdom." (INT 9/ATT2.4)

3. The importance of, and relationship between, Western science and traditional Thai culture and local wisdom	Some participants thought that scientific knowledge is more important than Thai local wisdom. They thought that scientific knowledge could encourage the development of Thailand. Also, science and technology provides more conveniences for people in everyday life than local wisdom does. Some interviewees believed that scientific knowledge had equal importance with traditional Thai culture and local wisdom. Some participants strongly agreed that scientific knowledge supports local wisdom. In some situations scientific knowledge supports local wisdom, whereas, in some cases local wisdom is the base of scientific knowledge. Also, some participants thought that scientific knowledge and traditional Thai culture and local wisdom should develop and merge together.
	3.1 The importance between scientific knowledge and traditional Thai culture and local wisdom **Example of expressions:** "Scientific knowledge is more important than traditional Thai culture and local wisdom because science and technology is around us and helps us in everything in everyday life." (INT 1/IR 3.1) "I think scientific knowledge and local wisdom are equal. Scientific knowledge is equal in importance with traditional Thai culture and local wisdom because Thai local wisdom is the base of Thai society. Our country has developed from previous Thai local wisdom and Thai local wisdom is suitable for the Thai community and our environment. Whereas, science and technology are important in the development of the country as well as other countries." (INT 3/IR 3.1)

"Equally, Scientific knowledge is important to develop Thai people and our country. However, traditional Thai culture and local wisdom is the base of Thai society because Thai local wisdom has developed from our community and is suitable for Thai people. Also, many people in the county side still use local wisdom in their daily life because it suits them more than modern science. I think, it depends on people to make their choice." (INT 18/IR 3.1)

3.2 The relationship between scientific knowledge and

  traditional Thai culture and local wisdom

Example of expressions:

"Traditional Thai culture and local wisdom is the first base for Thai people and scientific knowledge will support Thai local wisdom." (INT 11/IR 3.2)

"Scientific knowledge will support Thai local wisdom for example scientific knowledge helps people to better develop things such as agriculture and animal husbandry." (INT 9/IR 3.2)

"It depends on the situation. In some cases scientific knowledge supports Thai local wisdom such as agriculture and irrigation. Whereas, in other cases Thai local wisdom supports science such as textiles and pottery that is displayed in the gallery because local wisdom is the base of the scientific knowledge. Scientific knowledge was developed from local knowledge. It is difficult to highlight one over each other." (INT 18/IR 3.2)

	3.3 The development of both, scientific knowledge and traditional Thai culture and local wisdom
	Example of expressions:
	"I think each type of knowledge should develop in its own way. Scientific knowledge and Thai local wisdom should be separate because they are different. Scientific knowledge is about science and technology and Thai local wisdom is the knowledge of local people. They should not integrate together but each type of knowledge could support each other. " (INT 1/IR 3.3)
	"They could develop together. I joined the TTTA and studied the traditional Thai technology gallery. I think if we provided scientific knowledge to support the local wisdom and develop Thai traditional technology, it would be good." (INT 13/IR 3.3)
	"I think they could be developed together, because modern science was developed by scientists who did research that was proven by an international organisation. Thai local wisdom is suitable for our environment and community. If we develop both types of knowledge together, this may be useful because scientific knowledge will encourage the development of local wisdom such as local textiles or wickerwork. However, some local wisdom may be the base for scientific research, for example medicine." (INT 19/IR 3.3)

Bi-gnostic interview summary

The evidence from the bi-gnostic interview data indicated that participants have an awareness of Western modern science. They strongly agreed that the TTTA encouraged them to learn more about scientific knowledge and Thai local wisdom (bi-gnosis) after joining in the activities. They also thought that the TTTA inspired them to study more about scientific knowledge and Thai local wisdom. They thought that

TTTA were very interesting activities including the unique exhibition, the rare toys, the enthusiasm of the Explainer and the friendly Assistants that encouraged their learning. Participants also thought that the traditional Thai culture and local wisdom were very important to learn and conserve for the younger generation.

The interview data also show that some participants though that scientific knowledge is more important than Thai local wisdom and should be kept separate from local wisdom. They thought that scientific knowledge encourages better development of the country and provides more conveniences for people in their everyday lives than local wisdom. Both types of knowledge should be kept separate from each other. They should not be integrated. Each form of knowledge should develop in its own way but they could support each other.

Some interviewees think scientific knowledge has equal importance with Thai local wisdom. Some participants strongly agreed that scientific knowledge supports local wisdom and some of them argued that the strong points of both types of knowledge depend on the specific situation. In some situations scientific knowledge supports local wisdom, whereas in some cases local wisdom is the basis of scientific knowledge. Some interviewees strongly agreed that scientific knowledge and Thai local wisdom should develop together. They thought that both types of knowledge are very important for the development of the country.

4.3.3 Documentary analysis from the photographs

This research uses photographic data analysis to provide guided insights and characterisations of the TTTA. I took the photographs whilst participating in the TTTA as an observer. Before I took the photographs, I asked permission from all participants. They were all willing to be photographed by me because they understood the purpose of these activities as being the part of my research. Also, all the families were enthusiastic about joining in these activities because the toys fascinated them. They took pleasure in participating with us in all steps of the TTTA and the conducting of the research. After the activities, I selected the relevant images that illustrated the places, people and actions that supported the answers of the research

questions. I was aware of the validity, reliability and bias of selecting these photos, so I and the staff of the TTTA discussed and worked together to pick out the most relevant images to be used as the photographic data of this research.

The photographic data of this investigation was separated from the aim of this study and divided into seven categories which include:

1. The environment: traditional technology gallery, traditional Thai toys exhibition and the collection of old toys

2. The resources: toys' materials, toy handbooks, an Explainer and Assistants and the toys in TTTA

3. Participants character: playfulness and enthusiasm

4. Engagement: participants' engagement with the TTTA

5. Family play-learning: family play-learning in the TTTA

6. Traditional Thai toy activity: atmosphere of the activities

7. Toy learning outcomes: participants' learning at the TTTA

As the evidence of bi-gnostic learning and the families' motivation for learning at home could not be presented with photographs because bi-gnostic learning results were carried out from the interview and the families' motivation for learning at home questionnaire was conducted at the homes of the participants; I will present photographs for only seven of the themes of investigation as above.

Presentation and analysis of data from the photographs

These photographic data illustrated the atmosphere of the gallery and the activities; the exhibition and the collections of the traditional Thai toys; participants' behaviour whilst participating with TTTA; the working of the Explainer and Assistants and the level of family-learning. These photographs are also evidence supporting the finding of those questionnaires, observations and interviews. All of the relevant photographs of the TTTA have been presented below:

1. The environment: traditional Technology gallery, traditional Thai toys exhibition and the collection of old toys

Figure 4.11: The environment at the TTTA
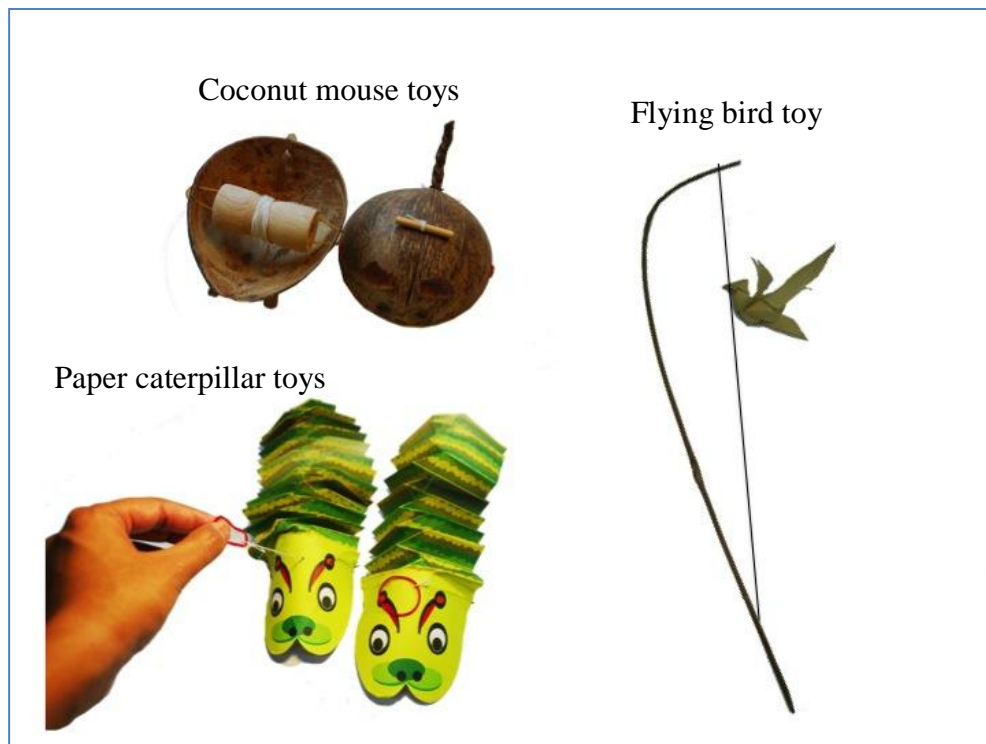

Sources: Traditional Thai toy activities at the National Science Museum, Thailand (February 2012)

The environment of the TTTA as shown in Figure 4.11 above, the four small photos show all the environments of these activities. The pictures illustrate the exhibition of the traditional Thai toys that included the history of these toys, the science illustrated inside them, clear pictures of toys' working and the cartoon characters that fascinated visitors who joined the activities. Moreover, the exhibition provided collections of old toys for participants to play with and learn about before and after the TTTA. Also, the photos show the facilities of the TTTA such as the wooden tables and the benches that are in the Thai cultural style; the position of the exhibition, toy collections, the Explainer's desk and all tools and the materials needed to make the toys. These photos present clearly the atmosphere of the TTTA for example: the traditional Thai atmosphere, how family participants join the TTTA and how the staff of the TTTA worked with participants.

2. The resources: Toys' materials, toy handbook, Explainers and Assistants and the toys in the TTTA

Figure 4.12: Resources provided for participants in the TTTA

Sources: Traditional Thai toy activities at the National Science Museum, Thailand (February 2012)

Figure 4.12 illustrates the resources of the TTTA, which were offered free to all participants. They include the tools, materials to make the toys, toy handbooks, Explainers and Assistants. The materials to make the toys were presented in packets for each person and the tools were divided into sets for sharing. One toy handbook was provided for each family for the purpose of encouraging family learning at home with the adults' teaching to their children. This figure also shows the task of the Explainer and the Assistants in these activities. The Explainer led the activities from the front of the room and the Assistants provided help and consultation when necessary for each group of participants as shown in the picture bottom left.

Figure 4.13: The toys in the TTTA

Sources: Traditional Thai toy activities at the National Science Museum, Thailand (February 2012)

There were three traditional Thai toys used for family play-learning with the TTTA in Figure 4.13 including the coconut mouse toy, the paper caterpillar toy and the flying bird (wicker work toy). The coconut mouse and the paper caterpillar are the same group of toys using the spring principle but with a different method of construction. The coconut mouse is made from a coconut shell, an elastic band, a wooden or clay wheel, string, a small bamboo stick, and the ears and tail of a mouse (made from natural materials). Participants who made it followed the Explainer easily and decorated it imaginatively when they finished. As for the paper caterpillar, the materials to make it are almost the same as the coconut mouse except for the body section. To make the paper caterpillar, participants had to learn how to fold the wavy body before they could construct it. This toy is more complicated than the coconut mouse toy but not too difficult. The flying bird is one of the gravity toy groups. It is made from the wickerwork of a palm leaf so it is the most complicated of the toys when compared with the others but it is not difficult for adults, teenagers or some

children to make it. I designed the three levels of toys for the TTTA with the purpose of studying about family play-learning in different situations and the results have been shown above.

3. Participants character: playfulness and enthusiasm

Figure 4.14: The character of the participants

Sources: Traditional Thai toy activities at the National Science Museum, Thailand (February 2012)

Figure 4.14 illustrates participants' playful character during their participation in the TTTA. This figure comprises two photos of participants' playfulness. The first picture on the left shows children preparing to race paper caterpillars after they had completed making the toys. They enjoyed playing with the toys with their new friends and a member of their family (sister and brother). Also, the photo on the right illustrates the playful character of a family while the parents were showing their son how to make the coconut mouse. The mother aimed to help their child to make the toys while the father made the toy himself with a playful smile on his face. As stated, during the playfulness observation, these families were willing to join the TTTA and spent their time learning how to make and play with these toys in the TTTA zone.

4. Engagement: participants' engagement with the TTTA

Figure 4.15: Participants engage with the TTTA

Sources: Traditional Thai toy activities at the National Science Museum, Thailand (February 2012)

Two photos of families' engaging with the TTTA are shown in Figure 4.15. The photo on the left illustrates mother and son occupied with making and playing with the flying bird toys. The mother is demonstrating to her son how to play with the toy. When her son completed it, he tried to look and play with the toy himself. In the right-hand picture, the father is giving guidance and teaching his daughter how to bind the string with the wheel to make the paper caterpillar. The girl watches intently and tries to bind the string following her fathers' guidance. These photos are an example of family participation with the TTTA and shows how families play-learn with the toy activities.

5. Family play-learning: family play-learning in the TTTA

5.1. Attention

Figure 4.16: Level one of family play-learning (Attention)

Sources: Traditional Thai toy activities at the National Science Museum, Thailand (February 2012)

Figure 4.16 presents the first level of family play-learning (Attention) where one of the family groups initiates a task and acts as a role model. He or she gains the attention of the others as they watch the task unfold'.

This figure includes three photos that separate the action of adults, teenagers and children during participation in the TTTA. The first picture shows an adult (mother) in the family listening intently and watching the steps to fold the paper body of the caterpillar toys as demonstrated by the Explainer. Her son watches the Explainer demonstration. As for the teenagers (the second photo), in this level, some teenagers could follow the Explainer's guidance. They tried to fold the body of the paper caterpillar. Children in the photograph three do not seem to be interested in watching or listening to the Explainer. They are waiting for the adults to help them make the toys after the adults understand and can make the toys themselves. The adults in this picture have every intention of learning how to make the paper caterpillar and of allowing their children sit beside them.

5.2. Retention

Figure 4.17: Level two of family play-learning (Retention)

Sources: Traditional Thai toy activities at the National Science Museum, Thailand (February 2012)

The photos of the second level of family play-learning (Retention) are shown in Figure 4.17. This level describes , 'when another member of the family begin tasks of their own, guided by the better, more accomplished, more experienced members of the group'.

After the adults in the family group have learned from the Explainer, how to make and play with toys at level one, their intention is to guide and teach their children to make and play with the toys. The first picture on the left shows two adults (fathers) from another family, were helping their daughter to make the paper caterpillar and one grandmother standing beside them to watch the family make the toys. Some teenagers in this level asked for guidance from the adults. Picture two (Middle) illustrates a mother guiding her teenage son to fold the body of the paper caterpillar. Also, the children in this level need some assistance from the adults. In picture three on the right a boy learns how to construct the coconut mouse with help from his mother. He is pulling the string from the body of the toys and trying to bind it. His mother sits beside him and watches how the boy makes the toy.

5.3. Motor reproduction

Figure 4.18: Level three of family play-learning (Motor reproduction)

Sources: Traditional Thai toy activities at the National Science Museum, Thailand (February 2012)

Figure 4.18 presents the third level of family play-learning ((Motor reproduction) when 'the learner' members of the family achieve their tasks supported by, but largely independent of, their family role models'.

After the adults helped their children to make and play with the toys and ensured that their children could make the toys themselves, adults returned to their own toys in order to make and decorate them while allowing their children to make the toys alone.

The two photographs on the left show adults returning and completing their own toys after they had given their children guidance. In these pictures, all adults planned to construct and decorate the toys without their children. As for teenagers and children in this level, the results were the same, they could also make and decorate the toys alone without their parents' guidance because they understood the process of toy making having learned from the adults.

The second photo in the centre shows young people completing the paper caterpillar by themselves the same as the girl in the third photograph on the right, she is decorating the coconut mouse toys alone after she had finished their construction.

5.4. Motivation

Figure 4.19: Level four of family play-learning (Motivation)
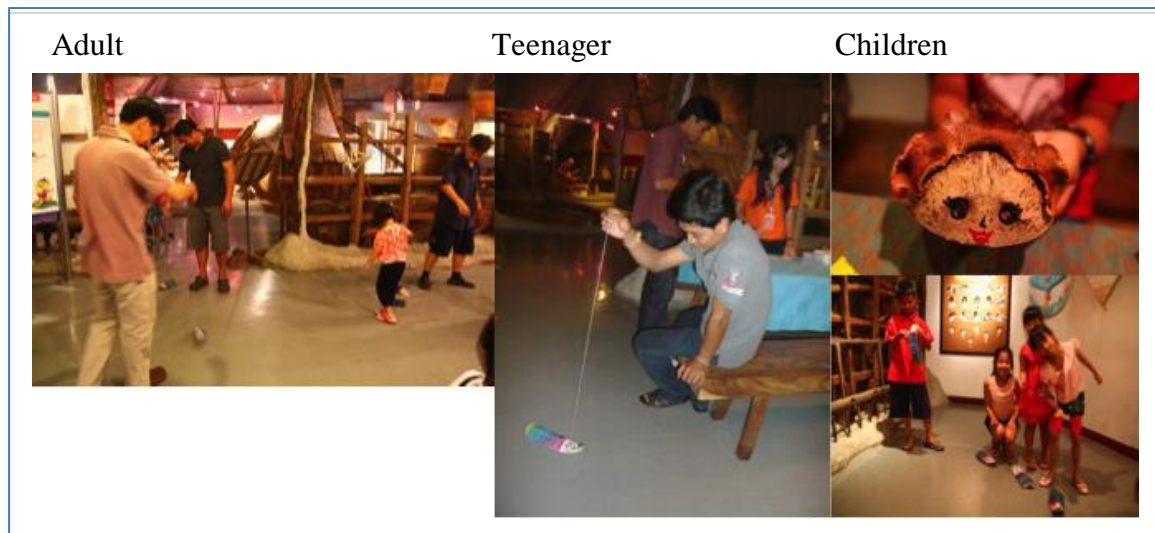
Sources: Traditional Thai toy activities at the National Science Museum, Thailand (February 2012)

The last level of family play-learning in Figure 4.19 indicated a level 4 action: that is 'the learners will try to take what they have learned from the setting and repeating, adapting and improving on what they had been doing'.

In this level, most participants play with their toys with their family or with new friends.

The first photos on the left show adults playing with the toys with other adults and their children after having finished the toy activities. The second photo in the middle shows a young man playing with the toys with his brother behind him. The last two photographs on the right show the toy that one girl made again after she had finished the first one and the picture in the bottom, children playing with the toys with their friends and members of the family group.

Some participants especially children and teenagers wanted to make the toys again and show the new toys to the staff and their family. Some of them wanted to play with others toys in the toy collection gallery. Some participants ask the staff for the materials to make the toys at home.

6. TTTA: the atmosphere of the TTTA

Figure 4.20: The atmosphere of the TTTA

Sources: Traditional Thai toy activities at the National Science Museum, Thailand (February 2012)

The atmosphere of the TTTA in Figure 4.20 illustrates the participants' engagement while learning the activities. They are following the processes of the making and playing activities demonstrated by the Explainer and the Assistants. They desire to

make the toys themselves and get involved in their groups (see two photographs above). Two photographs below illustrate what families learned from the exhibition and the collection of old toys at the TTTA which helped to provide the information about the scientific knowledge and local wisdom related to them. In the first photo a mother is playing with the toys and reading the information at the exhibition We also see a father and his daughter playing with the toys and daughter talking about the toys that she has in her hand, with her father. This figure assumes that families are interested to learn at the exhibition and with the collection of toys. The second photo on the right shows two girls who are also interested in playing and learning with the collection of toys in the exhibition area.

7. Toy learning outcomes: participants' learning at the TTTA

Figure 4.21: Participants and their toys that were made in the TTTA

Sources: Traditional Thai toy activities at the National Science Museum, Thailand (February 2012)

The results of the toy learning outcomes with the TTTA show that TTTA encourages positive attitudes towards Thai wisdom and science learning for family participants. Figure 4.21 cannot show all the learning, stimulation and the development of the themes as stated in the results of TLO questionnaire but these figures present the products of the participants' learning through the make and play activities; that is the completed toys.

Both photos illustrate families and members of families and their friends who participated with the TTTA, showing the toys that they had made themselves from the processes they had learned during the make and play activities used to learn science and local wisdom in the TTTA. So, these photos assume that participants gain more learning about the toys. Also, the TTTA stimulated knowledge, understanding, attitudes, values, enjoyment, inspiration and creativity and it helped to develop many skillful actions, behaviour and progress of participants.

Conclusion

The analysis of all research instruments data showed the positive results of this research. The summary of all questionnaire data indicated that families are playful during participation with the activities. They also gained all learning outcomes from the TTTA and developed the motivation to learn more about the toy activities at home. All observation data showed that families exhibited enjoyment with the activities, their family and other people at TTTA. Most participants were obviously engaged with the toy activities. Also, family play-learning observation data indicated that family play-learning's behaviour follows Bandura's (2005) social learning theory; that more experienced members of a family learn the activities from others and pass on this experience of learning to younger members as learners of the family. After the learners acquired this experience, they could complete the task alone. The last level indicated that most participants had the motivation to learn more about the toy activities at home. However, family play-learning processes not only filter downwards from adults to children but there is also an upward movement. The data from the bi-gnostic interviews indicated that participants gained knowledge and understanding about scientific knowledge and Thai local wisdom (bi-gnosis) through the TTTA. They thought both types of knowledge were very important and they gained an awareness of the need to conserve Thai local wisdom. Some participants had different perceptions about the integration of the two forms of knowledge. Some suggested separating them while others suggested an integration of both types of knowledge. As stated above these are the positive results to answer the research questions and more details of discussion and conclusion will be shown in Chapter 5 below.

CHAPTER 5
DISCUSSION, CONCLUSION AND FURTHER WORK

"Children can learn science and local wisdom from this activity. It is rare to see these toys nowadays. This is a good opportunity for them to learn about Thai culture. As for me, I have learned new skills by making and playing with the traditional toys. Also, this activity can bring family members together while learning these activities. This activity encourages close relationships within the family" (Mother F33).

5.1 Introduction

The aim of this study was to investigate family play-learning, learning outcomes, bi-gnostic learning and factors that encourage family play-learning in terms of the following research questions:

1. What family play-learning and learning outcomes can be achieved through traditional Thai toy activities in a science museum?

2. To what extent do traditional Thai toy activities influence family bi-gnostic learning?

3. How does learning with traditional Thai toys affect the relationship between participants' character and engagement, the environment and resources?

4. Can the model hypothesis of family play-learning through traditional Thai toy activities effectively be used to monitor family play-learning?

This research focused on two main themes which included family play-learning in a science museum and bi-gnostic learning. As stated in Chapter 1, current international literature discusses family learning in museums, yet does not emphasise family play-learning with toy activities at a science museum. Furthermore, there has only been a small amount of literature about bi-gnostic learning and that which does exist tends to discuss the similarities and differences between local indigenous knowledge and Western science (e.g. Aikenhead, 2001; Cajete, 2000; Hammond & Brandt, 2004; Michell, 2005; Snively & Corsiglia, 2001; Stephens, 2000). Bi-gnostic learning is

however accepted as a particular style of learning in countries such as, Canada, America, Australia and New Zealand (Cajete, 2000; Kawagley, 2000). Bi-gnostic learning in this study refers to a learning style with access to both scientific knowledge and local wisdom as distinctive knowledge systems that are provided within one activity at a science museum in Thailand.

This unique research has generated initial studies which include family play-learning in a science museum and bi-gnostic learning that emphasises scientific learning and local wisdom. However, the principle focus of this study is on family play-learning at a science museum and the outcomes of that learning which emphasises bi-gnostic learning.

One of the most important educational policies in Thailand aims to encourage informal science education through the support of more than 20 science and technology centres, the National Science Museum and other informal science environments around Thailand. The target group for this informal science education policy focuses on families, parents and other carers to share intellectual curiosity with their children to learn about science in informal environments (The National Science Foundation, 2001). Another important educational policy aims to encourage scientific and technological knowledge and skills, and knowledge about culture, local wisdom and the application of that wisdom in formal, non-formal and informal education (Office of the National Education Commission, 2002). Thus, this study is consistent with two major government policies for education which aim to encourage family learning in informal settings and the learning of science and Thai local wisdom.

