Istanbul Aquarium Edutainment Project

Dr. Mehmet Sinan YUM (Ph.D)
Istanbul Commerce University (ICU)
sinanyum@gmail.com

Abstract
Nowdays, public centers depend on technology centered design approaches in order to present collections to guests. Strategies based on design-oriented solutions provide enhanced educative outcomes and user experience values. Edutainment design is an educational model and a design method. The approach offers advantages in public buildings such as museums, aquariums and zoos, increasing the educational value of the exhibited content as well as encompassing the integrated use of education and entertainment concepts through technological implementations. The study presents an edutainment project carried out by the author and examines the interdisciplinary edutainment features of the project. Opened in 2011, Istanbul Aquarium is Europe's largest thematic aquarium. The aquarium themed in accordance with edutainment design methods, serves with interactive products suitable for educative design methodologies. The hypothesis of the study is 'edutainment design is an interdisciplinary design method'. The study aims to provide an insight on the subject by evaluating the products presented in the research and determining the interdisciplinary features of these implementations.
Keywords: Aquarium, Education, Edutainment, Interaction Design, User Experience.

Method of the Study
The research initially explains basic concepts and terms related to the subject, presents the case study project and products, and finally evaluates the products presented based on the literature evaluation criteria. The final section of the study presents the findings explaining their implications and makes suggestions for future studies. The study also offers aquarium edutaiment project examples in order to present an insignt on the design approach and to be able to prove the contemporary qualities of the method. The study covers concepts on edutainment, individual and social learning, interaction, knowledge formation and user experience. The research also focuses on the relationship between edutainment and interaction as the approach depends heavily on interactive products of various design disciplines. The study focuses on research questions such as: What are the main features of edutainment design? Which products are used in an edutainment scenario? What type of interactive experience do these products provide? What type of content is used for edutainment design? The study tries to provide answers for the questions presented, aiming to create an insight and understanding on the subject. The qualitative research presents information within the scope of concepts related to edutainment such as edutainment types, visitor identities, learning typologies, interaction types, design qualities, products features, etc.

Introduction
Data is one of the primary values of today's electronic age and is an essentiality for the environment we live in. To keep up with the needs of the age and in order to respond to the requirements of the public in terms of technology and information, digital products are implemented in many areas that provide various services. Public structures housing content related to nature, history, art provide cultural services to visitors. Most of these structures are designed in relation to content oriented concepts in order to convey various messages with effective strategies. Even though the content presented may have a traditional quality, interactive systems enhance the perception of the content as well as

providing an enjoyable experience for guests of diverse backgrounds and identities. Apart from having a value related to entertainment, this approach has a major effect on education influencing the visitors to obtain individual experiences. This approach in the field of design is called 'Edutainment' and is a design oriented educational model based on structural theming, interaction and user experience.

The study presents an edutainment project and products designed for a public aquarium in order to present, explain and evaluate the products based on literature criteria and collected data such as videos, photos, designer insight and communicative data collected during the design, implementation and maintainance stages. Istanbul Aquarium is the largest thematic aquarium in the world with its huge tank, countless species and the area it covers. Within the edutainment scenario, the educative and entertaining content has been applied on the interactive products, graphic designs, video content and atmospheric elements. Based on the harmony among the products, each piece of information can be perceived individually by the guests. Each piece of information is presented in portions through the edutainment products in order to prevent information floods and enable learning in various steps. Istanbul Aquarium edutainment scenario benefits from most of all possible design techniques and virtual technologies currently available today such as product, graphic, interaction and video design. The interior design of the aquarium has been realized based on regional concepts that derive from the geographical, ecological and tropical features of the globe. The aquarium is located at a strategic position 10 km from the airport, allowing daily public visits to the aquarium as well as its mall, restaurants and shopping centers. Many visitors have the opportunity to visit the aquarium from time to time in order to re-live the experience. Istanbul Aquarium is the second aquarium after Manila Ocean Park to be designed based on edutainment values by the company partnered by the author.

In the research, edutainment is referred as any content with high values on entertainment and education. In most edutainment projects in aquariums, video, visual and interactive content forms the infrastructure for the design method. Many implementations are generally integrated with gesture recognition, augmented reality and multitouch technologies. The way people learn has changed rapidly in the last 20 years due to the possibilities presented by technology. Unfortunately, understanding and technical knowledge alone are inadequate in order to deal with effect with various implications of cutting-edge technologies. This situation raises some questions concerning both what technology can accomplish and what it should do. It is of importance to understand what technology is, how to reach its goals and how to use, services, products and systems related to it.

The complexity of interaction can be overcome through the understanding of the balance between the technical aspects and human considerations as stated by (Budd & Wakkary, 2005). The technical aspects are made up of factors related to the utilitarian and performance-based features, meanwhile human considerations imply the social and cultural qualities related to humans. Recreational centers such as aquariums, zoos, botanical gardens and museums have become institutions that promote diffusion of education and culture as stated by (Falk & Dierking, 1992). Museum curators responsible for the organization and presentation of content have a role to play as the focus has shifted towards the definition of strategies related to communicative methods and storytelling scenarios. Curators find themselves in a challenging position in which they need to address difficult issues regarding the communicative issues for visitors of various identities and backgrounds. As museum have transformed into narrative spaces, curators carry the responsability in organising effective spatial and collection-oriented arrangements in order to convey effectively messages provided by exhibitions as mentioned by (Wagner et al., 2004: Hodge & D'Souza, 1999). Compared to museums, aquariums have a dynamic content based on living organisms. As pyhsical interaction

with the species is not allowed, especially young visitors tend to get bored from watching the fish after some time. In order to overcome boredom, interactive applications offer a great deal towards en enhanced experience centered on education and entertainment. Another aspect of interactive products is the possibility to update the content when necessary as well as data collection properties for feed back and marketing purposes.

1. EDUTAINMENT DESIGN
Any content designed or structured to be educative and entertaining can be defined as edutainment as stated by (Rapeepisarn et al., 2006). The concept of edutainment encompasses the integrated handling of the concepts of education and entertainment, that is, the transmission of educative content in entertaining ways. Edutainment has existed for many centuries in the form of legends, stories and tales leading to social changes. In order to attract the attention of viewers in contemporary life, areas such as television productions, exhibitions and education benefit from the edutainment approach. Locally centers such as Istanbul Toy Museum, Kidzania use edutainment design strategies in order to provide an enhanced experience to guests. The method is used in many international recreational centers in order to attract visitors through strategies on marketing and advertisement. Edutainment provides a unique value on controlled education that occurs in public structures. Away from the boredom of school, children tend to interact, learn and most important of all, preserve the information conveyed through interaction for a longer period of time.

Edutainment design includes providing education in fun ways. The qualities of the product used and learning objectives are the main characteristics that determine the ratio between education and entertainment. The approach necessitates the work of experts in the development of the edutainment design scenario, product and content. These experts are interdisciplinary design experts specialized in design as well as psychology, pedagogy and sociology. Edutainment design is used in games, entertainment, culture, education, military, sports and medical areas. The amount of entertainment effect found in edutainment practices increases the value of the method based on education. This value is expressed as 'ludic value'. Ludic value refers to creative experience that includes activities such as writing poetry, composing or drawing, rather than playing games as mentioned by Nam & Kim (2011). Edutainment based on location, media, target, content and purpose, can be classified as mention by (Rapeepisarn, 2006).

Location based edutainment:
   a) Interactive and participatory; children participate in games and play.
   b) Non-participant and observer; children sit and watch (cinema, museum, zoo).

Target audience based edutainment:
   a) Target-centered: Age-independent users with the same interest.
   b) Age-centered: Same age groups.
   c) Material oriented: Material content (game).

Media based edutainment:
   a) Programs on television (competitions, TV series, etc.)
   b) Computers (game, strategy, quiz, etc.)
   c) Internet (web-based software)

Content and purpose based edutainment:
   a) Discussion to improve the quality of life (informal information).
   b) Practices to create experience (skills training) and simulation applications.

In order to reach the design goals of an edutainment product, the compatibility of the target audience and content information is essential. In designs developed with the

contribution of users, the determination of tasks that fit the target audience reflects on the quality of the final product (Monteiro et al., 2014). The spontaneous and fluid nature of the experience offered in cultural centers of edutainment scenarios reveal the value of the experience in terms of visitor perception. The real challenge when designing an edutainment tool is to maintain the balance between education and entertainment by harmonizing experience goals and time-oriented perception.