As stated in Chapter 3, the purpose of all questionnaires, participant observations and bi-gnostic interviews was to achieve better insight and understanding of family play-learning, learning outcomes and factors that support family play-learning. Data obtained by the different methods indicated that family play-learning is inter-generational learning; that adults or more experienced members of the family group encourage their children to gain knowledge and skills with make and play activities through guidance, teaching and helping children to learn and gain outcomes of

learning from the activities. Family play-learning outcomes from the activities show that families appear to have learned most in relation to both 'Thai local wisdom' and 'scientific knowledge' when compared with the wider themes of toy learning outcomes. The data indicated that families developed skills, actions, behaviour and made progress and that the TTTA also stimulated knowledge, understanding, attitudes, values, enjoyment, inspiration and creativity within the family. Evidence derived from these methods strongly suggests that all environments and resources provided in the TTTA were appropriate and conducive for supporting family play-learning with toy activities at a science museum. Figure 5.1 illustrates the model hypothesis of this study that includes the following:

     1. Context of family play-learning

        - Personal

        - Social

        - Setting

     2. Conditions of family play-learning

        - Opportunity

        - Disposition

     3. Make and play activities

     4. Learning outcomes from the activities

The model hypothesis was adapted from the interactive experiences model and the contextual model of learning of Falk and Dierking (1997; 2000) to describe the context of visitors' learning in the museum. The interactive experience model illustrates the three interacting spheres, each representing one of three contexts including the physical context for museum experience, personal context that visitors perceive the world through their own personal and social context when they share various experiences with other people during visits to the museum (Falk and Dierking: 1997). The contextual model of learning (Falk and Dierking: 2000) explains learning in the museum as a free choice. Learning occurs while exploring the exhibitions or participating with the activities within the museum context. Learning depends on personal motivation to become involved in the museum. The contextual model of learning suggests that learning will be influenced through three overlapping contexts

which include the personal, the sociocultural and the physical contexts. Falk and Dierking (2000) also suggested that 'Learning can be contextualised as the integration and interaction of these three contexts' (p.13).

I adapted these two models to explain the context of family play-learning. It is free-choice learning when participants volunteer to join the TTTA to gain knowledge and understanding from their personal contexts including their motivations and interest to engage with the toy activities. According to the social context, families developed social collaborations with other family members during participation within the TTTA. This learning process occurred in the activity area in a science museum as the physical context. The museum provided a supportive environment and resources to make toys and play activities a conducive and appropriate setting for participants' learning.

Following the model as part of the condition, for make and play activities and learning outcomes, I adapted two zones of the play model (Kanhadilok and Watts: 2012c) to explain conditions of play. It depended on the opportunity to play (Zone 1 and Zone 2) and the deposition (playfulness). Make and play activities with the TTTA at the science museum and the learning outcomes from the TTTA include toy learning outcomes, bi-gnostic learning and the families' motivation for learning at home. The details of this model are further explained in the answer to the research question in this chapter.

Figure 5.1: The model hypothesis of family play-learning with TTTA
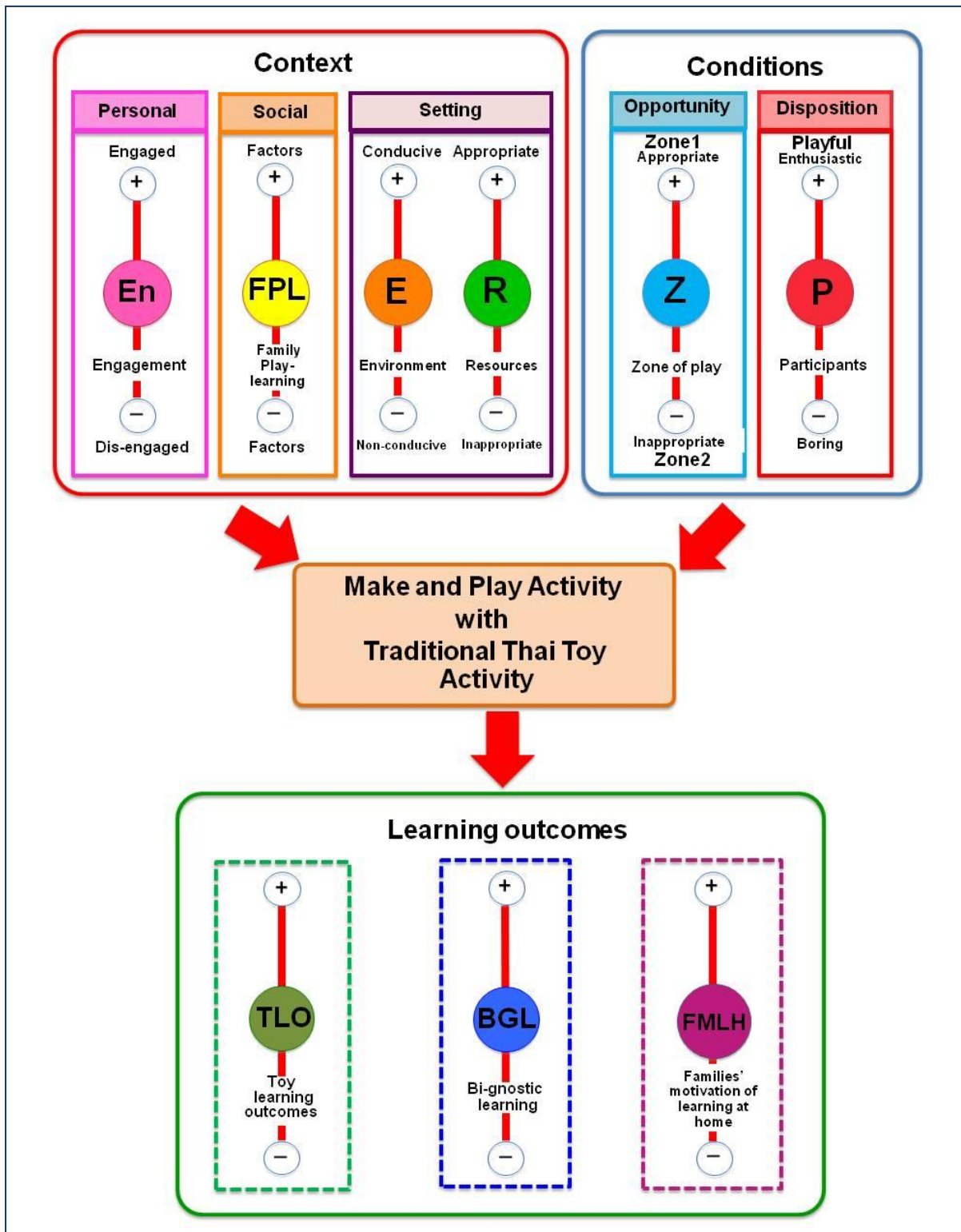
Source: Adapted from Falk and Dierking (1997: p.5 and 2000: p.12) and Kanhadilok and Watts (2012c: 882)

Data analysis procedures for this research used numerical analysis to analyse descriptive quantitative data. Also, content analysis, interpretative analysis and documentary analysis were used to describe the qualitative data. Methods used to gather data, the main outcomes of data analysis related to each of the research questions used to frame this study in Table 5.1 below.

Table 5.1 Summary of data collection methods and main outcomes of data analysis in relation to each research question

Research questions	Methods used for data collection	Main outcomes of data analysis
1. What family play-learning and learning outcomes can be achieved through traditional Thai toy activities in a science museum?	*Descriptive Quantitative data* - Playfulness questionnaire - Toy learning outcomes questionnaire - Families' s motivation of learning at home questionnaire *Interpretative Qualitative data* -Family play- learning observation - Playfulness observation - Engagement observation -Photographic evidence	-Family play-learning resonables inter-generational learning where more experienced members of the family transfer their knowledge and skills to children. There also is an upward transfer of knowledge and skills from young to old. - Learning outcomes from TLOQ indicated that TTTA provided the opportunities for learning through play. TTTA stimulated knowledge, understanding, attitudes, values, enjoyment, inspiration and creativity to participants. It also developed skills, actions, behaviour and progression and encourage 'Bi-gnostic learning'.
2. To what extent do traditional Thai toy activities influence family bi-gnostic learning?	*Descriptive Qualitative data* - Bi-gnostic interview	- TTTA encouraged family bi-gnostic learning. Families gained bi-gnostic knowledge and had a positive attitude toward Western science and Thai local wisdom after participating with TTTA.

3. How does learning with traditional Thai toys affect the relationship between participants' character and engagement, the environment and resources?	*Descriptive Quantitative data* - Playfulness questionnaire - Toy learning outcomes questionnaire - Families' s motivation of learning at home questionnaire *Interpretative Qualitative data* - Family play-learning observation - Playfulness observation - Engagement observation - Photographic evidences	- Factors that support family play-learning with TTTA: 1) Participants' character (playfulness) 2) Traditional Thai toys (TTT) 3) Participants' learning of engagement 4) Environment 5) Resources in the activity Encourage bi-gnostic learning as participants learned scientific knowledge and local wisdom, Developed many skills from TTTA such as physical, communication, emotional, intellectual and social skills.
4. Can the model hypothesis of family play-learning through traditional Thai toy activities effectively be used to monitor family play-learning?		-Model hypothesis of family play-learning can be used to explain family play-learning with TTTA

5.2 Research question 1

What family play-learning and learning outcomes can be achieved through traditional Thai toy activities in a science museum?

5.2.1 Family play-learning and inter-generational learning

The data from structured naturalistic observation indicate that, most family groups who participated in the TTTA included parents and children or father/mother and children. The minority of them are children with their grandfather/grandmother or both and children with their aunt/uncle or both. The findings of this study shows that, within the make-and-play activities, there is transfer of learning from older to younger and from younger to older. The analysis of family learning is based upon Bandura's (2001) social cognitive theories, used here in relation to this informal museum education. Family play-learning is seen statistically, where more experienced members

in the family transfer their knowledge and role-model their and skills to their children or younger members of the family. There is also an upward transfer where intelligent youth model the fun and creativity they bring to the tasks. As stated in Chapter 4, family play-learning is composed of four levels of action of family play-learning as follows:

1) Attention

'Level 1 action: Where one of the family groups initiates a task and acts as a role model. He or she gains the attention of the others as they watch the task unfold'.

The observation data indicate that adults in the family groups were interested in the TTTA. They invited their children to join the toy activities to gain more knowledge, skills about the toys, scientific knowledge and local wisdom. Family play-learning began learning with the exhibition and collections of the old toys through explaining the exhibition and playing with the toys. Adults in the family groups enthusiastically learnt the processes needed to make the toys, from the Explainer, with the definite intention to watch and listen to all information about the TTTA because they want to guide their children and this was an initial experience for some of them. Thus, adults had to understand clearly before being able to teach others. A woman in family 3 expressed that *she would like to understand how to make the toys clearly, because she had to teach her children to make this toy.*

2) Retention

'Level 2 action: When the other members of the family began tasks of their own they were, guided by the better, more accomplished, more experienced members of the group'.

The evidence from the observation data showed that most adults and some young adults understood the process to make the toys. They intended to guide their children to make the toys step by step, by closely observing the Explainer's method. After that they allowed their children to construct the toys by themselves until they believed their children could make the toy. So, then they let their children make the toys alone. A woman from family 32 stated that *Children learnt from her guidance. She just helped them with some parts.*

On the other hand, some children and teenagers could guide and help the adults to make and play with the toys because they gained this experience at an earlier time, when they visited the museum with school tours. However, most children and some teenagers enthusiastically intended to learn from the adults because they want to acquire the toys by their own performance. Some small children wanted the adults to make the toys for them. They thought the toys were too difficult for them. They wanted the adults to make it for them. Some of them complained that *this toy is difficult for him. He wanted his mother to make the toy to him.*

Also, participants felt happy when they joined the toy learning process together. Most of the children had pleasure when the adults guided and helped them to make and play with the toys. Some of participants said *they felt happy when they guided their children to learn how to make the toys.* A boy in family 22 stated that *he felt good when his father helped him to make the toys. His father helped him and told him something about this toy that he had never known before. The toys were very exciting for him.* They think family play-learning is one of the good ways to encourage family learning.

3) Motor reproduction

'Level 3 action: Where the 'learner' members of the family achieve their tasks supported by, but largely independent of, their family role models'.

The observation data show that younger members of the family groups could learn the methods to make the toys from adults through recognizing the steps of toy making, following the method and completing the toys by themselves. A girl from family 43 said that *she understood the method to make the toy. She thought she could make the toys by herself without the adults.*

Some young learners cannot make the toys alone, so older members of the family had to help and provide suggestions until the toys were completed. Then, most of them intended to decorate the toys using their imagination and proudly showed their toys to members of the family and others in TTTA. At this level, adults watched their children

make the toys. When they were sure that their children could make the toys alone, they allowed them to do so. They had to remake their own toys after using them to teach their children. They spent some time to beautify them, so their toys look better when contrasted with the children's toys. Children and teenagers' toys had a variety of decoration. They spent a lot of time creatively decorating their toys. Most of them created the coconut mouse to represent some kind of animal, for example ladybug, buffalo, cat, turtle or dinosaur. As for the paper caterpillar toys, they thought *they looked like a snake or dragon.*

They thought that the toys that they made were interesting and exciting because these toys could move as the real animals. One boy stated that *they had never seen these toys before. This was the first time for them to make traditional toys.* Most of them invited other members of the family and other people in the TTTA to play with the toys with them. While adults remade their toys.

4) Motivation

'Level 4 action: that the learners will try to take what they have learned from the setting and repeat, adapt and improve on what they have been doing'.

The evidence from the observation data in this level shows that participants repeat making the toys and playing with other toys. Some participants including children, teenagers and adults, asked the Explainer for the materials to make the toys again in order to present them to their friends or other people at school or in the workplace. Some of them wanted to teach the process of toy making to other people in their home. Some participants stated that *they wanted to improve these toys again when they got back home. For example, they wanted to redesign the figure of these toys; change the materials to make the toys and adapt the toys to other uses.* Some of them asked the Explainers and Assistants *how to learn to make other toys or when does the activity change which toy to make? Where can we buy these toys?* They were also interested in the traditional Thai toys and looked for other kinds of these toys to play with.

The families' motivation of learning at home questionnaire data showed the participants responses to their motivation about the traditional Thai toys after participating TTTA that they wanted to:

- Talk about the TTTA to the other members of the family, friends and teachers
- Make the toys again
- Take the toys to give other members of the family
- Take the toys to school to make with their friends
- Teach others to make the toys
- Play with the toys with other members of the family at home.
- Adapt it to their work (Teacher teaches students)
- Adapt to study (Students make project)

It was clear that participants gained motivation from the TTTA because they would make the toys again, think to adapt the toys to their work or study and had ideas to change the toys to other figures or other uses. Family play-learning also provided several benefits for family learning including playful learning; and family play-learning is useful for museum learning; continuing family play-learning at home; inter-generation learning, and the time of family as shown below:

1) Family play-learning is playful learning

The main purpose of play is playfulness. Playfulness relates to imagination and creativity for children. When children are playful, they are creative and can use a lot of imagination (Taylor and Roger, 2001). Playfulness also affects positively adults' work (Glynn and Webster (1992). Family play-learning is the learning process that proposes that children could learn through play with their family. Through this play children gain confidence in their abilities, which will encourage them to do new things and support gross motor skills as well as logical thinking (Moyles, 1999).

Family play-learning is a playful learning experience that encourages families to enjoy learning with the TTTA. A father and son in family 20 enjoyed racing the flying bird toy and said those *whose toys flew to the bottom first was the winner.*

When participants are playful, they will exhibit curiosity and enthusiasm to learn the activity. Also, playfulness will provide imagination and creativity for all participants. One boy named his coconut mouse "Bobby", and carried it around as his pet. One girl enjoyed decorating the coconut mouse toy and said that *it looked like a rabbit when she added the long ears and big teeth to it.*

2) Family play-learning is useful for museum learning

Family play-learning is consistent with the purpose of museums and other settings. The purpose of exhibitions and the activities in the museum is designed for adults in a family group have more experience to encourage their children to learn the information in a museum. Museums help children not only to gain confidence in themselves as capable learners, but also encourages them to develop relationships with adults in the family and to support adults (parents and grandparents) as effective teachers of children (Black, 2005). However, museums want parents and adults in the family groups to learn in museums and encourage children's learning through asking and answering the questions, talking about the exhibits, pointing to the section of the exhibits, reading texts and engaging in hands on activities. Adult visitors enjoy learning in a museum in parallel with teaching or introducing knowledge to their children (Hilke, 1987). One woman in family 32 said that *she learnt more about science and local wisdom through this activity and the exhibition. Also, her children could learn this knowledge too because these toys are very interesting and rare to see nowadays.*

In the Children's Discovery Museum, USA, investigators found that parents play an important role to help their children to select and identify appropriate details in the exhibition and activities. Also, children who engage with their parents in visiting a museum, viewed the exhibition with more perceptive eyes. They made longer and broader explorations and focused on the comparisons more than children who explored the exhibition on their own (Fenichel and Schweingruber, 2010).

One man in family 82 said that *the exhibition provides an explanation about science and local wisdom as related to the traditional toys. The collections of the old toys are*

rare to find nowadays. This exhibition and the toys help them and their children to gain more understanding about the toys and how to play with them.

3) Continuing family play-learning at home

As stated above parents or adults in the family groups gain knowledge and enjoy learning in a museum in parallel with teaching or introducing knowledge to their children. When the family goes back home, adults can repeat, guide or teach their children again when children need suggestions and more information about learning from the museum. Parents are effective teachers of children as stated above. One boy in family 52 said *he wanted to make the toy again and took the toy home to play with it with his brother.* One girl in family 5 said *she want to talk about this activity to other members of her family at home.* One woman in family 33 said *she would teach other members of her family to make the toys* and one woman in family 46 said *she would take this toy for her children at home to play with.* One interviewee said *the toy handbook provided knowledge about these toys and the relevant scientific knowledge and local wisdom. She would use this book to teach their children again when they went back home.*

4) Inter-generational learning

Family play-learning is about a family enjoying learning together that includes all members of the family, parents, grandmother and grandfather, aunt or uncle or other carers and children. The observation and short questions data indicate that the most inter-generational groups comprise two generations (parents and children) but some families contain three generations who visited a science museum and participated in the TTTA. The data also indicated that multi-generations provide more learning and more knowledge. For example, two or three families who joined the TTTA were three generational families. These families included parents, grandmother or grandfather or both, and children. The observation data indicated that during the TTTA parents guided their children make the toys, grandmother/grandfather guided the parents or adults in family. Because grandparents have more experience about the traditional Thai toys, they provided more knowledge in the TTTA. One woman in family 32 said *her family joined the TTTA with three generations included herself, her husband,*

children, and her mother. She enjoyed it when her mother talked about these toys in the past and her mother also helped her to guide the children to make and play with the toys. The result were also consistent with the work of Moussouri (2003) that when grandparents look at the exhibition in the Museum of Science and Industry, these exhibitions gave them the opportunity to relive past experiences while at the same time they could transfer biographic information or information on family history to their children (p.482).

5) The time of family

Family play-learning can bring all members of the family together. They spent the time together for enjoyment, talking, visiting the museum, making, playing and learning. At the present, families are busy, adults have to go to work and children have to study. They have almost no time to learn together. One women in family 21 stated that *she did not have time for her children at home. This activity allowed her to spend some time learning about the toys together with her children.*

5.2.2 Learning outcomes from the traditional Thai toy activities

This research employed a Toy Learning Outcomes Questionnaire (TLOQ) to investigate families' learning outcomes from the TTTA with 51 families, comprising 125 participants. The TLOQ is based upon the work of the Research Centre of Museums and Galleries at the University of Leicester (Hooper-Greenhill, 2007). The evidence from TLOQ data in Appendix 6, Figure AP 6.29 shows that families appear to have learned most in relation to two of these areas, 'Scientific knowledge' and 'Thai local wisdom', when compared with the other themes of learning.

Children, teenagers and adults were not significantly different in gaining learning outcomes in six themes of learning (Knowledge and understanding; Skills; Attitude and value; Enjoyment, inspiration and creativity; Action, behaviour and progression; and Attitude toward Thai local wisdom) from the TTTA. However, their responses were significantly different on the theme of Scientific learning. The responses of males and females towards all seven themes of learning were not significantly different.

This is largely consistent with the purpose of the study. It was pointed out that participants could gain new knowledge about traditional Thai toys, culture and local wisdom from the TTTA because the TTTA is very interesting and rare to find in schools or other places. Also, they learned scientific knowledge from this activity through making and playing with the toys. Participants could develop skills, actions, behaviour and progress from this activity and the TTTA could stimulate knowledge, understanding, attitudes, values, enjoyment, inspiration and creativity. Nearnchalearm (2005) pointed out that traditional Thai toys provide playfulness, enjoyment, awareness and impressiveness. When using traditional Thai toys to learn scientific knowledge, these toys could encourage learners to acquire scientific knowledge, scientific processes, scientific methods and creativity. One interviewee said *this activity motivated her family to learn science from the toys. Her child liked this activity very much because he could make the toys by himself and learnt the science inside the toys.*

The summary of investigating the seven outcomes of learning from the TTTA is as follows:

(1) Knowledge and understanding: participants gained knowledge and understanding from the TTTA. They learnt how to make and play with the toys; gained understanding about the toys; the toys helped them make the links or relationships between other things; and the toys gave specific information to them. Nearnchalearm. (2005) points out that traditional Thai toy gives knowledge about toys to the learners for example: the knowledge about selecting the suitable materials to make the toys, the techniques needed to construct the toys, and the knowledge about resource management such as how to use sustainable local resources. One girl said *she like this activity very much because this activity could help children have fun, gain more knowledge and understanding about the toys and science.*

(2) Skills: participants gained skills from the TTTA. They developed communication, physical, intellectual, social and emotional skills. Also, child participants developed the physical skills of hand and eye-cooperation. Most participants gained new skills regarding the making and playing with the traditional Thai toys because this activity is difficult to see in any other place. Also, the data from participants perceptions indicate that TTTA

encourages participants to develop their skills especially children, they can develop handicraft skill from making the toy. They also develop social and communication skills when they had discussions and played with the toys with other people. Some of the participants stated that *this is a good activity that allows children to learn how to make the toys. This is a new accomplishment for them because they have never made this toy before. This activity should continue.*

(3) Attitude and values: participants have positive attitudes and an awareness of the values of the TTTA. They think the toys make them enjoy their family. They gained confidence and changed their feelings about playing with the toys. They also have more positive attitudes towards Thai culture, Thai local wisdom and scientific learning. One woman stated that *she preferred to conserve local wisdom because examples are increasingly rare to find nowadays.*

(4) Enjoyment, inspiration and creativity: participants gained enjoyment, inspiration and creativity from the TTTA. They had fun when they played with the toys. The toys motivated them to be creative and surprised them. The toys also provided inspiration for innovative thoughts to them. The analysis of the data indicates that they were playful during the make and play activities which is consistent with the purpose of the study. When children have fun, they increase their imagination and creativity (Taylor and Roger, 2001).The National Science and Technology Development Agency (2006) pointed out that learning from traditional Thai toys can help learners to discover, create and solve problems as well.

Perceptions of the participants indicate that most families enjoyed the activities. They were happy to make and play with the toys in the family or with other people. One girl wrote that she perceived *she wanted to visit NSM again because she enjoyed making, playing and touching the toys. She liked the caterpillar paper toy.* One woman wrote that *this activity encouraged creativity and cognitive thinking in their children.*

(5) Action, behaviour and progression: participants gained more action, behaviour and progression from the TTTA. They understood the intentions of the toy maker and why people love to make and play with the toys. The toys helped them to be interested in

playing with other toys. This is consistent with Harlen (2000) that good scientific activities have to engage the interest of children and relate to real life and everyday experiences.

Moreover, they think making and playing with the toys changed their behavior, for example they could be free to show their emotions to other people. One participant wrote that *his son, who is normally very shy, could play with other children that he had never known before.*

(6) **Scientific learning:** participants gained scientific knowledge from the TTTA. They wanted to engage in learning scientific knowledge at a science museum again because when making and playing with the toys they had fun and were inspired to learn more. Adults were outstandingly more interested to go to science museum again than were other people because they thought science museums provided scientific knowledge and skills to them and their children, so, it would benefit them to go again. Teenagers more than other people, had fun learning science at the TTTA, whereas, children more than others understood the science involved with toys. As stated above teenagers labeled themselves as playful more so than other people did, so, they had fun learning science with the TTTA. When compared with other ages, children commenced learning science at a younger age than other groups. So, they could learn new scientific knowledge and skills from the TTTA, but teenagers and adults had gained this knowledge before. The results also indicated that participants gained more knowledge and better skills than previously. Harlen (2000) points out that scientific activities should enable children to use and develop scientific processing skills. Also, they encourage scientific attitudes and give opportunities for children to exercise some choice. Some of them think making and playing with the toys inspired them to be a scientist. One participant wrote that *he gained scientific knowledge from the activity. He would take this knowledge home to teach his other children*

(7) **Attitude towards Thai local wisdom:** participants had a positive attitude towards Thai local wisdom. TTTA made them understand more about Thai local wisdom and inspired them to further study Thai local wisdom and to conserve it. The Child Institute and Child Foundation (2007) point out that by making traditional Thai toys

based on the local wisdom of the community, the students could not only learn science from traditional Thai toys, but also that there are ways to support the production of technology in the community. Learners would be impressed by the value of the legacy from their ancestors and the true value of a community's culture.