Because experience and time include expressing the time, form and result interacted. In some cases, it may not be easy for users to grasp the purpose of the task at hand. In such cases, if possible unnecessary entertainment and laborious practices should be avoided. It is of utmost importance to separate the game content from the learning materials perceptively and try not to exceed the amount of essential content provided. The correct use of edutainment design is the development of content that is suitable for user identities, in measures suitable for edutainment goals and with communicative methods. Edutainment design products consisting of graphic, digital and physical objects, can provide an integrated communication with users through spatial theming in accordance with the identity of the center. Edutainment design allows individuals to access information according to their preferences in accordance with different user identities. Veenstra et al. (2009) state that useful and higher education can take place in a strong learning environment. Spatial elements carefully positioned in a center support learning outcomes and enhance the overall experience. De Jong & Pieters (2006) define strong learning environments as places that encourage active and constructive learning, meanwhile Bétrancourt et al. (2003) mentions that strong learning environments provide visitors with higher educative outcomes. In a strong learning environment, individuals are encouraged to learn with other, learn through realistic scenarios and most of all build their own knowledge. Edutainment software offers tools for constructing new knowledge, as an alternative to presenting illustrative information or practicing specific skills based on repetitive data. Customized informative content aspect of edutainment systems enable the users to advance based on their own pace.

1.1 Interdisciplinary Features of Edutainment Design

Edutainment is an interdisciplinary approach based on design methods and approach. It merges many disciplines related to design and social sciences with a method that enables connectivity between the context and the content. During the creation of an edutainment concept, multiple disciplines in design and technology-centered applications join a common path in order to produce the essential result. Apart from the previously mentioned design disciplines, edutainment strives to serve the public with a unique content and an experiential outcome. In order for the edutainment process to work, information regarding the user identities has to be implemented inside the content. User centered factors related to psychology, sociology and pedagogy provide the necessary input on user identities that can be merged to the system content that allows customized information to be shared. Edutainment design produces an entity that is made up of the combination many productions, all merging into a concept that transfers the means to obtain a unique experience.

In many centers, technology-driven implementations based on computers and softwares allow the production of an interactive product that communicates with the users. The term 'Interaction Design' has been used to describe the communicative activity between the user and system. And the activity of the human element in computational sciences has caused the development of *Human-Computer Interaction* (HCI). The process regarding the design stages of edutainment designs include 'User Experience Design' alongside HCI. The aim of the design stages is to create an interactive experience that achieves efficiency. It is important to plan and order properly stages of development in an edutainment project, just as any design process. The goals on interdisciplinary design based on interaction can be listed as shown below.

a) Drawing a road map that adapts to various situations.
b) Exploring every possibility.
c) Evaluating the design.
d) Providing non-engineering solutions.
e) Preparing physical and audio presentations.
f) Combining function and technical qualities with ethical and aesthetic features.

The key to success lies in the usability of any system. Even though usability on interactive products is based on the performance of the software, functional software does not suffice in edutainment. Just as usability evolving into user experience, edutainment requires a high degree of experiential qualities. The performance of any system depends on the quality of the user interface that constitutes a communicative experience value. *Graphic User Interface* (GUI) is the medium on which the user and the system communicate. The quality of the user interface has a dşrect effect on the performance of the user and the efficiency of the system. Elements of an interface consist of vector-based icons, pictograms, text, etc. As mentioned by Hourcade (2007), additional elements such as sound, menus and simulations help enhance the effects of the overall experience creating engagement. Technology provides support in adapting content suitable for users. Interaction design is a method used in edutainment design especially suitable for children contributing to the conceptual development of their physical, intellectual and social qualities with the aim of creating a positive impact on their emotional and moral development.

1.2 Aquarium Edutainment Examples
Edutainment is a design approach used often in public structures offering various services related to user experience. Some of the major aquariums that benefit from edutainment design are presented below.

Figure 1: Aquarium edutainment examples

The visuals represent edutainment design implementations for the Georgia Aquarium, Monterey Bay Aquarium, Manila Ocean Park and North Carolina Aquarium. Georgia Aquarium presents a platform that enables the creation, deployment and update regarding AR content for iOS and Android devices aligning with all products, systems and services. The aquarium houses more than 60,000 animals, has a 100 feet long underwater tunnels and interactive applications linked to underwater cameras. Monterey Bay Aquarium has two gigantic tanks with various exhibits connected to the world's largest single paned observation windows. Manila Ocean Park is a theme park and an edutainment facility designed by the company partnered by the author prior to Istanbul Aquarium. Various edutainment implementations have been made forming an edutainment-based strategy for locals and tourists. North Carolina Aquarium exhibits an interactive exhibition based on the ultimate predator, a megalodon. The prehistoric fish creates an engaging experience for guests with its interactive features contributing a unique quality to the center.