Also, most of the participants had fun learning Thai local wisdom. Perceptions from participants indicated that they not only learned about Thai local wisdom but also Thai culture and traditional Thai toys from the TTTA. They were inspired to conserve local wisdom because examples today are increasingly rare to find. Examples of their perceptions were that *they gained knowledge about Thai local wisdom and traditional Thai toys from the TTTA. They wanted to preserve Thai local wisdom.* Also, one of participants wrote that *this activity should continue because it will encourage children to recognize the materials, the toys and how to make the toys that at present are difficult to see. It also conserves the methods involved in the making of traditional Thai toys.*

The data analysis from TLOQ is consistent with the Learning Impact Research Project (2003) that used five generic outcomes to measure generic outcomes of learning from culture in museums and libraries. The results indicated that the generic outcomes of learning from culture are: (1) an increase in knowledge, (2) an increase in skills, (3) a change in attitudes or values, (4) enjoyment, inspiration, creativity, (5) action, behaviour, progression (Hooper-Greenhill, 2004). He also points out that learning in a museum is multi-faceted. Children gain confidence and are relaxed because they are able to use multiple learning styles. They learn through experience; using intuition, experiment, immediate response, and emotion. They have new and exciting experiences, which demand open-minded, receptive modes of attention, leading to new ideas, and the development of imagination (Hooper-Greenhill, 2007:8).

5.3 Research question 2

To what extent do traditional Thai toy activities influence family bi-gnostic learning?

Family bi-gnostic learning (Western modern science and Thai local wisdom)

As stated above the aim of bi-gnostic learning is not just encouraging one form of understanding, but two. To foster bi-gnosis, I wanted participants to gain information about scientific knowledge (Western science) and Thai local wisdom in parallel. The evidence from the toy learning outcomes questionnaire (TLOQ) data as stated above indicated that participants seemed to have gained bi-gnostic learning outcomes from TTTA because the highest responses were towards 'Attitude toward Thai wisdom' and 'Scientific learning'. These data indicated that families appear to have learned most in relation to both 'Thai local wisdom' and 'scientific knowledge' through the TTTA.

In this research, bi-gnostic learning means that one activity (TTTA) could provide two forms of knowledge and understanding. The TTTA aims to provide information about scientific knowledge (Western science) and Thai local wisdom to participants in parallel. This aim is consistent with the work of Aikenhead (2001), who stated that Aboriginal students should learn Western science but, without being assimilated into Western culture, that is, without losing their cultural identity as Aboriginals. So, bi-gnostic learning means having access to both scientific knowledge and local wisdom as distinctive knowledge systems, each having value in their own right, and not some mixture, integration or infusion of the two (Kanhadilok and Watts, 2013b). My position, then, is that rather than seeing traditional toys as a step towards Western modern science, I see the two knowledge systems sitting alongside each other, in balance and making distinctive contributions to understanding.

Moreover, family play-learning encourages bi-gnostic learning when adults in the family groups encourage their children to learn bi-gnostic knowledge in the TTTA through guidance, teaching, playing with the toys and exploring the exhibition. As well as at a science museum; in their home adults could continue their transferring of this information to their children. Family play-learning is consistent with Thai family

learning in the past, when knowledge was passed from generation to generation within the family. Younger people in the family would gain knowledge and skills about the family's work from their parents or the older members of the family (Office of SMEs, 2010).

TTTA is a unique activity which aims to encourage people to learn scientific knowledge in parallel with Thai local wisdom through make and play activities with traditional Thai toys in a science museum. This activity is consistent with the national education policy that 'all education approaches shall give emphasis to (1) Scientific and technological knowledge and skills and (2) Knowledge about religion, Thai wisdom, and the application of wisdom (Office of the National Education Commission, 2002). The evidence of the bi-gnosis interviews indicated that TTTA is a unique activity that most of participants had never seen before and through which participants could learn scientific knowledge and local wisdom. One interviewee said *Traditional Thai toys were rare to find and TTTA taught him about science and local wisdom that he could not find in other places. The Explainer introduced him to knowledge and understanding of traditional toys and Thai play in the past. The activity inspired his children to study more about Thai culture and local wisdom.*

The interview data indicated that the TTTA encouraged participants to learn more about scientific knowledge and local wisdom after joining in all the facilities of the activities. The TTTA inspired them to study more about bi-gnosis. TTTA also stimulated them to conserve Thai culture and Thai local wisdom. Also, they gained an awareness about Western modern science and local wisdom and the importance of both these knowledge systems to the development of the country.

Although the interview data also indicated that some participants thought that scientific knowledge is more important and should be kept separate from local Thai wisdom, because scientific knowledge encourages the development of the country and provides conveniences for people in everyday life whereas Thai local wisdom does not do that, therefore they should be studied separately and not integrated. Each system should be allowed to develop in its own way but they should support each other   .

On the other hand, some interviewees believed that scientific knowledge is of equal importance with Thai local wisdom. Some participants strongly agreed that scientific knowledge supports local wisdom and some of them argued that the strong points of both types of knowledge depend on the situation. In some situations scientific knowledge supports local wisdom, whereas, in other cases local wisdom is the base of scientific knowledge. Some interviewees strongly agreed that scientific knowledge and Thai local wisdom should develop and integrate together. They thought that both types of knowledge are very important for the development of the country.

In my view scientific knowledge and Thai local wisdom should be kept separate for study and when making educational policy, because these two forms of knowledge are different. Scientific knowledge and local wisdom are different in terms of the origin of the knowledge, its transition, theoretical knowledge, value and approach as stated in Chapter 2. Thai local wisdom should be preserved and taught separately and distinctively in schools, universities and communities. In my view, I see that scientific knowledge parallels Thai local wisdom as double helix of a DNA strand. They should study, work, and develop in parallel but should not be integrated together. However, sometimes they do touch each other but do not mix, integrate or fuse together. The touch points may be one or more than one in each situation. For example the processes that developed Thai gold-ware were based in scientific knowledge plus Thai local wisdom and the traditional technology gallery at the Science Museum that displays Thai local wisdom technologies and explains them scientifically. These examples are consistent with Feyerabend (2006) that presented the knowledge of two cultures (science and non-science) through the double helix DNA strand.

The TTTA is also one of the touched points of bi-gnosis where one activity provides two types of knowledge for the participants. These activities allow participants to learn scientific knowledge in close parallel with Thai local wisdom. It provides bi-gnostic learning and the inspiration to further study bi-gnosis. For more understanding about bi-gnosis that provide two forms of parallel learning, I will present bi-gnosis of science learning and Thai local wisdom and the touched points of them through the model of a double helix of bi-gnosis in the Figure 5.2 below.

Figure 5.2: The model of the double helix of bi-gnosis
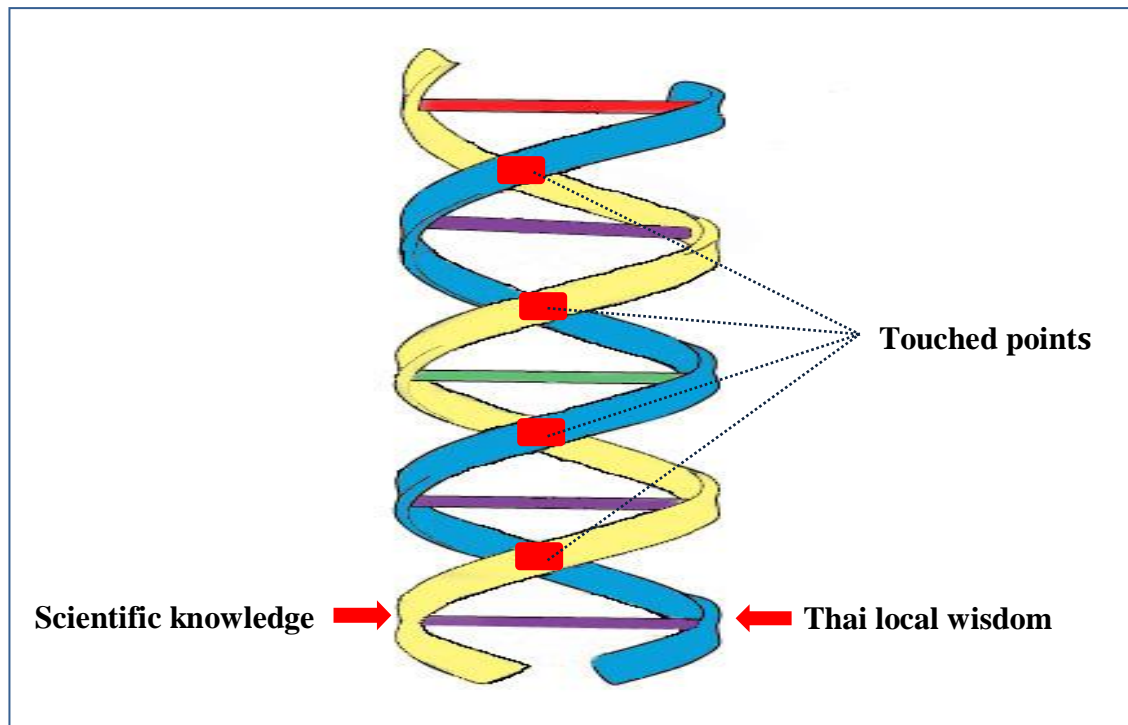
Source: Adapted from the double helix of two cultures (Feyerabend: 2006)

5.4 Research question 3

How does learning with traditional Thai toys affect the relationship between participants' character and engagement, the environment and resources?

Factors that encourage family play-learning with TTTA

This research identified factors encouraging family play-learning with TTTA: participants' character (playfulness), participants' engagement, environments and resources. The detail of all factors as shown below:

5.4.1 Participants' character (playfulness)

The first factor is the participants' character (playfulness). This research specifically discusses the playfulness character of a family group, it does not describe all characters of the participants. The evidence from the playfulness questionnaire data in Appendix 5, Figure AP 5.4 shows that most of the respondents described themselves are closest to the playfulness characteristic of **Friendly, Happy and Cheerful**

respectively. These results are consistent with the work of Barnett (2006) that these playfulness characteristics of friendly, happy and cheerful related to the characteristic of playful in the group of 'Gregarious' which refers to respondents like to play all members in family group and enjoy to involve with other people in the activity. It was pointed out that most respondents were friendly and they were happy and cheerful to visit a science museum and join the activity with their families.

Also, the playfulness observation adapted from Lieberman (1977) describes the playfulness quality as including five components. The evidence from this observed data indicates that:

1) **Physical spontaneity;** participants enthusiastically intend to make the toy. They repeated the movements and actions. They had clear facial enjoyment when playing with the toys. Participants had enthusiasm to make and play with the toys. They enjoyed exploring, learning from the exhibition and playing with the collection of toys.

2) **Social spontaneity:** participants showed their playfulness when they presented their toys to family or other people and played with the toys with them. They were also involved in their group through sharing the materials and tools to make the toys; helping other people; talking and having discussions in their group and playing with the toys with family and other people in the TTTA.

3) **Cognitive spontaneity:** participants showed considerable enthusiasm in following the activities led by the museum's Explainers. They listened intently and watched the presentation and the demonstration of the process of toy making. So, they learnt the skills to make the toys and could happily make the toys by themselves and would imaginatively decorate their toys. Children and teenagers showed more imagination in decorating the toys than adults.

4) **Manifest joy:** participants were clearly interested in the information and pictures of the toys, enjoyed the cartoon characters in the graphics panels, and also happily played

with the exhibition toys that are rare to find. When participants were fascinated by the toys, they showed their curiosity and enthusiasm to learn with the TTTA.

5) A sense of humour: Participants enjoyed playing with the toys in the exhibition zone and the toys that they made in the TTTA. They were always smiling or laughing with these toys. They also enjoyed decorating their toys and felt a proud sense of achievement when the toys were finished.

It was clear that playfulness provides amusement and entertainment for people (Mandal, 2011). Playfulness is important to help develop the imagination, creativity and problem-solving abilities for young people (Taylor and Roger, 2001). When people have playfulness, they are ready to learn and are prompted to learn in the learning environment where the TTTA provides enjoyment and playfulness to participants and which stimulates the curiosity and enthusiasm of participants to learn in the TTTA. This is one of the factors that encourages family play-learning with the TTTA.

5.4.2 Participants' engagement

The second factor that encourages family play-learning with the TTTA is the participants' engagement. This research adapted the engagement learning model from Hawryszkiewycz (2007) as the engagement learning model to study families' engagement with the TTTA. Families' engagement with learning in this study included four engagement learning aspects with the activity. The evidence from the engagement observation data indicates:

1) Engagement with the activity: participants engaged with the TTTA enthusiastically. They understood the purpose and idea of the activity; followed the process to make the toys and succeeded in the goals of the activity through making the toys by themselves.

Participants explored the goals and the ideas of the toys making. They also had curiosity and enthusiasm to learn the story of traditional Thai toys and the scientific knowledge and local wisdom inside the toys.

2) Learning from the activity: participants could learn from the TTTA. They could follow the activities led by an Explainer, make and play with the toys by themselves, and gain knowledge and skills from the activities.

3) Involvement in their group: participants engaged in the activities with their families and other people in the TTTA. They were involved in their group, by sharing materials to make the toys with other people, helping others and by sharing ideas with others.

4) Engagement with the environments and resources: participants engaged with all the environment and the resources in the TTTA. The environment included the exhibition of the traditional Thai toys and the collection of the old toys to encourage family play-learning. Also, the resources of TTTA comprised an Explainer, Assistants, the toys and the toys handbook, they are very important in supporting family learning with the TTTA. When participants engaged with all the factors in the learning environment including the environments, resources, content, activity, other people in their group and the Explainer in the activity, they would learn more (Hawryszkiewycz, 2007).

5.4.3 The environment and resources in the activity

The third and fourth factors supporting family play-learning are the environment and the resources in the activity. As stated above environment and resources are an important factor to encourage family play-learning in a science museum. The evidence from TLOQ data shows that the environment and resources in the TTTA are conducive and appropriate for participants' learning. The environments of the TTTA include the exhibition, the toy collection and the atmosphere of the TTTA attracts them to join in the activities. Participants are interested in the exhibition of the traditional Thai toys with the design of Thai cartoon characters, beautiful pictures of the toys and the information about bi-gnostic learning inside these toys and the collection of the old toys that rare to find. Participants also engaged with the resources of the TTTA through collaborating with the Explainer and the Assistants, having an interest in the toys handbook and the toys that they made in the TTTA.

It was pointed out that all factors in the TTTA as stated above include participants' characteristic of (playfulness), the traditional Thai toys, participants' engagement, the environment and resources in the TTTA play an important role in encouraging family play-learning with TTTA at a science museum. The playfulness characteristic of participants encourages readiness, curiosity and enthusiasm of the participants for learning as well as their engagement with the activities. The traditional Thai toys are used as props for play to support experience, skills, imagination and creativity while participants learn through the activities. The environment and resources in the TTTA also support participants' learning in the science museum and in their homes.

5.5 Research question 4

Can the model hypothesis of family play-learning through traditional Thai toy activities effectively be used to monitor family play-learning?

The model hypothesis was adapted from the interactive experiences model (1997) and the contextual model of learning (2000) of Falk and Dierking (1997, 2000) to described the context of participantss' learning with the TTTA and my two zones of play model (Kanhadilok and Watts: 2012c) to explain conditions of play, make and play activities and learning outcomes from TTTA.

As presented in Figure 5.1 the model hypothesis of family play-learning through traditional Thai toy activity comprises the factors that encourage learning and the outcomes of learning in make-and-play activities. The details of all factors that encourage family play-learning that follow this model will be shown below:

5.5.1 Context of family play-learning

(1) Personal

The personal context in the contextual model of learning (Falk and Dierking, 2000) emphasises on motivation and interest of visitors' learning in the museum that encourage visitors to visit museum and join museum's activities. This research emphasizes the participants' personal engagement in learning with the activities. Engaged learning within the learning environments and activities lays emphasis on the

participants involving active cognitive processes, for example, creating, problem-solving, reasoning, decision-making, and evaluation. Participants are intrinsically motivated to learning due to the meaningful nature of the learning environment and activities. It is consistent with the constructivist approach because the emphasis is on the cooperation among peers and the community of learning (Kearsley and Shneiderman, 1999). The evidence from the observation data shows that most of the participants have motivation and interest to learning and engaged with the TTTA.

(2) Social

Social context occurs when visitors share various experiences within their group or other people during visiting the museum (Falk and Dierking, 1997). The social context of the TTTA encourage collaboration of all members of family group and other people in the TTTA through sharing, cooperation, helping, guidance and playing with others. Harlen (2000) points out that the scientific activities have to involve children in working cooperatively and combining their ideas (p.67). TTTA have one side which is a scientific activity that emphasises social collaboration and the relationship between all members in the learning group. This research emphasises family groups that are composed of parents and children or father/mother and children or older members of the family and children. TTTA proposes to encourage family play-learning by introducing make and play activities with the traditional Thai toys at a science museum. As stated in Chapter 3, in this research, I am interested in inter-generational learning, where family groupings influence and learn from each other.

This research not only provides social collaboration and relationship learning in the family but also encourages social collaboration and relationship between members of the family with other people in the TTTA. One of the purposes of the TTTA is to encourage participants to develop social skills through working in groups, sharing, helping others and discussing their ideas.

(3) Setting

Setting or the physical context of museum's visitors can include a multitude of events or features, it is generally assumed that objects, exhibitions and labels in the museums have the greatest influence on the museum experience of visitors (Falk and Dierking,

1997). TTTA at a science museum is a programme placed in an informal setting (Morrison, 1993). As stated in Chapter 3, these settings are consistent with the TTTA at a science museum that is a programme set by humans in a physical environment, a science museum's environment is an informal environment for learning. As stated in Chapter 2 TTTA took place in the traditional technology gallery at the Science Museum in the National Science Museum, Thailand which is an informal educational setting. The physical setting of the TTTA comprises two main settings including environments and resources for make and play learning with TTTA as stated above.

5.5.2 The condition of learning

Condition of learning includes two main factors as shown below:

(1) Opportunity to play

The two zones in Figure 5.1 represent those environments where play is - and is not - deemed appropriate. Zone 1 is a play zone that is appropriate for learning. Zone 2 is intended to represent the opposite, a no-play zone, a space where play is deemed a distraction, inappropriate, is uninvited and curtailed as stated in Chapter 2. However it is clear that even with that distinction there are occasions when some play may be possible, especially where this contravenes conventions, conformity, and causes amusement. Even when the zone is appropriate, where the people and the settings are right, play will take place (Kanhadilok and Watts, 2012c). As Else (2009) maintains, play is personally directed, trades upon a disposition, a momentary mood and is undertaken for its own rewards. The TTTA provides opportunity of play for family learning at a science museum. A Science museum is Zoned 1 as a play zone that offers physical, and virtual spaces where play can commonly take place, including the atmosphere of the galleries, the exhibitions, the collection of the toys, Explainers, Assistants, materials to make the toys and the toy handbooks. These facilities encourage opportunity for make and play for family groups.

(2) Disposition of the participants

The disposition of the participants in this research emphasises a playful disposition. All the observational data indicate that participants gained playfulness during their participating in the TTTA that is consistent Else (2009) and Lieberman (1965). When

the environments and resources are appropriate, where the people and the setting are right, play can take place. Play depends on disposition. Play must involve pleasure: where there is no pleasure, no fun, no enjoyment, then there is no play and; no play no learning. Playful dispositions encourage participants' learning. Also, playful dispositions provide enjoyment, readiness, curiosity, enthusiasm, motor activity, social skills, imagination and creativity to the player when joining the activity.

5.5.3 Make and play activity with traditional Thai toy activity

This research employs make and play activities as the tools to study family play-learning at a science museum because learning through play enables participants to find out about themselves and the world. Play provides happiness, prevents boredom, reduces stress and encourages learning. As stated in Chapter 2, play is universal and important for children's' development. Play is a way that children learn about themselves and the world around them (Davis, Larkin and Graves, 2002). Henderson and Atencio (2007) describe play as an integral part of development. Through play, a child can develop their capacities in creativity, problem solving, logic, social knowledge, communication, self-regulation, cognitive processing and social development. Play behaviour is important for children to develop their social, cognitive and motor skills. Play might encourage establishment of social relationships between individuals (Nunes, Muecke, Sanchez, Hoffmeier and Lancaster, 2004).

5.5.4 Learning outcomes from the activity

Learning outcomes are expressed in terms of the 'can do' verb. The context of higher education 'can do' refers to knowing, become aware, appreciating, understanding, enjoying, and learning (Moussouri, 2002; p.6). This meaning of learning outcomes is consistent with the learning outcomes from the TTTA. TTTA aims to encourage visitors' learning of science and local wisdom. The learning outcomes from TTTA in the thesis are adapted from Generic Learning Outcomes (GLO) of school students at the workshops in the museum, based upon the work of the Research Centre of Museums and Galleries at the University of Leicester (Hooper-Greenhill, 2007). This study separated learning outcomes of TTTA into seven types of toy learning outcomes these include: knowledge and understanding; skills; attitudes and values; enjoyment,

inspiration and creativity; activity behavior and progression (Hooper-Greenhill, 2007); scientific learning, and attitudes toward Thai local wisdom (Kanhadilok and Watts, 2012c). Learning outcomes from TTTA include toy learning outcomes, bi-gnostic learning and families' motivation of learning at home.

It was clear that the model hypothesis of family play-learning presented the factors that support family play-learn with TTTA at a science museum. There are two main factors including (i) the *context* of the play, which emphasizes the participants' personal engagement, social relationships, and the physical setting (the environment and resources in the TTTA); and (ii) the *conditions* to play, the playfulness of the participants and the opportunities they take to learn together through play. These factors are consistent with Moussouri's (2003) work that identifies the factors determining the families' agenda for the museum visits including the family profile, socio-cultural patterns, personal context, social context and the exhibitions.

5.6 Conclusion

This research is an initial study about family play-learning through make-and-play activity with the traditional Thai toys at a science museum. This study focuses on family groups in the TTTA at the National Science Museum, Thailand. Families in the toy-making activities are members of the general public, day visitors to the museum who volunteer to join the activities, they represent all age groups, have varied levels of educational achievement, backgrounds in science and dispositions towards play. This research emphasises four points to answer the research question, including how (1) family play-learning, (2) family learning outcomes after participating in the TTTA, (3) family bi-gnostic learning (Western modern science and Thai local wisdom), the (4) factors that encourage family play-learning and the model of family play-learning. To describe all foci of the research, I will use the model hypothesis of family play-learning with TTTA in Figure 5.1 to conclude family play-learning with the TTTA at a science museum.

This research applies TTTA as the tool to study family play-leaning and family bi-gnostic learning. TTTA is an 'edutainment' activity within the informal educational

system of a science museum. This activity allows family groups to participate with make and play activities in the traditional technology gallery that displays local wisdom technology and scientific knowledge. The aim of TTTA is to encourage scientific learning, local wisdom knowledge and enjoyment to visitors who join the TTTA. I designed make and play activities to stimulate the scientific learning process, scientific skills, physical, social and communication skills plus local wisdom learning. TTTA is a learning environment setting that provides environments and resources for participants' learning. The findings from the research show that the environments and resources in the TTTA are conducive and appropriate for family play-learning as play zone one. The environment of the TTTA includes the exhibition, collections of the toys and the atmosphere of the TTTA stimulates participants to join in the activities. Most of the participants were interested in the exhibition of the traditional Thai toys that were designed as Thai cartoon characters, beautiful pictures of the toys and the information about traditional Thai toys, local wisdom and scientific knowledge inside these toys and the collection of the old toys that are now rare to find. Participants also enthusiastically engaged with the exhibition and the collection of the old toys. They explored the exhibition, played with the toys with their families and explained the information of the toys to their children. The resources of TTTA comprised an Explainer, Assistants, the material to make the toys and the toys handbooks that are appropriate for family learning. Participants collaborated with the Explainer and the Assistants. They were also interested in the toys handbook that encourages participants to learn more about the scientific principles inside the toys' workings, the relationship between this scientific knowledge and daily life, Thai culture and local wisdom.

During their participation in the TTTA, participants were playful. They enjoyed the exhibition and the collection of the old toys. They also took pleasure in making the toys following the Explainer and the adults in their group, and playing with the toys with members of their family and other people. Participants showed imagination and creativity when they decorated the toys. Children and teenagers especially, enjoyed creating their toys in many different ways. It is evident that playfulness provides amusement and entertainment to the participants. When participants gained playfulness from the activity, they also gained curiosity, enthusiasm, and readiness to

learn with TTTA. Moreover, playfulness provided imagination and creativity to the participants during the activity. Also, playfulness and the interest of the participants stimulated the participants to engage in the activities. The findings from the research indicate that participants were interested in the environments and resources in the TTTA as state above. So, they engaged with all facilities in the TTTA enthusiastically. Participants who also engaged with the activities showed that they intended to learn the activity from the Explainer. They understood the activity and the process of toy making and could make the toys by themselves. Participants also involved in their group by sharing the materials to make the toys, help other people, playing and having discussions with their group. As with the characteristic of playfulness; participants' engagement can also stimulate people to learn in the learning environment.

Through the TTTA, I explored family play-learning (based upon Bandura's (2001) social cognitive theories) during the activity I found that family play-learning is an important family learning style that adults or more experienced members in the family group could learn, making and playing with the toys during the activities. From their learning, they can transfer the knowledge and skills about the toys activities to their children or younger members (learners) of the family. The learners in the family could learn knowledge and skills about the toy making from more experience members of the family. Thus, they could complete the toys alone. There is also an upward transfer, when younger members who have gained this experience can guide older members of the family. Family play-learning also encourages motivation and creativity for learning to all members of the family. Also, family play-learning provides several benefits for family learning including playful learning; family play-learning is useful for museum learning; continuing family play-learning at home; inter-generational learning, and family- time as stated above.

However, the most important purpose of the TTTA is the learning outcomes from the activities. The results of this research indicate that families gained learning outcomes from the TTTA. They have learned most in relation to both 'Thai local wisdom' and 'scientific knowledge' when compared with other learning themes. This is largely consistent with the purpose of the study. The results also indicate that participants

gained knowledge and understanding; developed skills; have positive attitudes and value towards TTTA; had enjoyment, inspiration and creativity from the activities; developed action, behaviour and progression; and learnt about scientific knowledge and local wisdom (bi-gnostic learning) from the TTTA.

In this research bi-gnostic learning means one activity (TTTA) could provide two forms of knowledge and understanding including scientific knowledge (Western science) and Thai local wisdom to participants in parallel. There is consistency with the work of Aikenhead (2001) that Aboriginal students should learn Western science, without losing their cultural identity as an Aboriginal. The results of this research indicate that participants gained bi-gnostic knowledge from TTTA. TTTA also encourages bi-gnostic learning through all the facilities in the activity area. The results also show that participants have positive attitudes towards Western science and have awareness towards the importance of scientific knowledge the same as local wisdom. TTTA encourages participants to learn about Thai culture and local wisdom. Also, participants are aware of the importance of Thai local wisdom from the activities. They appreciate the value of local wisdom and prefer to conserve local wisdom for the new generation. Participants suggest that scientific knowledge and local wisdom could develop together because both types of knowledge could support each other and bi-gnostic knowledge is very important to help develop a country.

It was clear that, TTTA enabled me to explore the factors that encourage family play-learning with the activities of a science museum and explained how family play-learning occurred during with the activities. It also provides learning outcomes after having learnt through this activity. Moreover, it encourages participants to learn more about scientific knowledge and local wisdom (bi-gnostic learning) after having joined all facilities of the activities.

5.7 Importance of the research

As stated above, this study is a unique research that brings both initial studies together, that includes 'family play-learning' and 'bi-gnostic learning.

The current international literature discusses family learning in the science museums with the exhibition or hands-on/interactive exhibitions (Goolnik and Curtis, 1995;

Durbin, 1996 and Black, 2005). Most research does not emphasise family play-learning with the traditional toys activities at a science museum. The TTTA is also a unique activity that allows visitors of the museum to learn make and play with the traditional Thai toys in the traditional culture atmosphere (traditional technology gallery) in a modern science museum. The uniqueness of family play-learning with TTTA is make-and-play activities and inter-generation learning where family groupings influence and learn from each other. The analysis of family learning is based upon Bandura's (2001) social cognitive theories, used in relation to this informal museum education. Family play-learning is seen as important, where more experienced members in the family transfer their knowledge and skills to their children or younger members of the family. There is also upward transfer where intelligent youth model the fun and creativity they bring to the tasks. Also, make-and-play activities emphasise learning by doing; so that learners can gain experiences include knowledge and skills through doing (making, playing, acting, drawing etc.) by themselves (Kanhadilok and Watts, 2013a).

The second unique aspect of this research is bi-gnostic learning that discusses local indigenous and Western scientific learning (Aikenhead, 2011; Kanhadilok and Watts, 2013b). However, only a few countries have an interest in bi-gnostic learning for example, Canada, America, Australia and New Zealand (Cajete, 2000; Kawagley, 2000). The bi-gnostic learning in this study is an initial learning style having access to both scientific knowledge and local wisdom as distinctive knowledge system that are provided in one activity (TTTA) at a science museum in Thailand (Kanhadilok and Watts, 2013b).

Nevertheless, the importance of this thesis is to encourage two main government policies of education that encourages family learning in informal education and learning of science and local wisdom. The government's informal educational policy is to encourage informal science education through science and technology centres and the National Science Museum, Thailand. Also, the target group focuses on family groups (The National Science Foundation, 2001). Moreover, the important core policy of education is to encourage scientific and technological knowledge, and knowledge

about culture, local wisdom and the application of wisdom in formal, non-formal and informal education as discussed in the Chapter 2 (Office of the National Education Commission, 2002).

Traditional Thai toys are repositories of local knowledge that have been collected for generations, with the aim of providing opportunities for learning through play. In the Science Museum, traditional Thai toys are used to stimulate understanding, knowledge, imagination, construction, and to encourage awareness of values in local wisdom. Traditional Thai toys are made from local or waste materials that adults and children use to make toys for play. Playing with traditional Thai toys reflects local wisdom, ways of life and the cultures of the community (Kanhadilok and Watts, 2013b). It was clear that TTTA inspires participants to learn more about Thai culture and local wisdom. It also stimulates the awareness of participants that there is a need to conserve this knowledge.

The advantages of family play-learning with TTTA at the Science Museum is that it would benefit researchers, museum educators, activity designers and museum curators, in developing science and local wisdom exhibitions and activities. This research would also encourage museum educational teams to understand how family play-learning and visitors' learning outcomes from the activities of science museum and the factors that encourage visitors' learning with the activities in a science museum. Moreover, the significance of this research would benefit family visitors and all those involved in the field of science education, science museum education, Thai local wisdom and potentially elsewhere. This research is an initial research about family play-learning and bi-gnostic learning. I anticipant this research will be of benefit to the museum organisation and pedagogy of science in the science museum and school of science in Thailand.

5.8 Unique contribution to knowledge

As stated above this is a unique research that emphasises on family play-learning and bi-gnostic leaning with the traditional Thai toy activities.

Family play-learning

The finding of this study indicates that family play-learning is of benefit to family groups with TTTA at a science facility and their home. This learning places emphasis on the transmission of knowledge and skills from more experienced members of family (mainly adults) to their children or younger learners. There is also upward transfer. Family play-learning is a family learning model that is a unique knowledge of play-learning with family groups through TTTA at a science museum. This knowledge would help science museum educators to develop the activities and exhibitions for museum visitors and would benefit family groups in a science museum and elsewhere.

Bi-gnostic learning with TTTA

Bi-gnostic learning has been studied in some countries as stated above. In this research 'bi-gnostic learning' places emphasis on one activity that provides two knowledge systems: scientific knowledge and Thai local wisdom through make and play activities with TTTA in a science museum. This is a unique research that contributes unique knowledge. As stated above, bi-gnostic learning benefits the learner to learn one type of knowledge in parallel with other knowledge in one activity for inspiration of their further learning. The results of this research indicate that participants learnt science parallel local wisdom through TTTA and they have also gained awareness toward the importance of science and technology, and the conservation of Thai local wisdom. Bi-gnostic learning in this research would benefit museum educators and help them to develop the activities and exhibitions and teachers to develop their activities for alternative teaching.

5.9 Limitations of the study and further work and recommendations

5.9.1 Limitations of the study

The research has been limited to family play-learning with make and play activities at a science museum. There was limited space in the TTTA area at the traditional technology gallery at the Science Museum. Moreover, participants at the TTTA were limited to 88 families including adults, teenagers and children. The data was conducted with the family groups who volunteered to participate with the TTTA in the activities area when this research was carried out. Also, this research places emphasis

only on family groups, it does not focus on any other groups such as students, teachers, or school tours etc.

Although, this study is concerned with family play-learning and family learning outcomes from the activities and the factors that encourage the family play- learning in a science museum. This research does not place emphasis directly on the science learning from the school curriculum but focuses on modern science in everyday life, society, traditional Thai culture and basic local wisdom.

Traditional Thai toys in the traditional Thai toys gallery displays several kinds of traditional Thai toys but the toys in the TTTA used only three traditional toys including coconut mouse, paper caterpillar (Toys that use a spring) and flying bird toys (Gravity group) to conduct research. However, these toys were selected from the responses of most visitors collected through a survey done before conducting this research.

5.9.2 Further work and recommendations

This thesis has exclusively studied how family play-learning, family learning outcomes from TTTA, family bi-gnostic learning and the factors that encourage family play-learning. This research places emphasis only on traditional Thai toy activities. The significance of this study is that it will benefit educators, curators, museum staff, teachers, academic researchers and policy makers. In particular, all these audiences should be considered both within Thailand and other countries around the world. However, there are still many ways to research the effectiveness of family play-learning and bi-gnosis learning in a science museum and other places. Hence, further research could be carried out in all these diverse learning places, not only in Thailand but also worldwide. The details of further work and recommendations as follows:

The findings of this research indicate that TTTA provided knowledge, skills, inspiration, creativity, attitude, enjoyment, scientific knowledge and local wisdom to family member groups. It was clear that this activity benefited people for all ages. A further study could be carried out with emphasis on the other groups, for example

student or, teacher groups who are interested in the TTT, or other interested groups. Also, the comments of the participants indicated that TTTA were useful for family groups to study bi-gnostic learning. They suggested that TTTA should find its way into the school curriculum or teacher training in order to conserve traditional Thai toys, Thai culture, local wisdom and the learning of scientific knowledge together. Further research could conduct the TTTA within schools or teacher training programmes to find out the way to insert these make and play activities into the school curriculum. This research and activity should be supported and promoted officially because it is following the main policy of education in part of Thai culture and the preservation of traditions in Thailand. So, the policy makers and teachers should consider about the importance of make and play activity and bi-gnostic learning, not only in the museums but also at school or to the curriculum worldwide.

However, the limitation of this research is that it was conducted only in the TTTA area at the Science Museum with only middle class participants. Most of them live in the centre of Thailand. Further research could be conducted in the different museums or other places and with different groups of people. For example, further research in Thailand could be conducted with the science caravan of NSM that could travel around Thailand to exhibit scientific knowledge. This research would explore the bi-gnostic learning of Thai people and provide these knowledge systems to them. This group would represent all levels of Thai society. So, this research would encourage Thai people to learn science and local wisdom from this activity. Also, TTTA would inspire them to study more about bi-gnosis to develop their study and further adapt to their work, for the sustainable development of the country that is consistent with the mission of the National Science Museum, Thailand.

For an international research suggestion, academic researchers or museum staff worldwide should consider and apply 'Bi-gnostic learning' to learners meaning that one activity can provide two types of knowledge systems for the learner. This research provides emphasis on scientific knowledge and Thai local wisdom. Further research of bi-gnostic learning in other countries could place emphasis on the other pairs of learning, for example scientific learning and other countries' wisdom, or scientific

learning with local language, or other pairs of subjects, etc. These researches would depend on the researchers' interest. It would benefit students to parallel the study of two types of knowledge and to conserve their own indigenous knowledge, cultures or the local wisdom of their own country.

Moreover, policymakers, museum staff, teachers, and academic researchers worldwide should consider the importance of family play-learning; that family groups could learn from each family member as an intergenerational learning process. Further research could be developed to investigate the effectiveness of family play-learning in different aspects or different learning environments, for example in art museums, historical museums, learning centres, zoos, etc. These researches would be of benefit to family groups and stakeholder audiences as I mentioned before and also these researches would   benefit pedagogy in schools, museums or other learning environments in Thailand and worldwide.

"Family play- learning is very good for our family because I can learn about the toys and my children can learn from me. We enjoy playing with the toys. We have playfulness to learn with the toys and to gain scientific knowledge and local wisdom. It is a time for the family" (Mother F50).

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APPENDICES

APPENDIX 1

PQ

| **Playfulness questionnaire** | Number……… |

My name is Peeranut Kanhadilok. I am a student at Brunel University London and I am conducting a survey about peoples' interest in personal playfulness. The following questions are designed to find out about the playfulness of your character. Please complete this questionnaire. Because it is anonymous and confidential you do not need to write your name.

Part 1: General Questions

1. How old are you? *Fill in the blank*

………………..years

2. Are you male or female? ☑ *The box*

☐ Male   ☐ Female

3. What is your education? ☑ *The box*

☐ Primary school   ☐ Secondary school

☐ High school   ☐ Bachelor degree

☐ Master's degree   ☐ PhD

4. What words in your opinion best describe your character?

(Choose the option that relates closest to your ideas about yourself)

Your character	Very like me	Quite like me	Not quite like me	Not at all
1. Cheerful				
2. Happy				
3. Friendly				
4. Outgoing				
5. Sociable				
6. Spontaneous				
7. Impulsive				
8. Unpredictable				
9. Adventurous				
10. Funny				
11. Active				
12. Energetic				

Adapted from Barnett (2007)

APPENDIX 2

Number...............

Toy Learning Outcomes questionnaire about interest in toys

My name is Peeranut Kanhadilok. I am a student at Brunel University London and I am conducting a survey about your interest in toys and the outcomes learnt from making and playing with toys. The following questions are designed to find out your opinions and interest in toys and the outcomes from participation in traditional Thai toy activities. Because it is confidential you do not need to write your name.

Part 1: General Questions

1. How old are you?   *Fill in the blank*

……………………....years

2. Are you male or female?   ☑ *Please tick the boxes*

☐ Male   ☐ Female

3. What is your education? ☑ *Please tick the boxes*

☐ Primary school   ☐ Secondary school

☐ High school   ☐ Bachelor degree

☐ Master's degree   ☐ PhD

Part 2: Your character about playfulness

4. Would you describe yourself as playful?

☐ Very like me   ☐ Quite like me

☐ Not quite like me   ☐ Not at all

Part 3: Your interest in toys

5. Do you usually play with toys?

☐ Often   ☐ Sometimes

☐ Seldom   ☐ Never

6. What kind of toys do you like to play with?

Your answer ……………………………………………………………

……………………………………………………………………………..

7. When you play with toys, which characteristic best describes how you feel?

(Choose <u>one characteristic </u>that relates closest your feelings)

☐ Very interested   ☐ Bored

☐ Interested   ☐ Very bored

8. When you make and play with toys in the traditional Thai toy activity area,

what do you think about these toys?

(Choose the option that most closely relates to your ideas)

☐ Very fascinating   ☐ Boring

☐ Fascinating   ☐ Very boring

9. When you make and play with toys, what do you think about your learning

from the toys?

(Choose the option that most closely relates to your ideas)

9.1 Knowledge and understanding	A lot	Some	Little	Nothing
1) You learned how to make and play with the toys, something you didn't know before				
2) You understood the toys				
3) The toys gave you specific information. For example, its history, how it was used by people or where it was used				
4) How the toy makes links and relationships between other things in life that you know about it. For example, people, animals, places, or objects				
9.2 Skills	**A lot**	**Some**	**Little**	**Nothing**
1) You gained intellectual skills from the toys. For example, ideas, thinking, making, listening				
2) You achieved new physical skills from the making and playing with toys. For example, in making, handling, playing and painting				
3) You learned new social skills from the making and playing with the toys. For example, meeting new people, sharing with friends and family, team working, working with others				
4) You learned new emotional skills from making and playing with the toys. For example, recognizing the feelings of others, managing your feelings				

	A lot	Some	Little	Nothing
5) You learned new communication skills from making and playing with the toys. For example, listening to others, discussing, describing, making yourself clear to others				
9.3 Attitude and values	**A lot**	**Some**	**Little**	**Nothing**
1) The toys changed your feelings and perceptions about playing with toys, something you didn't feel before				
2) You gained confidence with other people from making and playing with the toys				
3) You changed your opinion or attitudes towards other people when you made and played with the toys with other people				
4) The toys helped you enjoy your family or your friends				
5) You gained positive attitudes from the making and playing with the toys				
9.4. Enjoyment, inspiration and creativity	**A lot**	**Some**	**Little**	**Nothing**
1) You had fun, when you played with the toys				
2) The toys surprised you				
3) After you had made and played with the toys, you had innovative thoughts				
4) The toys prompted you to be creative				
9.5 Action, behaviour and progression	**A lot**	**Some**	**Little**	**Nothing**
1) You understood why the people love to make and play with toys				
2) You understood the intentions of the toy maker				
3) When you played with the toys, you felt more independent from study or working				
4) Toys helped you to be interested in playing with other toys				
5) Making and playing with the toys changed your behaviour				

9.6 Scientific learning	A lot	Some	Little	Nothing
1)You understood the science involved with toys				
2) Making and playing with these toys made you understand science better than before. For example, about energy, force and motion, sound				
3) You learned scientific skills from making and playing with the toys. For example, observation, experiment, presentation and discussion				
4) You had fun learning science by making and playing with these toys				
5) Making and playing with these toys inspired you to be a scientist				
6) Making and playing with these toys inspired you to go to the Science Museum again				
9.7 Attitude towards Thai local wisdom	**A lot**	**Some**	**Little**	**Nothing**
1) Toys helped you understand more about Thai wisdom. For example, Thai culture, Thai wisdom of life style, belief or narratives				
2) You had fun learning Thai local wisdom with making and playing with these toys				
3) Making and playing with these toys inspired you to study Thai local wisdom further				
4) Making and playing with these toys inspired you to conserve Thai local wisdom				

Part 3: <u>Environment and Resources</u>

10. When you made and played with toys, what did you think about the environment and resources in the Traditional Thai Toy Activities area?

(Choose the option that most closely relates to your ideas)

10.1 Environment

Exhibition	Most conducive	Conducive	Partially conducive	Non-conducive
1. The exhibition helped your learning				
2. The light and sound (atmosphere) in the exhibition area was suitable for your learning				
3. The collection of the old traditional Thai toys helped you to understand about Traditional Thai Toys				

10.2 Resources

Resources	Most Appropriate	Appropriate	Partially Appropriate	Inappropriate
1.The Explainer helped you to understand the science and local wisdom from TTTA				
2. Assistants in your group helped you to make and play with your toys				
3. The materials for making the toys were appropriate and sufficient enough for you to construct the toys				
4. The Toys hand book helped your learning and was suitable for you				
5. The toys that you made today were appropriate for you				

Please add a comment about making and playing with toys in this activity

----

Thank you very much
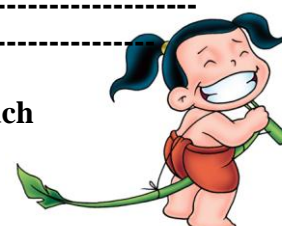
APPENDIX 3

Family number……………

FMLHQ

Families' motivation of learning at home questionnaire

My name is Peeranut Kanhadilok. I am a student at Brunel University London and I am conducting a survey about families' motivation of learning at home after participating in a traditional Thai toy activity in the Science Museum. Please complete this questionnaire – as this survey is anonymous and confidential you do not need to write your name.

After your family participated with TTTA and then returned home:

1. Did you use the skills or knowledge from TTTA in your daily life?

(Tick the options that most closely relate to your ideas)

☐ Taught other people to make the traditional Thai toys

☐ They enabled me to better adapt to my work

☐ Told others about the traditional Thai activities and how to make the toys

☐ Made the toys again

☐ Gave the toys to other people

☐ Did nothing

☐ Other reasons…………………………………………………………………….

2. Did your children use the skills or knowledge from TTTA in their daily lives?

(Tick the options that most closely relate to your ideas)

☐ Taught other people to make the traditional Thai toys

☐ Helped them to adapt to their work or study

☐ Told others about the traditional Thai activities and how to make the toys

☐ Made the toys again

☐ Gave the toys to other people

☐ Did nothing

☐ Other reasons…………………………………………………………………….

Thank you very much
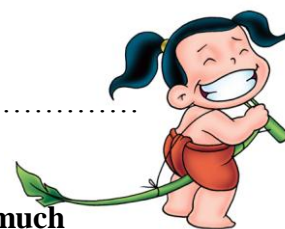
APPENDIX 4

Bi-gnostic learning interview questions: awareness of Western modern science and traditional Thai culture and local wisdom

Introduction:

My name is Peeranut Kanhadilok. I am a student at Brunel University London and I am interested in learning about how participating in TTTA may have an impact on people's awareness of Western science and local wisdom. This interview will be anonymous and confidential you do not need to write your name.

Part 1: *General background*

1. How old are you?....................years

2. (Observes gender) ☐ Male   ☐ Female

3. What is your education?

☐ Primary school   ☐ Secondary school

☐ High school   ☐ Bachelor degree

☐ Master's degree   ☐ PhD

Part 2: *Awareness of Western science*

1. Does TTTA help you gain more understanding about some scientific knowledge? Give your reason.

Answer ………………………………………………………………………………

2. Does TTTA inspire you to study more science in the future?

  Give your reason.

Answer…………………………………………………………………………..

 3. Is scientific knowledge important? How? Give your reason.

Answer …………………………………………………………………………..

Part 3: *Awareness of traditional Thai culture and local wisdom*

1. Does TTTA help you understand more about traditional Thai culture and local wisdom? Give your reason.

Answer …………………………………………………………………………………

2. Does TTTA inspire you to study traditional Thai culture and local wisdom in the future? Give your reason.

Answer .……………………………………………………………………………..

3. Does TTTA inspire you to conserve traditional Thai culture and local wisdom? Give your reason.

Answer …………………………………………………………………………..

4. Is traditional Thai culture and local wisdom important? How? Give your reason.

Answer …………………………………………………………………………..

Part 4: *Awareness of Western modern science and traditional Thai culture and local wisdom*

1. Between scientific knowledge (SK) and traditional Thai culture (TTC) and local wisdom (LW), which one is the most important for Thailand? Give your reason.

Answer …………………………………………………………………………..

2. What is the relationship between scientific knowledge (SK) and traditional Thai culture (TTC) and local wisdom (LW)? For example SK, TTC and LW support and interact with each other. Give your reason.

Answer ………………………………………………………………………….

3. Does scientific knowledge (SK) and traditional Thai culture (TTC) and local wisdom (LW) develop together? Give your reason.

Answer …………………………………………………………………………

Thank you very much
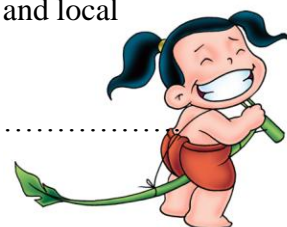
APPENDIX 5

Analysis of the playfulness questionnaire (PQ) data

Part one: Respondents' background

Figure AP5.1: The age of respondents
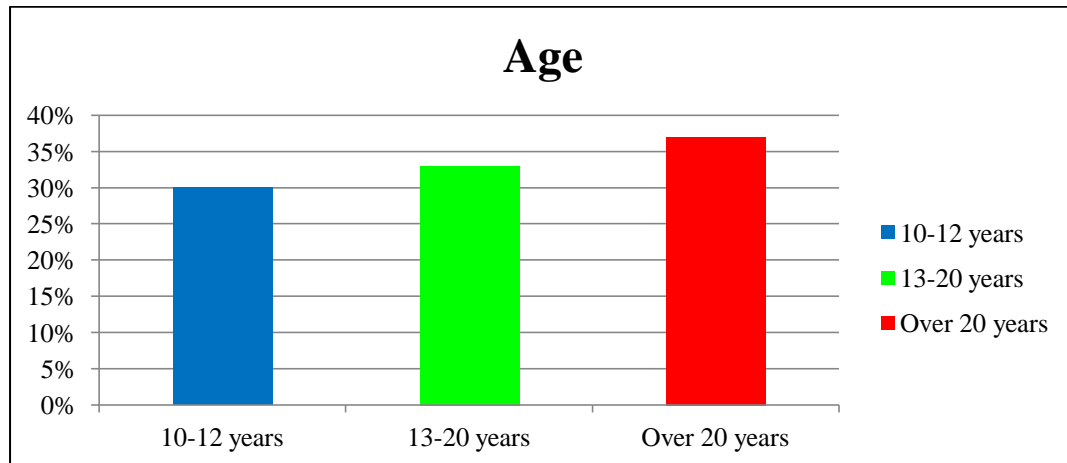
Figure AP5.2: The gender of respondents
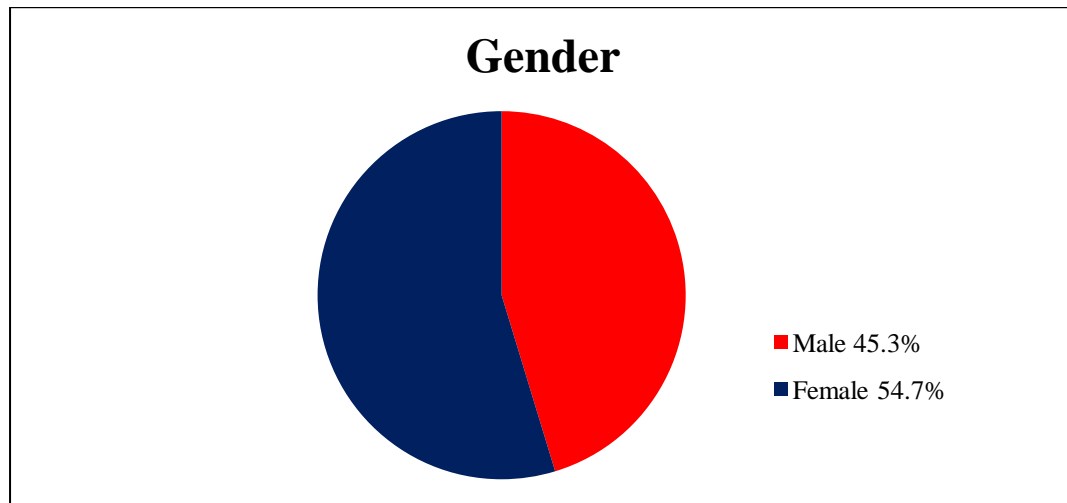
Figure AP5.3: The education of respondents
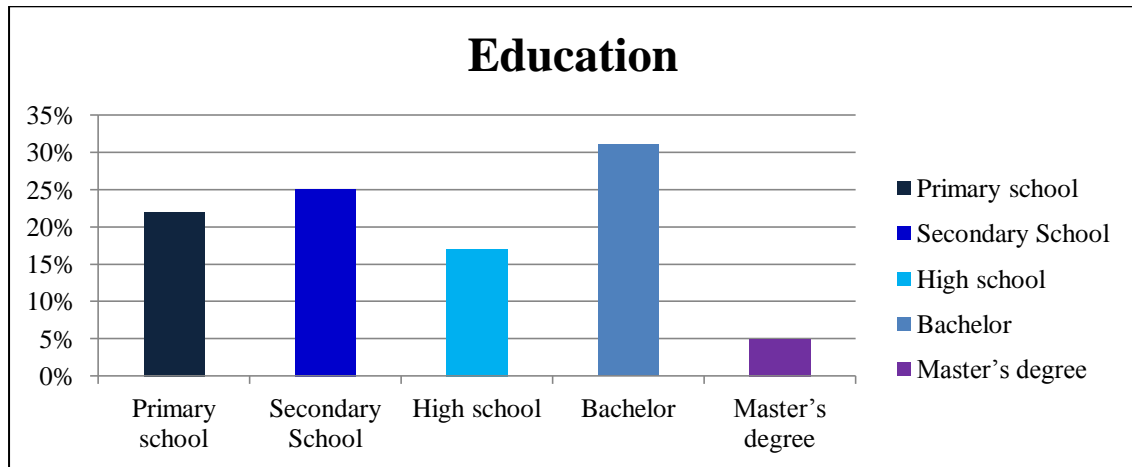
Part two: Family playfulness characteristics

Figure AP5.4: The average of playfulness characteristics for the whole population
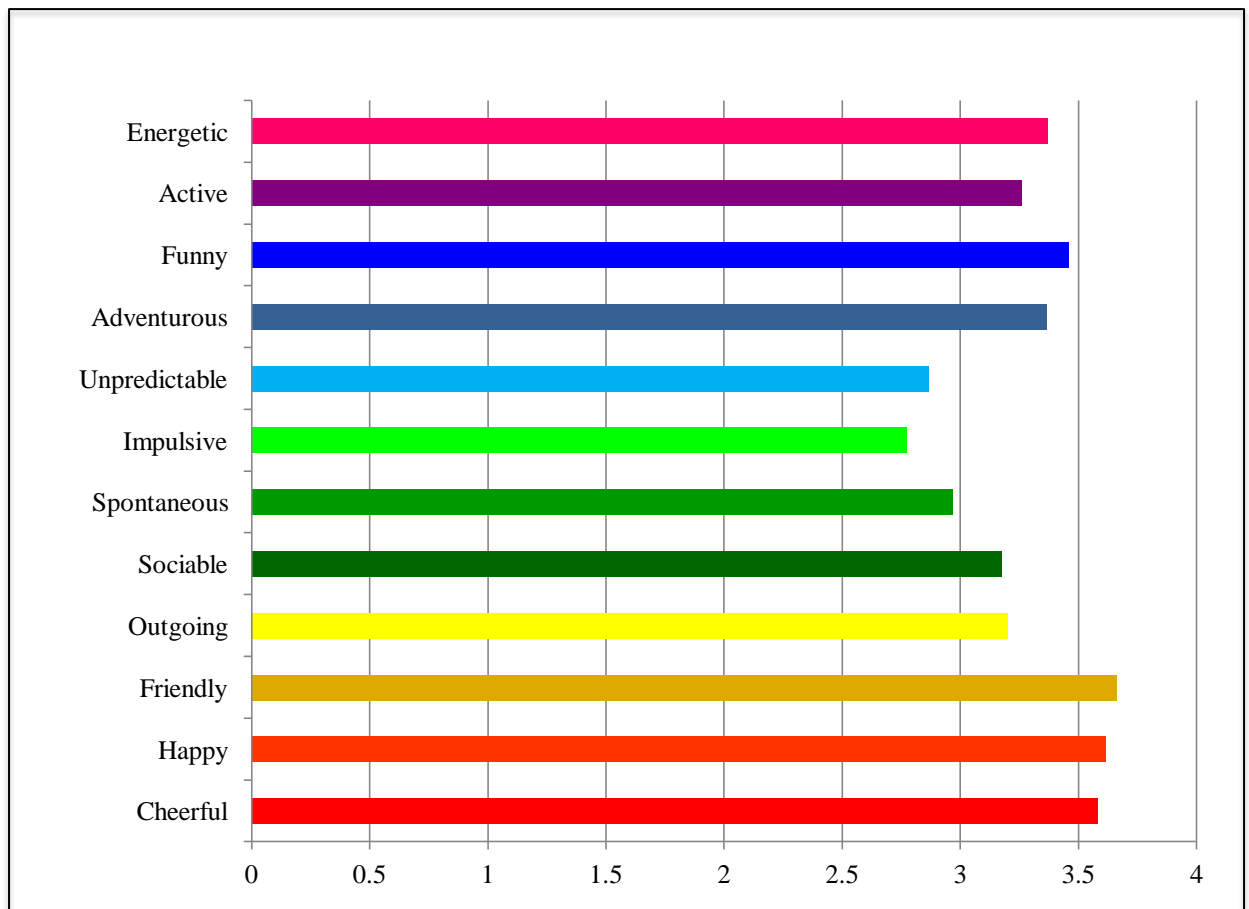
(1: Not at all, 2: Not quite like me, 3: Quite like me and 4: Very like me)

Figure AP5.5: The average of playfulness characteristics between each family age group
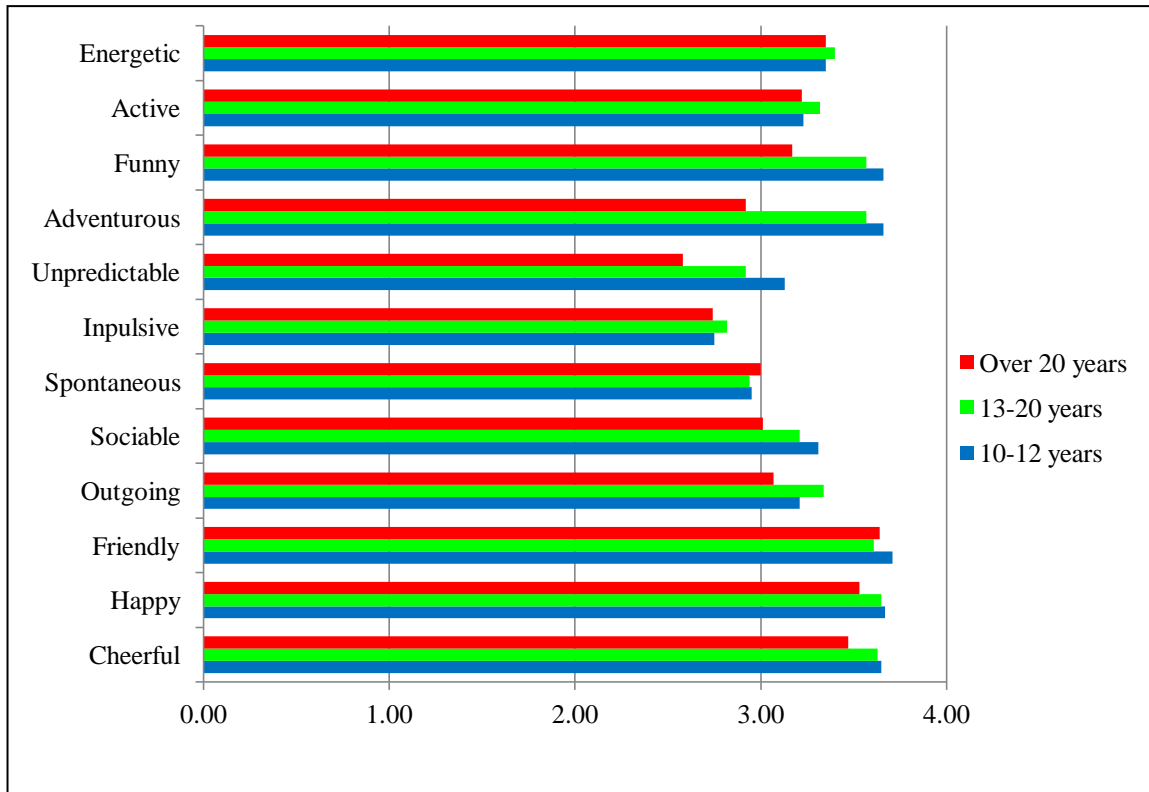
Figure AP5.6: The average of playfulness characteristic between genders in the family group
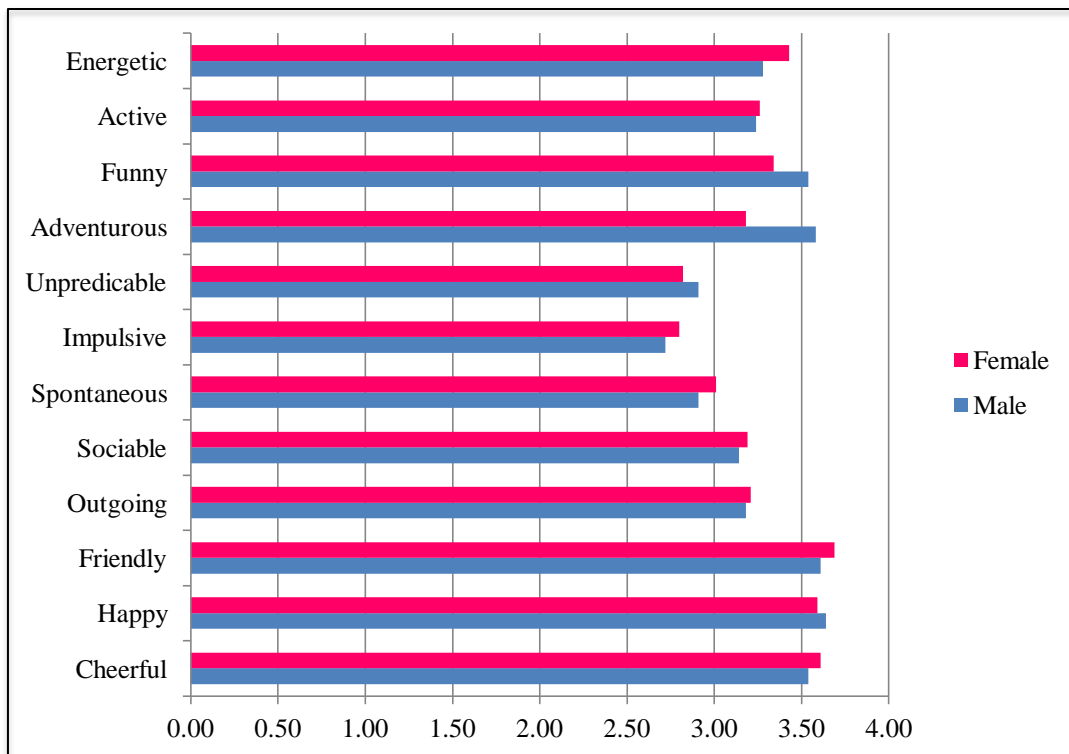
APPENDIX 6

Analysis of toy learning outcomes questionnaire (TLOQ) data

Part 1: The background of participants

Figure AP6.1: The age of participants
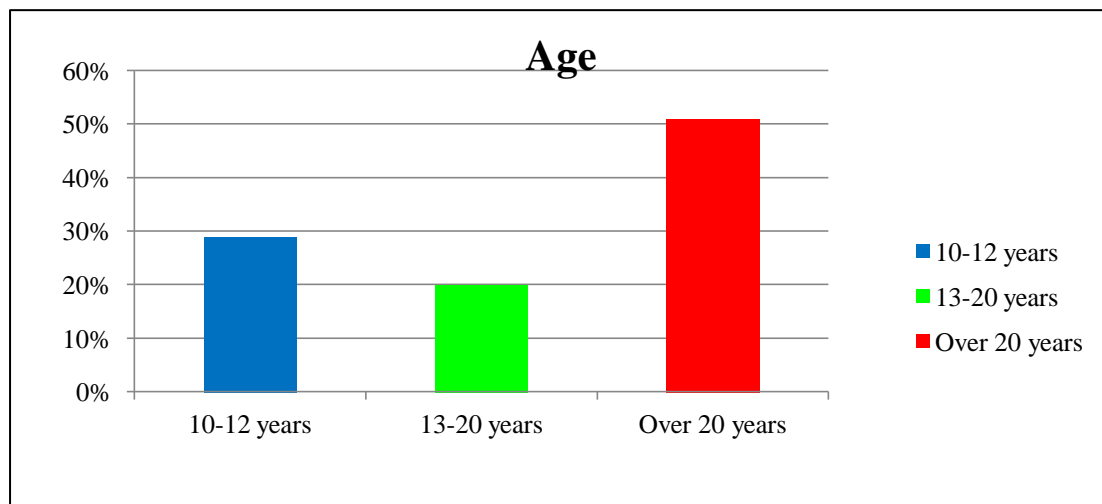
Table AP6.1: Mean, Median and mode of Adults' ages

Statistics

N	Valid	64 people
	Missing	0 people
Mean		39.31 years
Median		39.50 years
Mode		38 years

Figure AP6.2: The age of adults

Ages of adults
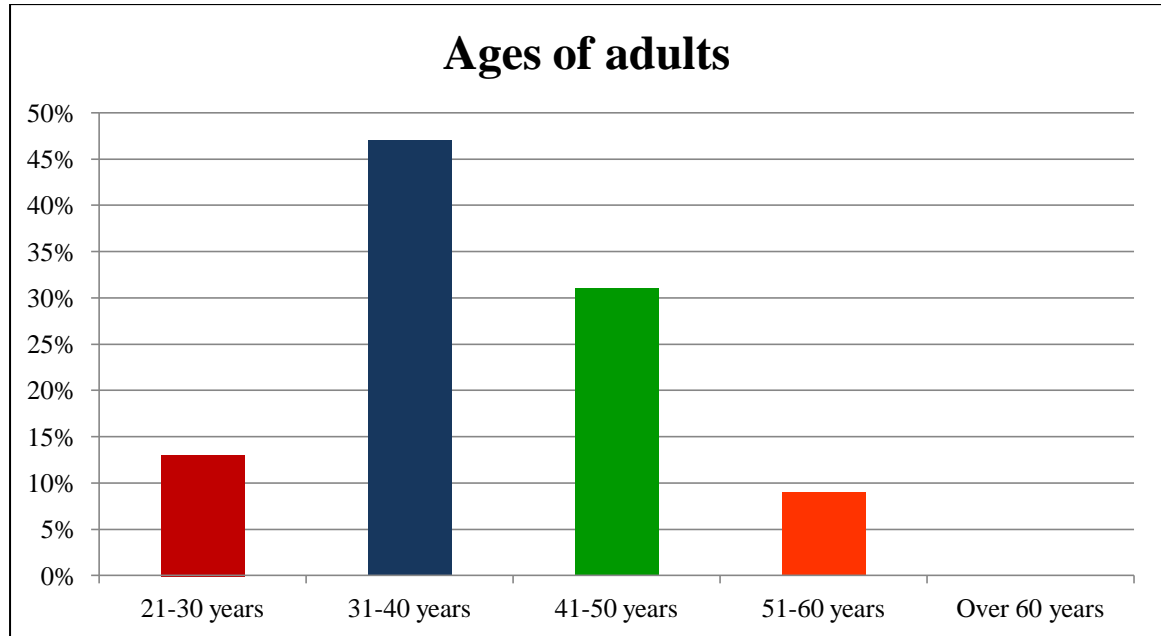
Figure AP6.3: The gender of participants

Gender

Male 38%　Female 62%
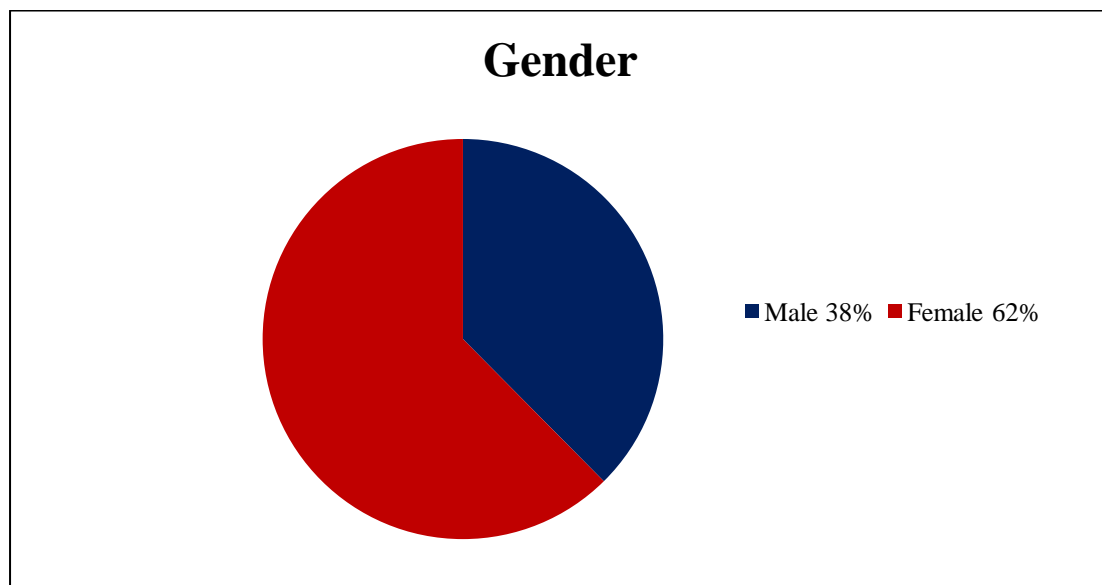
Figure AP6.4: The education of participants

Education
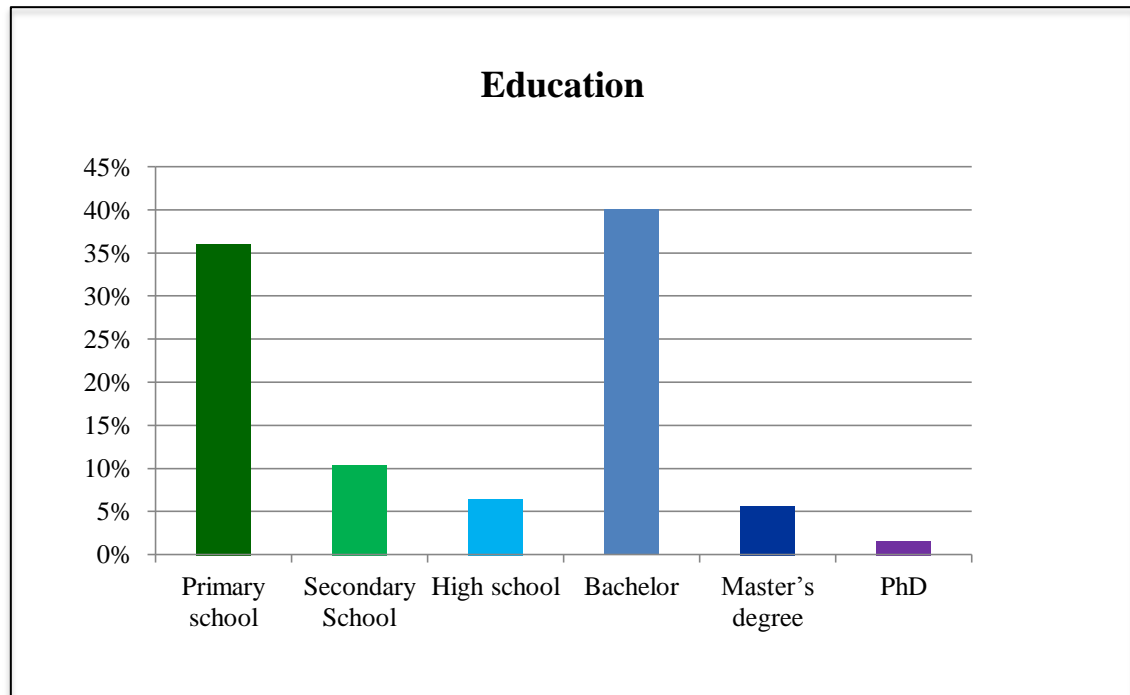
Part 2: Participants' interest in the toys and toy learning outcomes

2.1 Participants' playfulness

Figure AP6.5: Comparison between the ages of participants who label themselves as playful
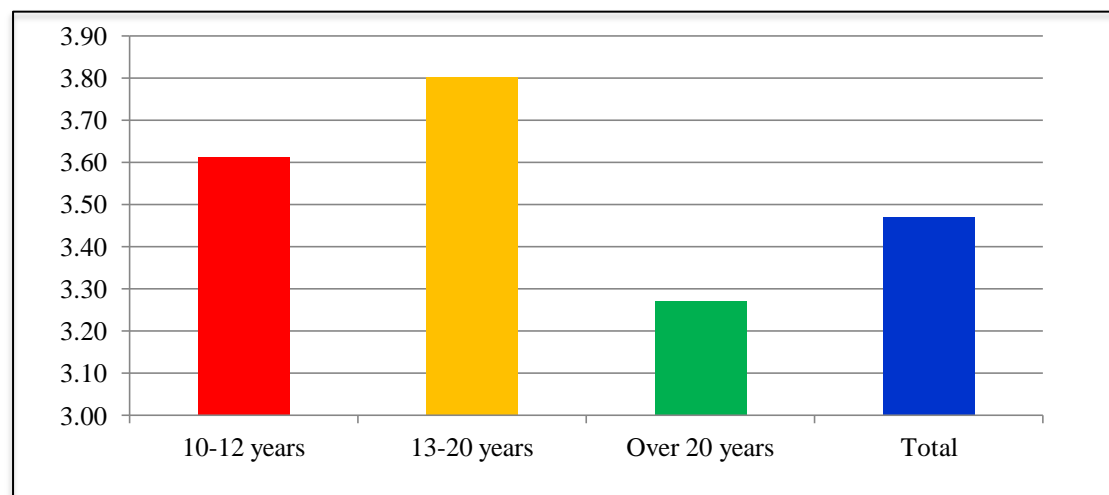
Figure AP6.6: Comparison between the genders of participants who label themselves as playful
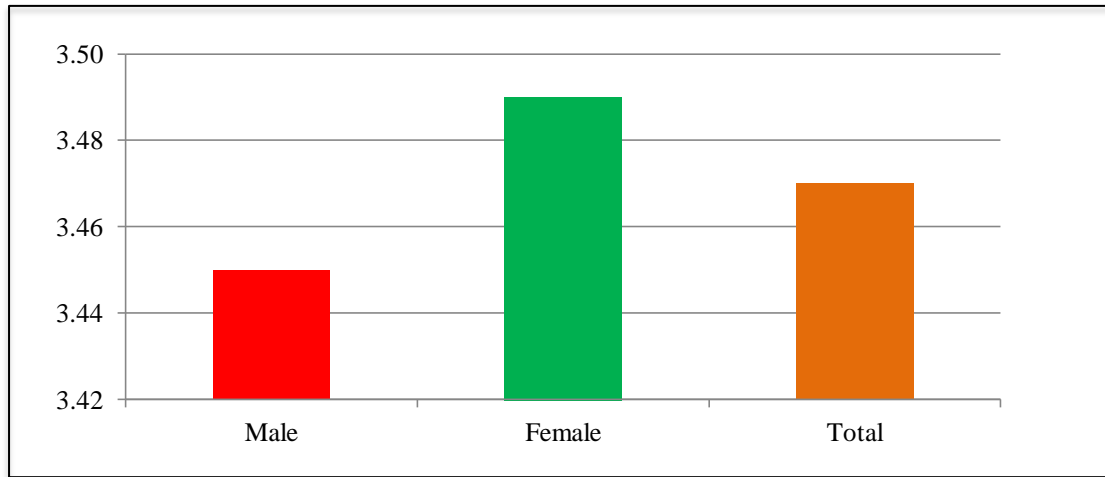
2.2 How often participants play with the toys

Figure AP6.7: Comparison between participants' ages and how often they play with the toys
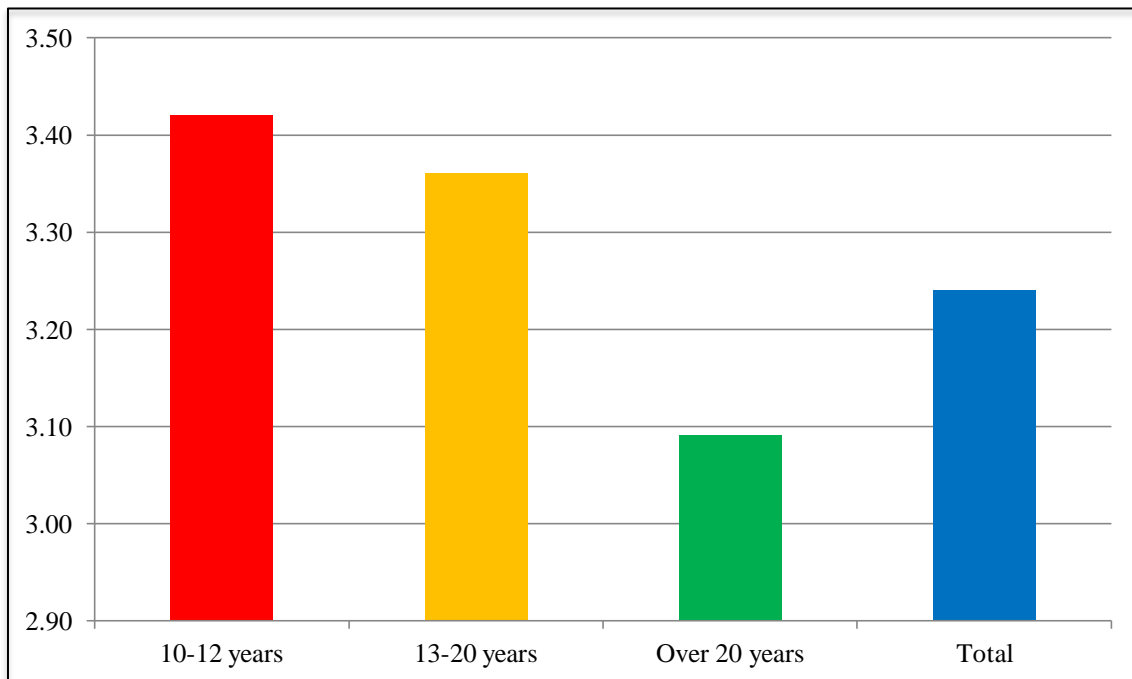
Figure AP6.8: Comparison between genders and how often they play with the toys
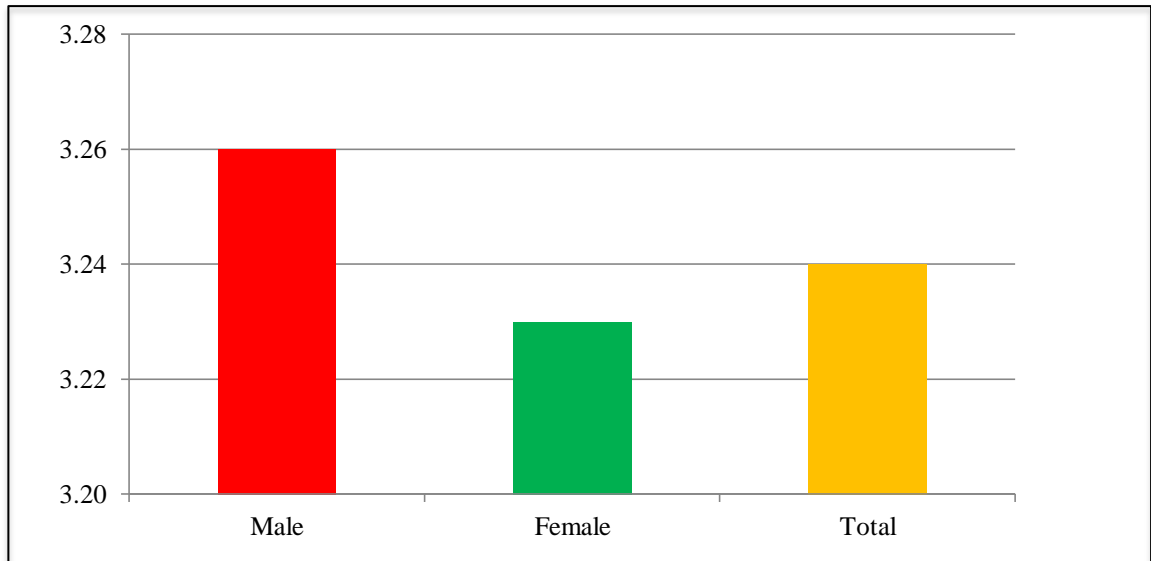
2.3 Participants' favourite toys

Figure AP6.9: The kind of toys that participants like to play with
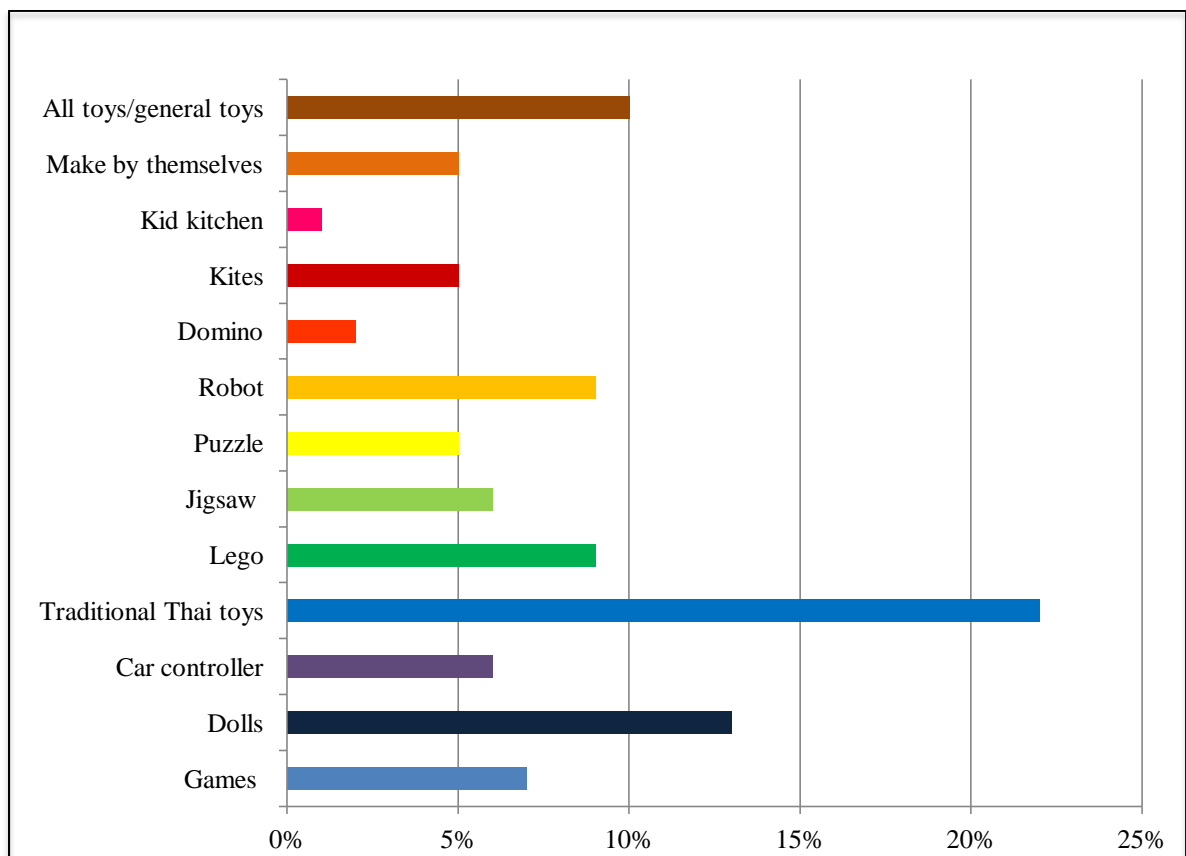
2.4 The feeling of participants through playing with the toys

Figure AP6.10: Comparison between participants' ages and how they feel during play with the toys
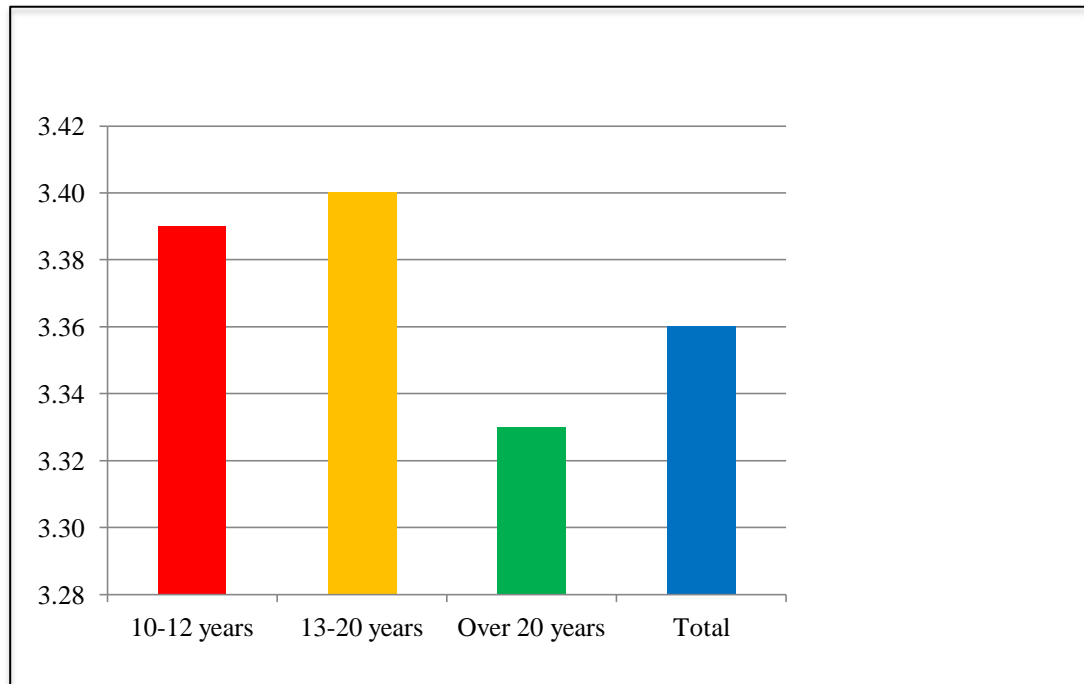
Figure AP6.11: Comparison between participants' genders and how they feel during play with the toys
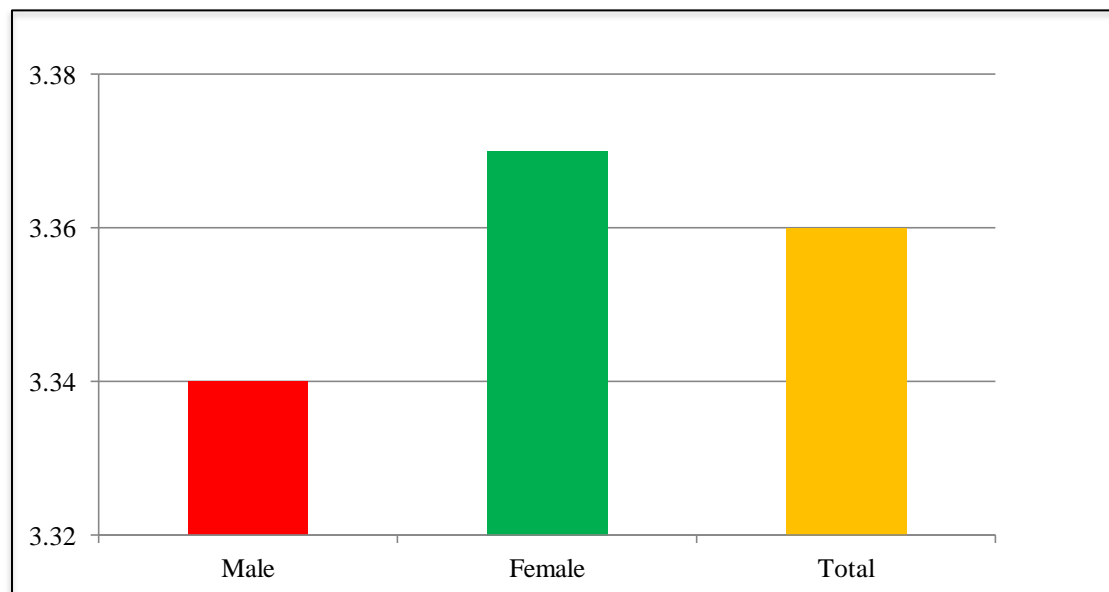
2.5 Participants' thinking about the toys they made in the TTTA

Figure AP6.12: Comparison between participants' ages and what they think about the toys they made and played with in the TTTA.
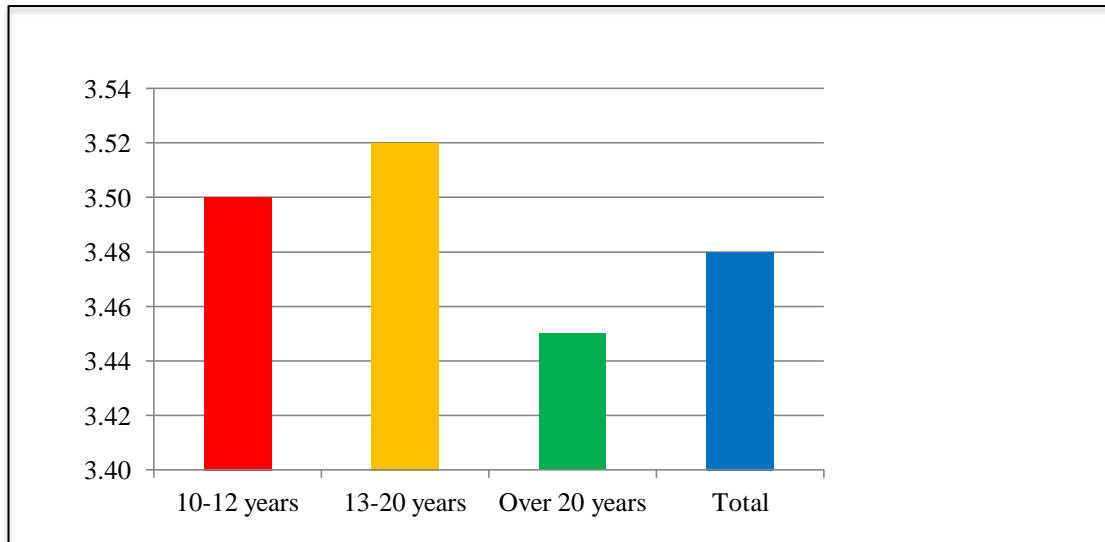
Figure AP6.13 Comparison between participants' genders and what they think about the toys they made and played with in the TTTA.
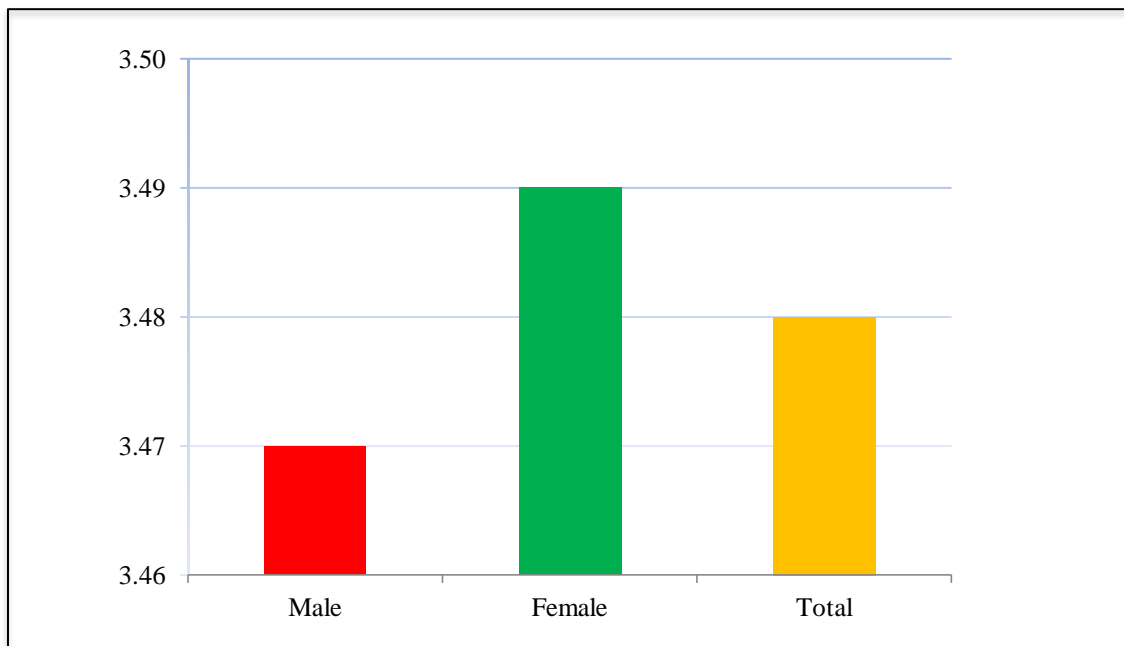
2.6 Toy learning outcomes

The meaning of the scale of learning outcomes from the TTTA

(1: Nothing, 2: Little, 3: Some and 4: A lot)

2.6.1. Knowledge and understanding

Figure AP6.14: Comparison between participants' ages and how they gained knowledge and understanding
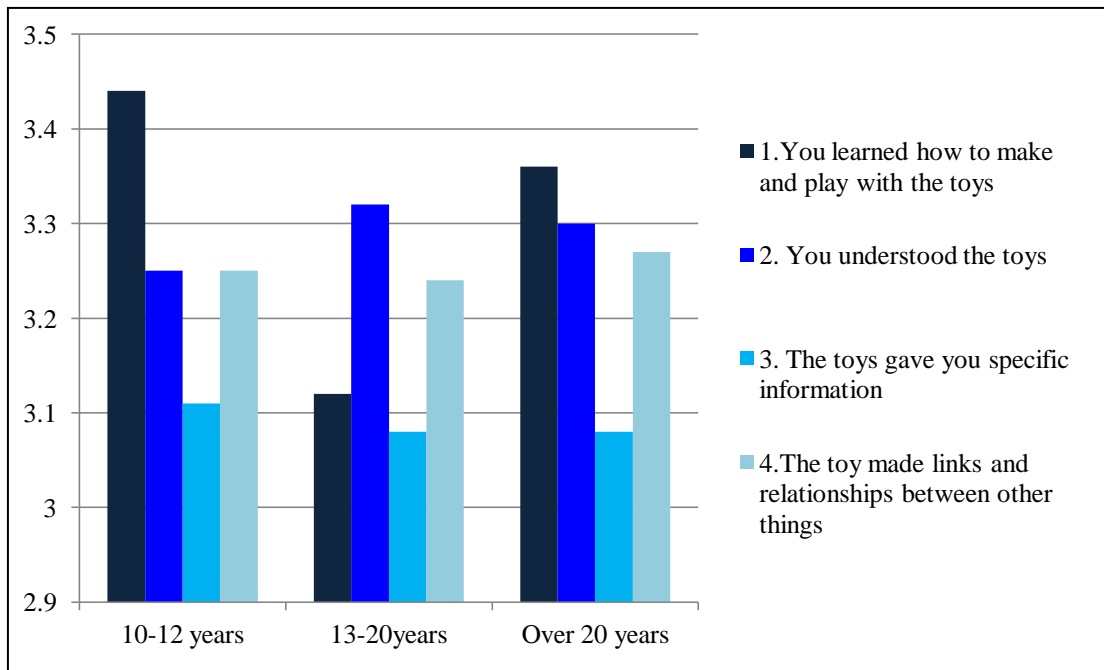
Figure AP6.15: The average of all areas of knowledge and understanding
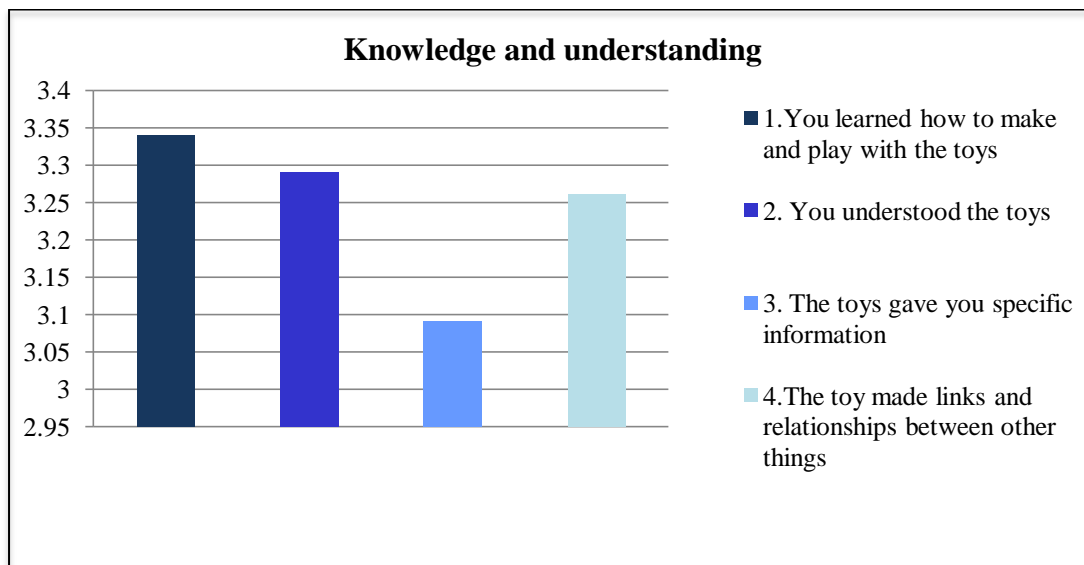
2.6.2. Skills

Figure AP6.16: Comparison between participants' ages and how they developed skills
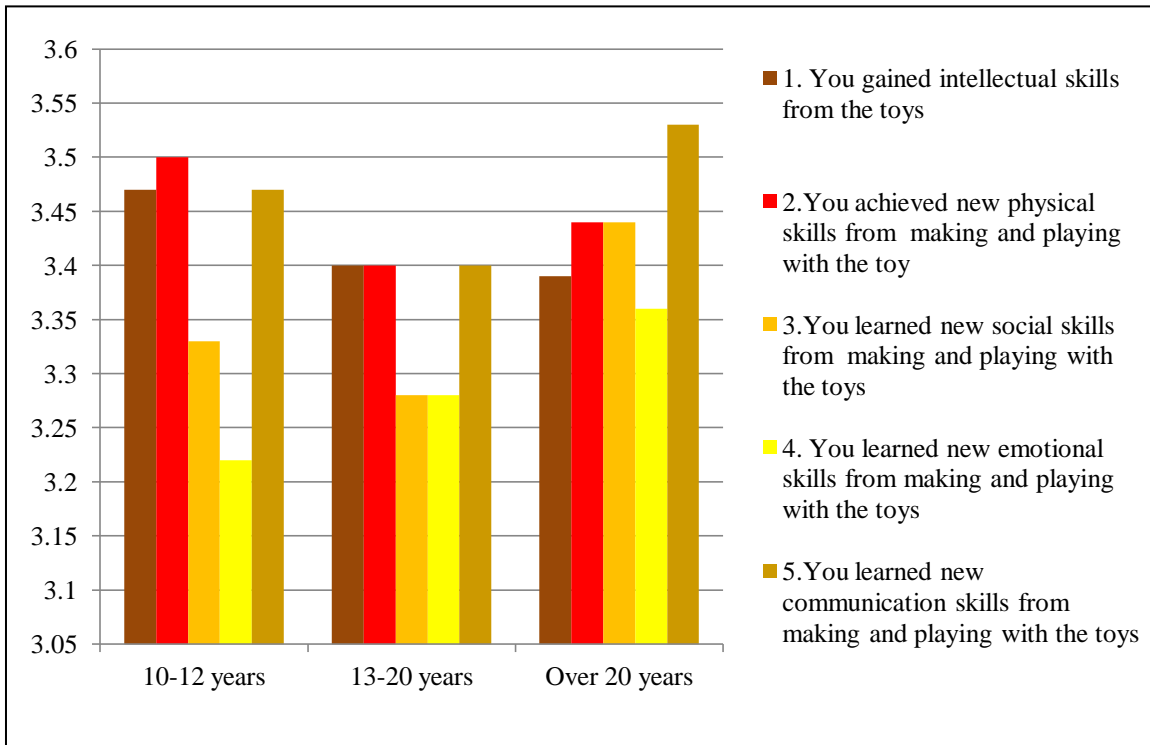
Figure AP6.17: The average of all areas of skills
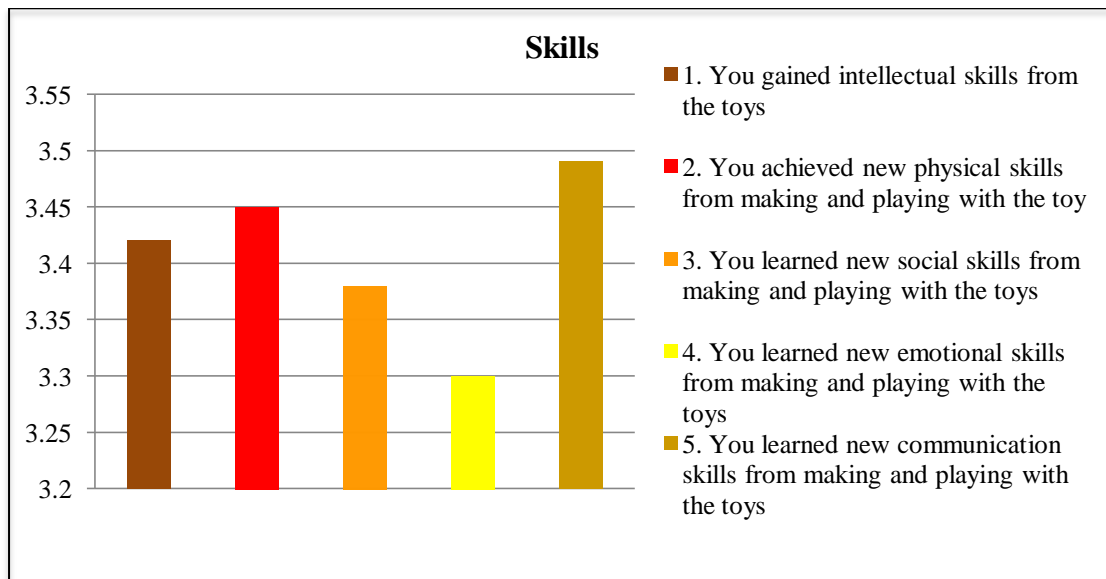
2.6.3. Attitude and values

Figure AP6.18: Comparison between participants' ages and how they developed attitude and values
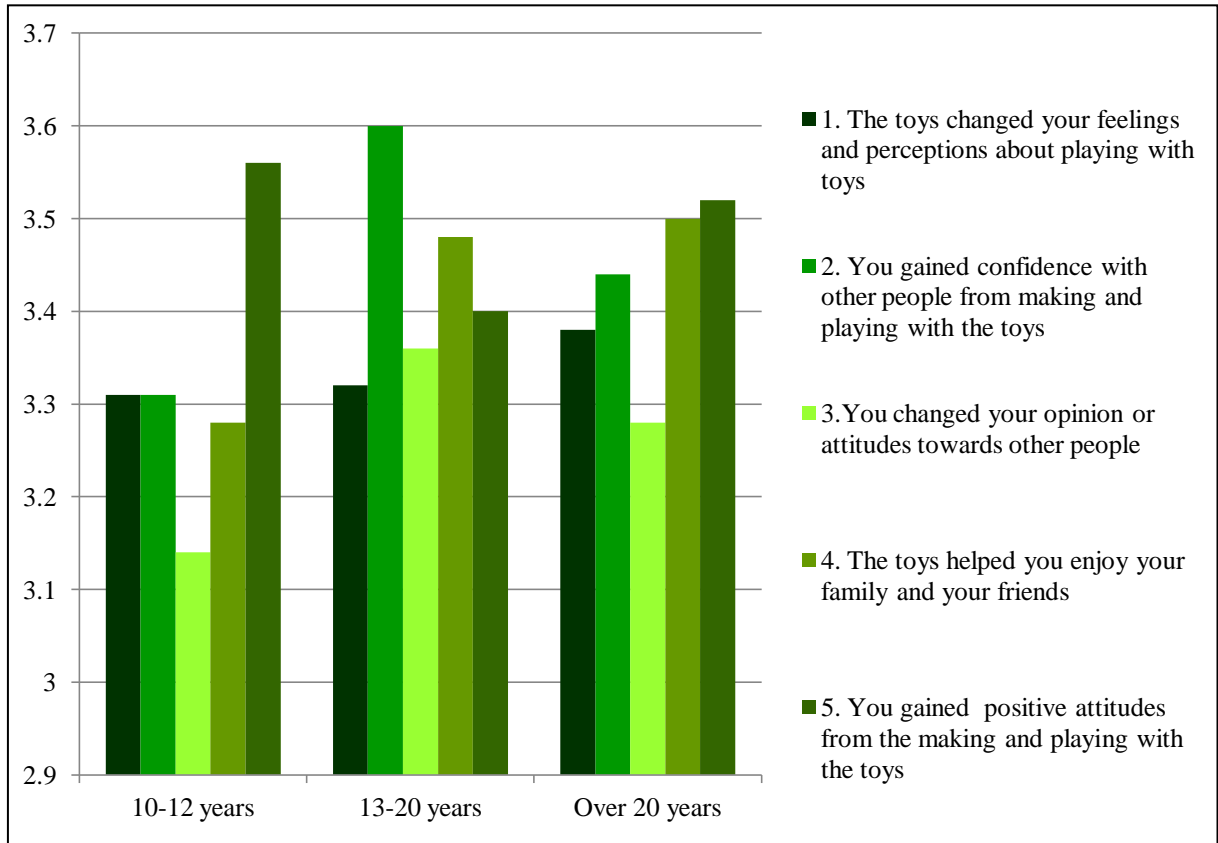
Figure AP6.19: The average of all areas of attitude and values
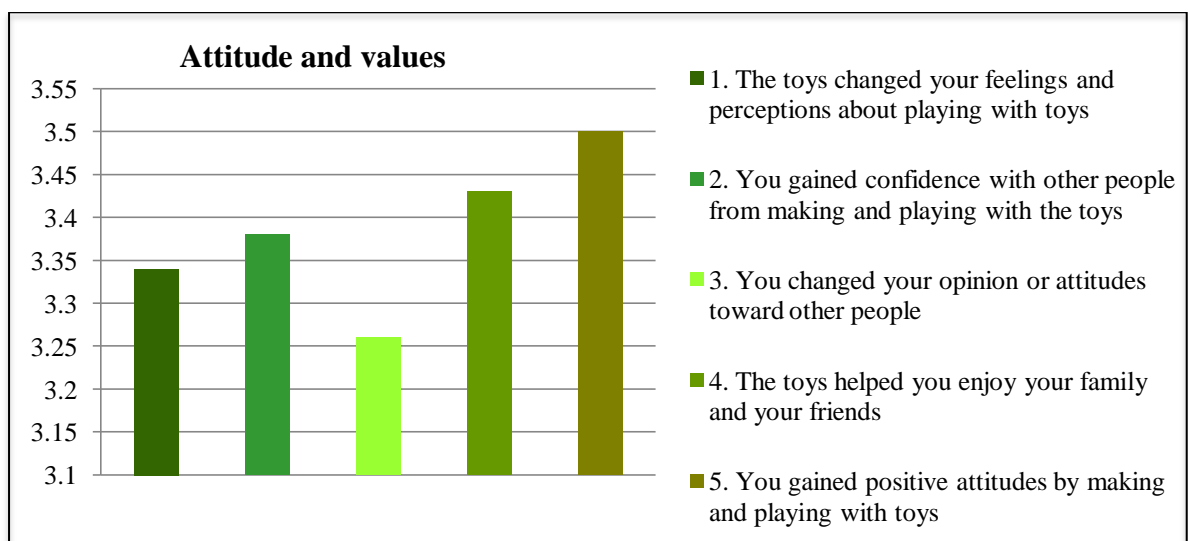
2.6.4. Enjoyment, inspiration and creativity

Figure AP6.20: Comparison between participants' ages and how they gained enjoyment, inspiration and creativity
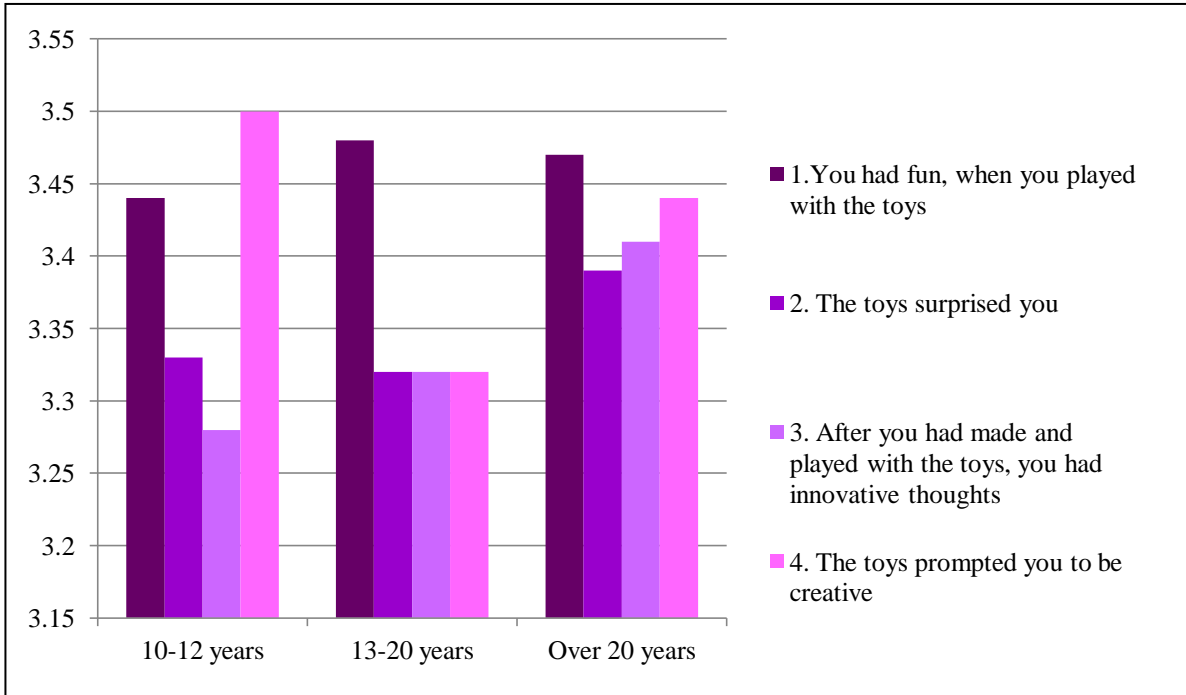
Figure AP6.21: The average of all areas of enjoyment, inspiration and creativity
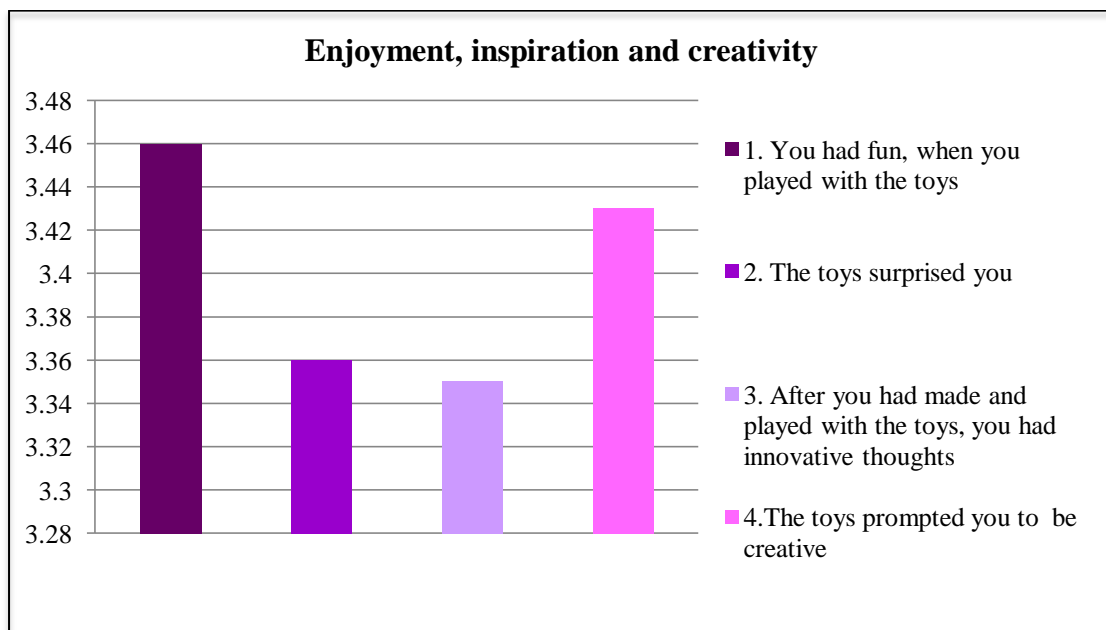
2.6.5 Action, behaviour and progression

Figure AP6.22: Comparison between participants' ages and how they developed action, behaviour and progression
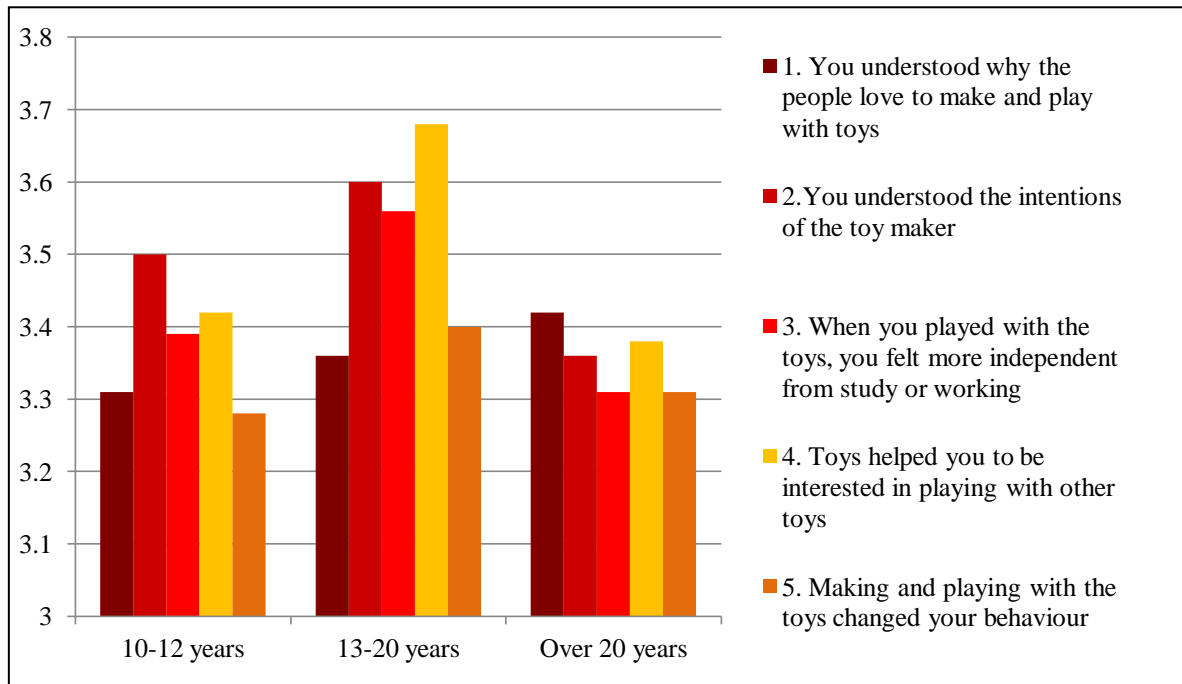
Figure AP6.23: The average of all areas of action, behaviour and progression
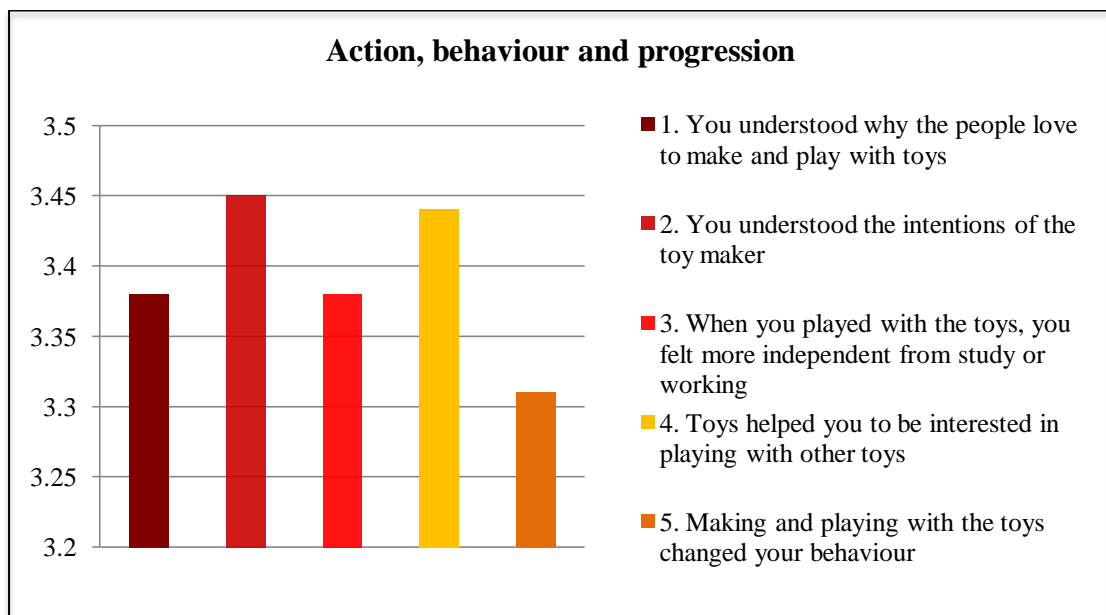
2.6.6 Science learning

Figure AP6.24: Comparison between participants' ages and how they learnt science
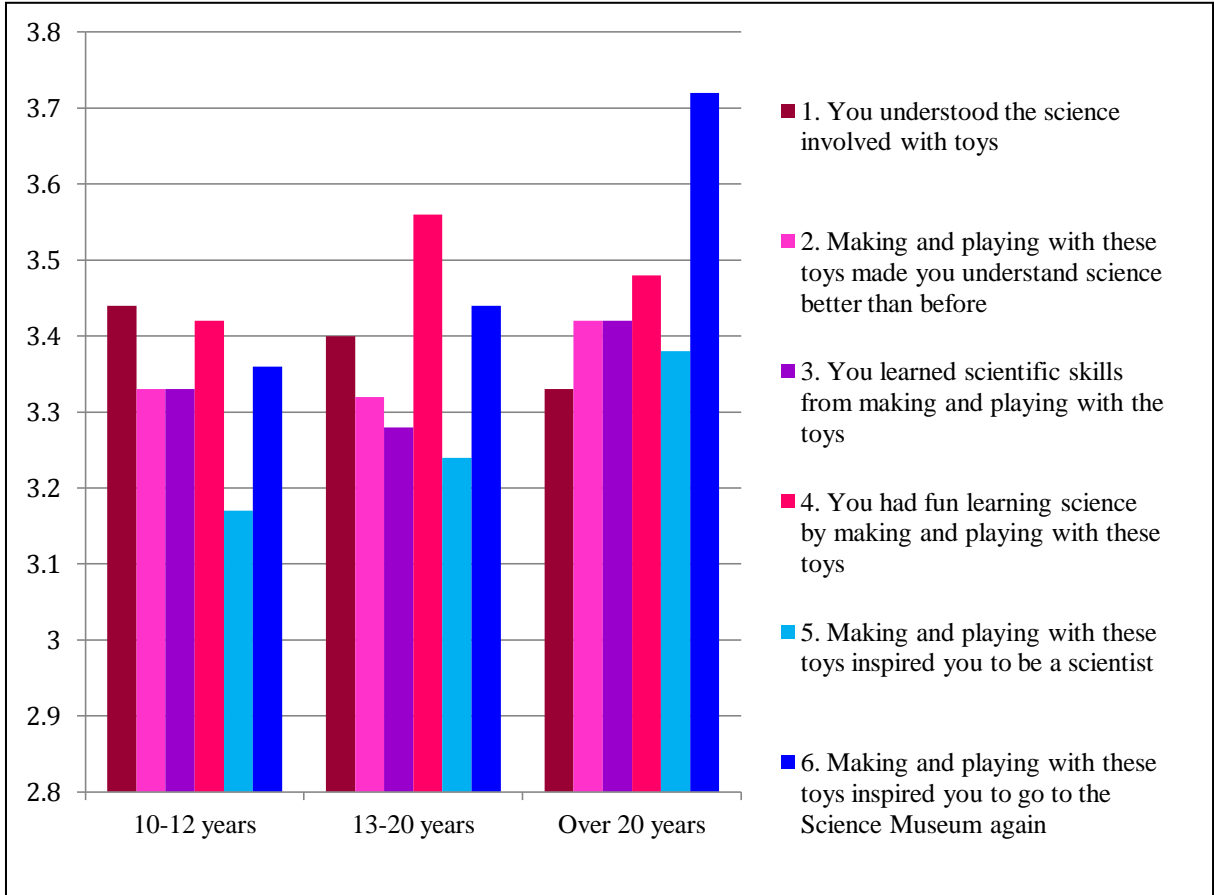
Figure AP6.25: The average of all areas of science learning
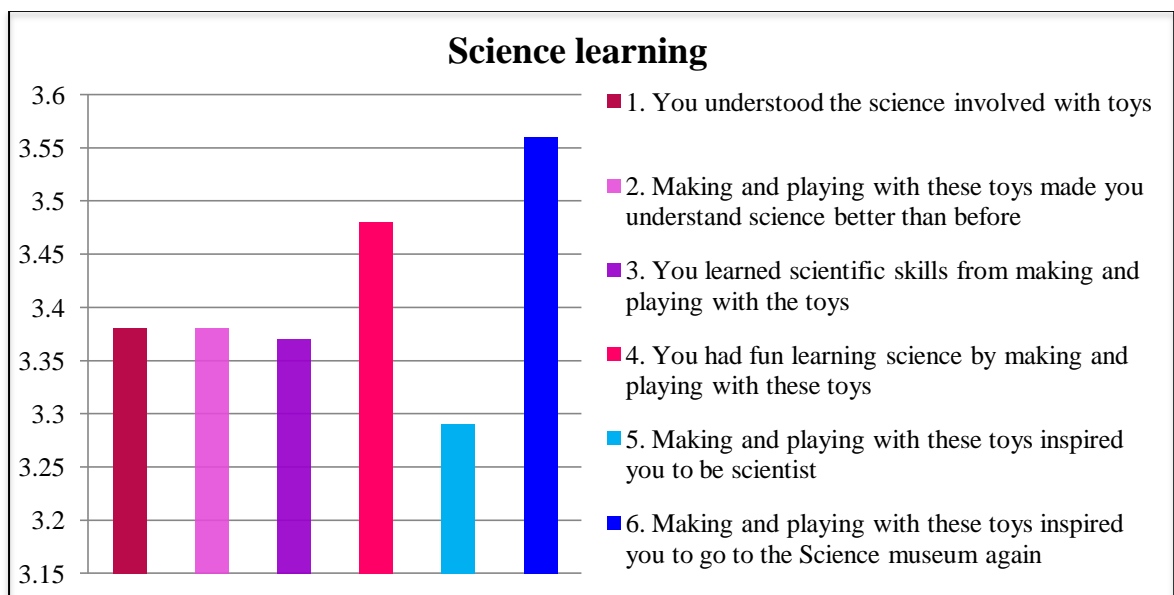
2.6.7 Attitude towards local wisdom

Figure AP6.26: Comparison between participants' ages and how they learnt local wisdom and changed their attitude of Thai local wisdom
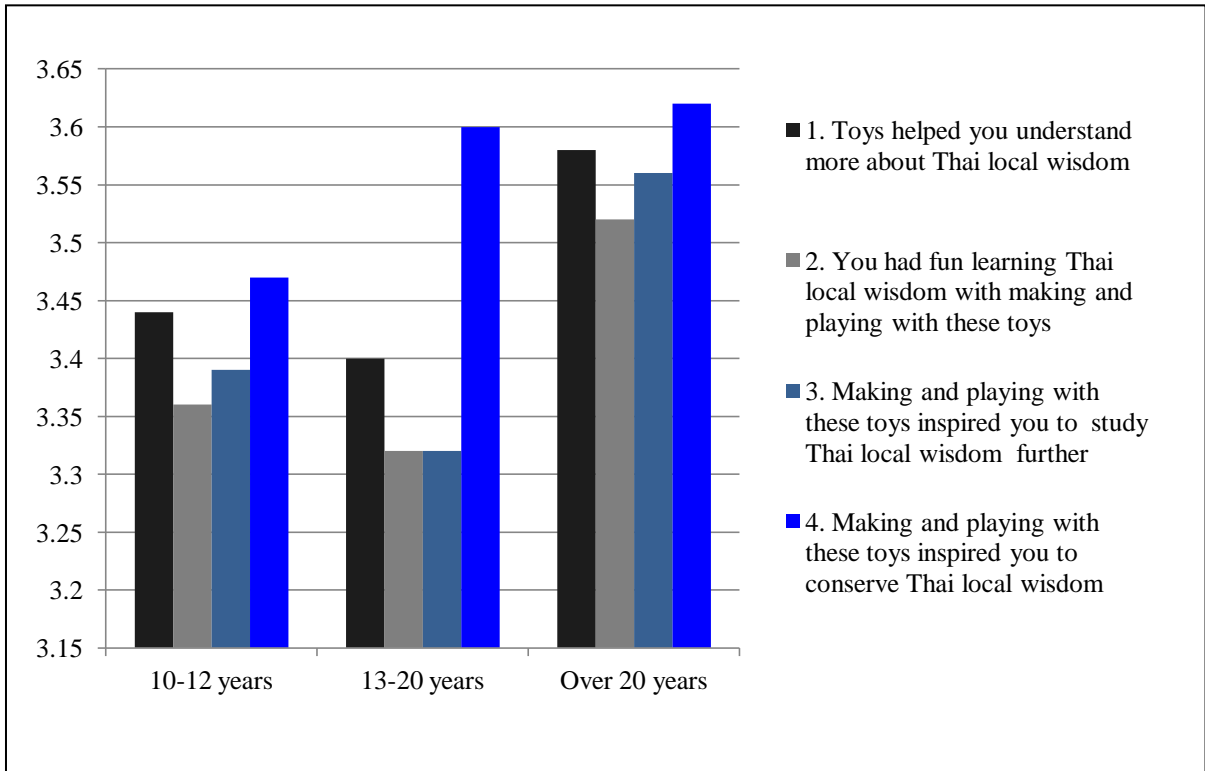
Figure AP6.27: The average of all areas of attitude towards local wisdom
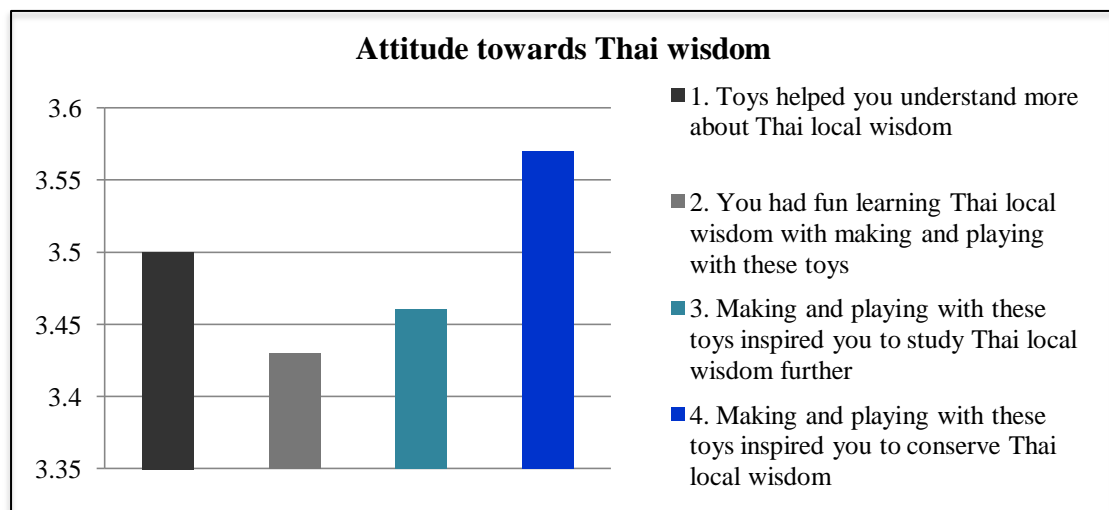
2.6.8 Toy learning outcomes

Figure AP6.28: Comparison between participants' ages and all toy learning outcomes
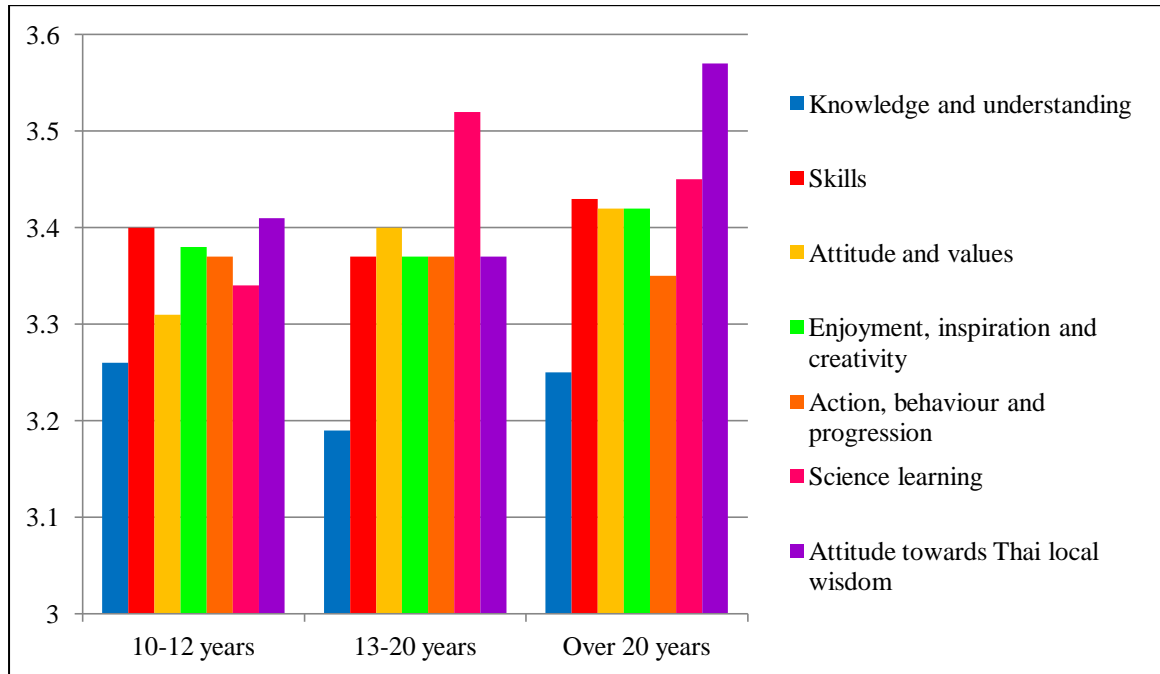
Figure AP6.29: The average results of all areas of toy learning outcomes
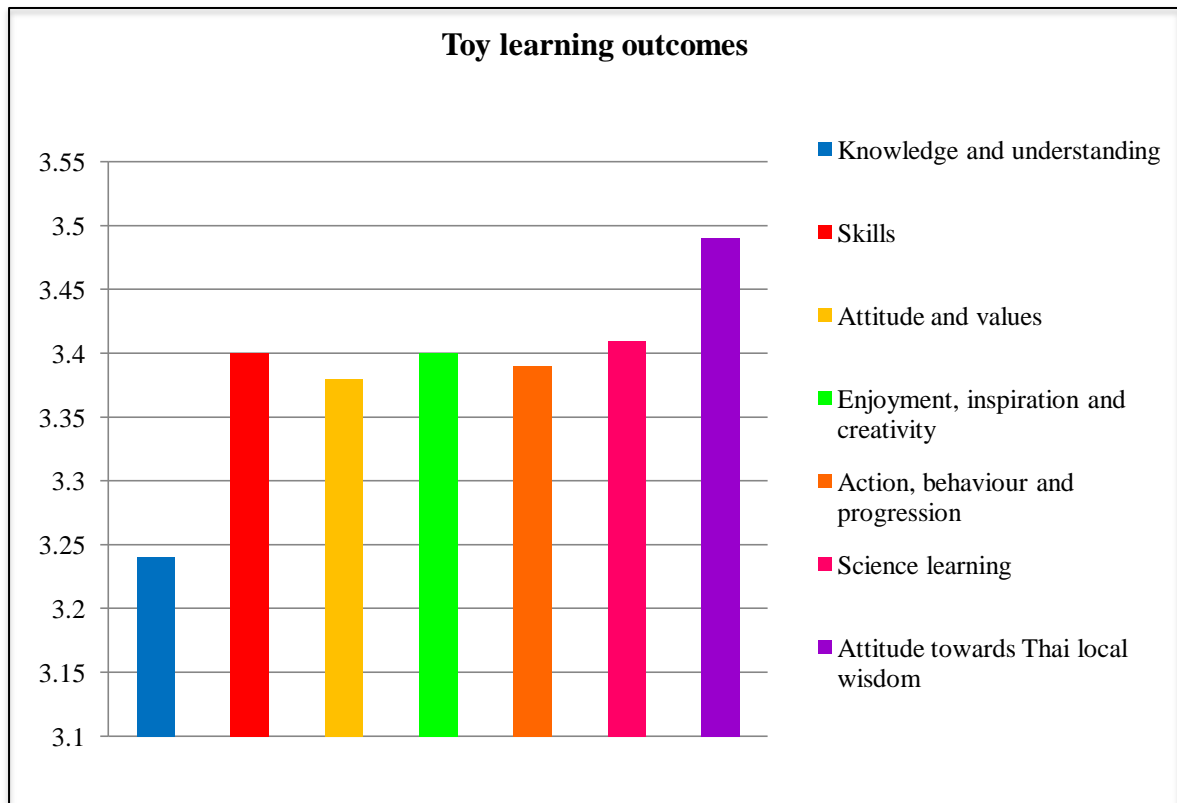
Part 3: Environment and resources

The meaning of the scale of conducive environment

 1: Non-conducive, 2: Partially conducive, 3: Conducive and 4: Most conducive

3.1 Environment

Figure AP6.30: Comparison between participants' ages and conducive environment to learn with TTTA
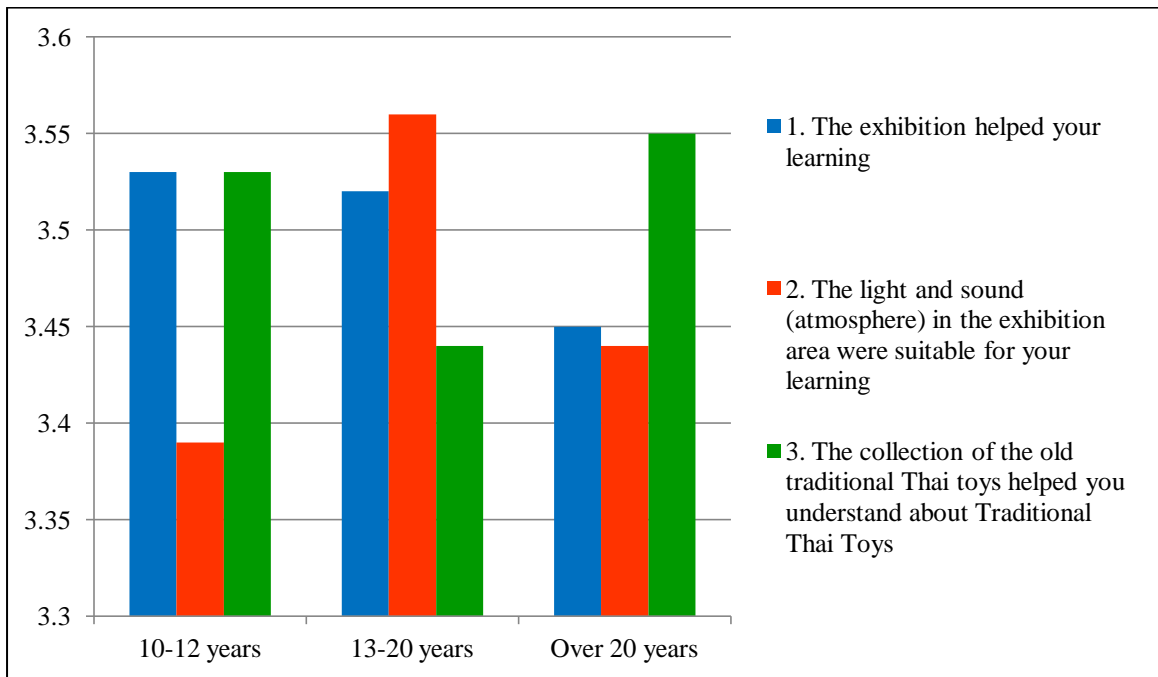
Figure AP6.31: Environment
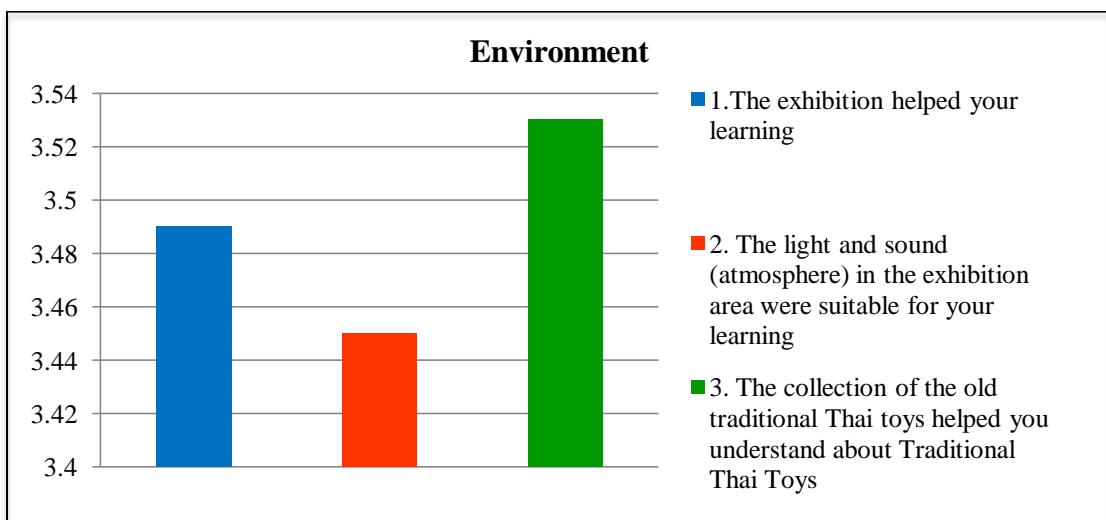
3.2 Resources

The meaning of the scale of appropriate environment

1: Inappropriate, 2Partially appropriate, 3: Appropriate and 4: Most appropriate

Figure AP6.32: Comparison between participants' ages and appropriate resources to learn with TTTA
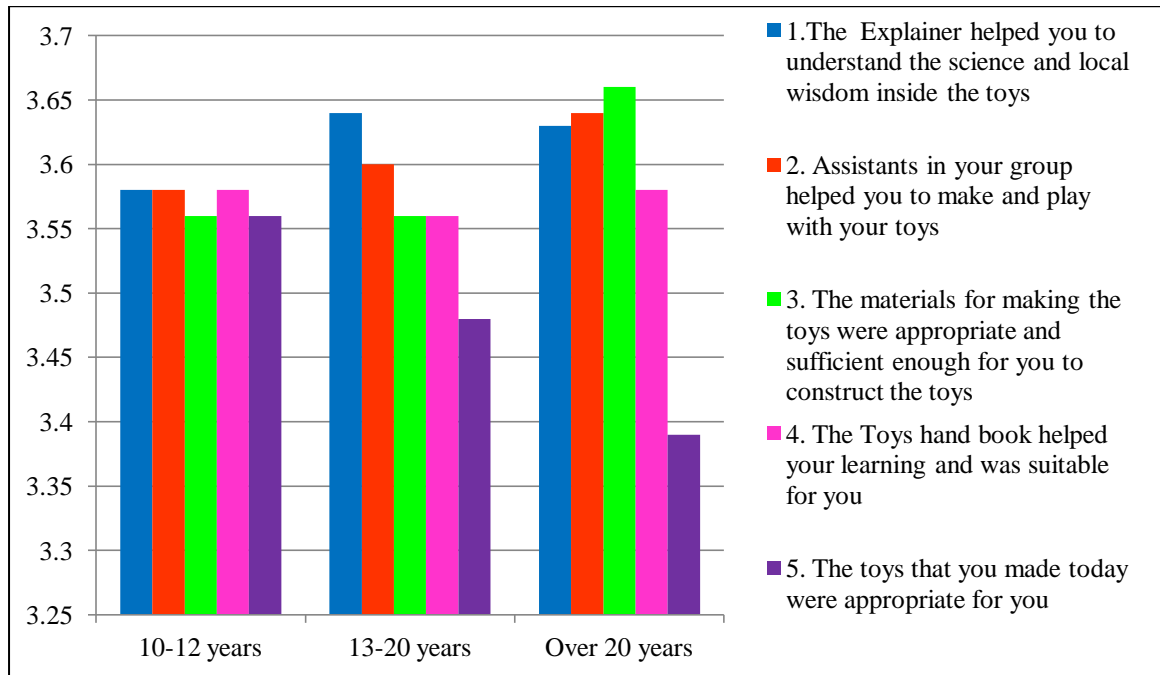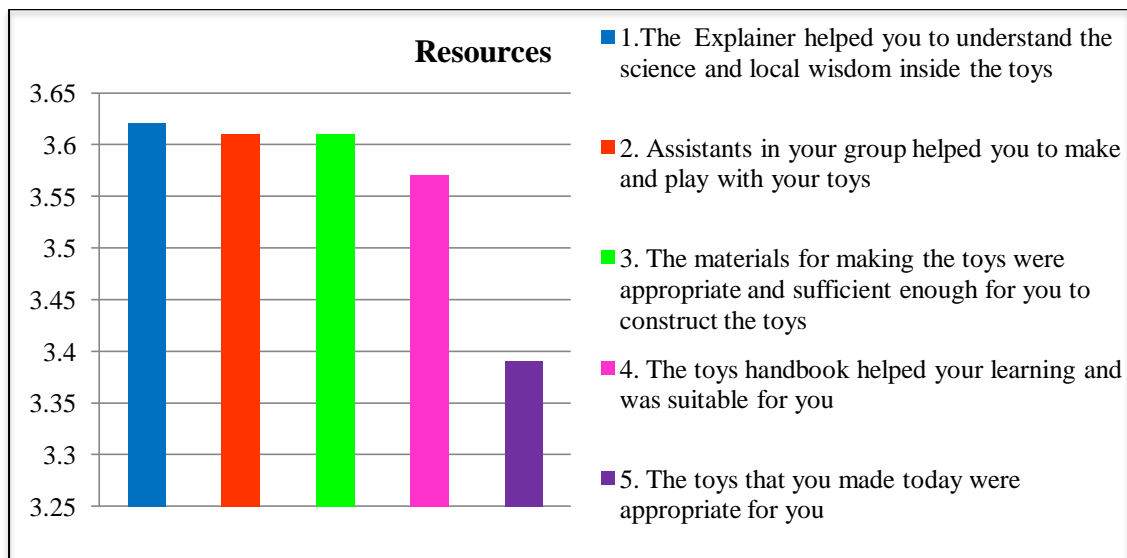

Figure AP6.33: Resources

3.3 Environment and resources

Figure AP6.34: Comparison between participants' ages, and conducive environment and appropriate resources to learn with TTTA
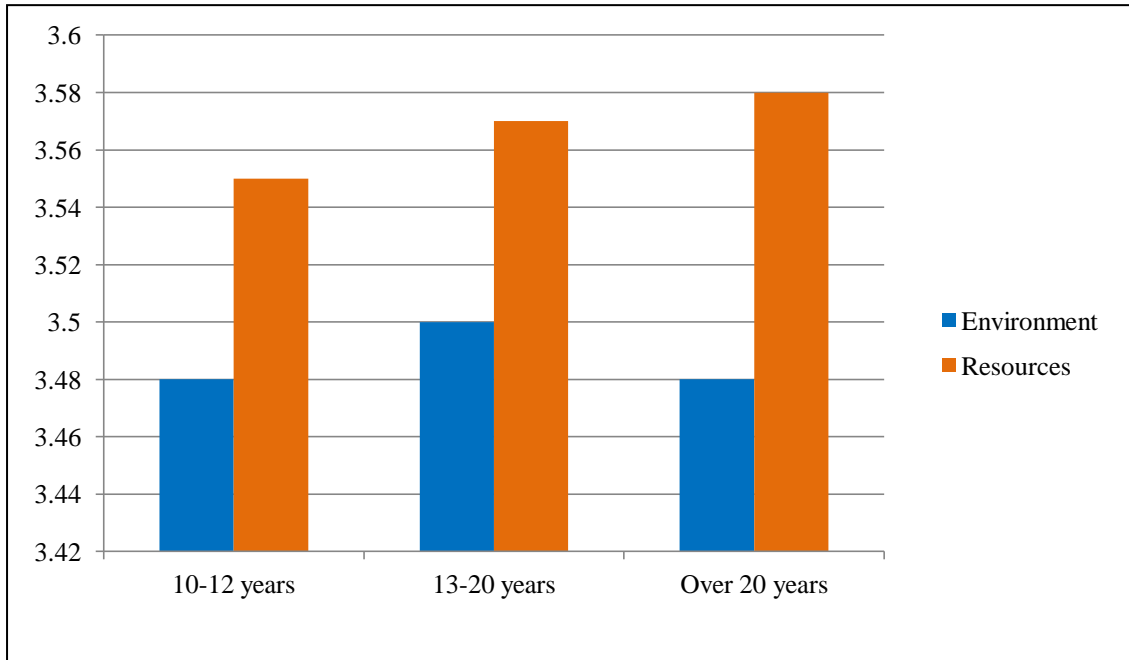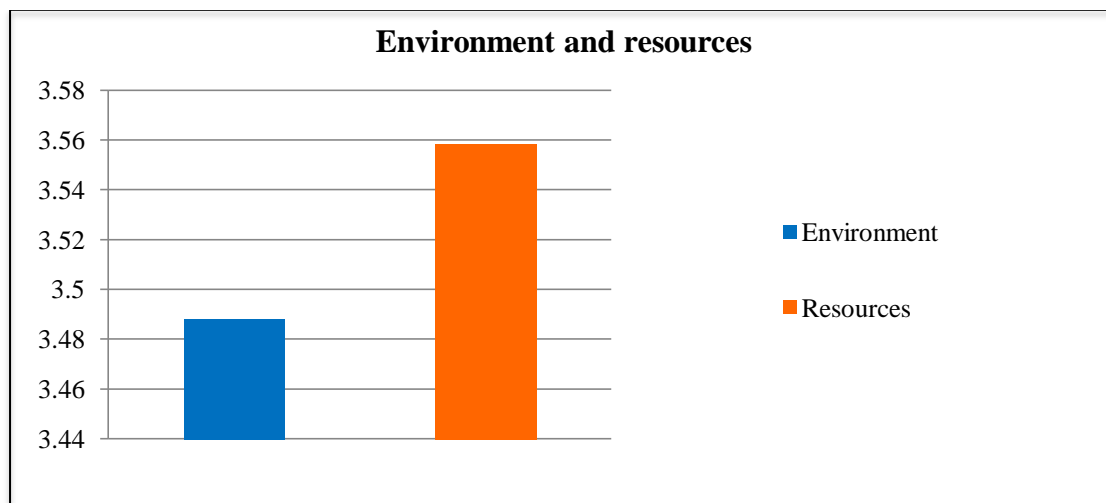

Figure AP6.35: Environment and resources

APPENDIX 7

Analysis of families' motivation of learning at home questionnaire (FMLHQ) data

Figure AP7.1: The percentages of family's behaviour at home after they learn from the TTTA