2. LEARNING & KNOWLEDGE CONSTRUCTION
Meaningful, motivational and relatable content provides a sense of familiarity to learners as well as triggering pleasure and curiosity. Edutainment design is a method based on entertainment and education, education referring to learning and mental knowledge

construction. There are various types of learning depending on the subject, content and object. The main approach to follow in terms of purpose and content as mentioned by (Walldén & Soronen, 2004), can be listed as shown below.

a) Formal learning: Education institutions.
b) Informal learning: Daily experiences.
c) Semi-formal learning: Clubs, unions and civil society organizations.
d) Accidental learning: Everyday activities.

Learning in interactive systems is based on informal learning. Individual psychology, emotions and state-of-mind has an effect on the permance of learning that occurs. During the learning process, motivating, relevant and meaningful content triggers curiosity resulting with higher span on longetivity regarding knowledge preservation. Piaget (1964) has conducted researches on education-centered knowledge construction and preservation in children, that constitutes an infrastructure for interaction design approaches of today. According to Piaget, there are four basic factors that effect development in children and these factors are maturity, experience, social factors and emotions. Piaget states that experience, social factors and emotions regulate the way and intensity learning occurs, meanwhile maturation can create a restriction on learning. One of the building blocks of knowledge building related interaction design approaches are based on the studies conducted by Seymour Papert. Papert has developed a constructivist approach based on the theories by Piaget (Hourcade, 2007). According to Papert, children present an advanced self-created communicative aptness rather than finding themselves in a previously configured situation. This statement reveals the creative potential of children regarding the ability to be the creators of computer-oriented systems.

The concept of scaffolding refers to teaching by providing assistance and constitutes a technique that creates a deeper learning and understanding (Soloway et al., 1998). Scaffolding is about social development in children that refers to the provision of the exact supportive input learner requires. The approach provides an active learning experience by supporting the learner with hints and clues as much as necessary instead of giving instructions. The effort put into the process of overcoming the problem by the child, enables learning with effects on permanence and experience. The approach consists of providing the necessary quantity of support, allowing the child to reach a higher level of understanding regarding the subject. Giving appropriate scaffolding instructions for individual differences is important and necessary, in order to simplify the task and to structuralize to the problem according to individual differences. The design and creation of an interactive product relies on the usage of scaffolding strategies related to user experience. Characteristics of scaffolding properties on interactive products can be explained as diversity, difference, individuality, control, competition, imagination, collaboration and reward (Rogers et al., 2002). For a positive learning experience to occur, imagination of the learner use should be stimulated. Edutainment design implementations benefit from the scaffolding qualities of interactive products, providing service to individuals belonging to different user identities.

Free Choice Learning (FCL), occurs when the individual has a control over the educative content. The learner regulates own schedule in order for the teaching to occur, willingness and openness are decisive factors on the process. FCL can happen anywhere, anytime, as long as the individual is open to the consumption of new knowledge and information. Karydis (2011), states that, FCL can take place in aquariums, museums, zoos, web, television or exhibition areas as long as the person is willing to learn. Museums define themselves as centers for semi-formal learning. Interactive products are education-centered objects that carry ludic values. Gaming approaches in edutainment is different from a typical game approach as they are developed under certain educative

restrictions. Content is created based on the goals on education and entertainment through the regulation of these two aspects in different quantities. The main quality of edutainment software is called 'Ludic Value'. As mentioned previously, the term 'Ludic Value' covers most creative areas referring to cognitive process that occurs when composing music, writing literature and engaging in a mental creative activity. With the desire to explore, interaction-oriented individual experiences come to life in centers that implement interactive products on edutainment purposes.

2.1 Learning Environments in Edutainment

Edutainment design requires especially organized spaces for purposes on integrated education and entertainment that enhance user experience through spatial perception. Areas that interactive products are placed present a unified perception and convey a common messeage regarding the educative goals of the center. Most space used for social activities are mainly designed for various services. These spaces can be converted into a wider space depending on the goals of the activity, such as exhibitions, concerts and symposiums. Most of these spaces have multiple functions in order to host the activity depending on the scope and content. For example a convention center may simultaneously host an event, exhibition or a conference. The main important aspect on creating an area dedicated to edutainment is the definition of the purpose based on the content.

The area designed for edutainment purposes has to reflect a unique spatial perception centered on user experience with theming applications and interactive products. Only then it may be possible to reach the essential quality of a enhanced learning environment. What causes the attraction is the content of an environment and it is essential to configure the information presented under considerations on the target audience. As mentioned by Veenstra et al., (2009) enhanced learning environments provide powerful means of learning. The concept and content of the exhibition define the communicative, spatial and technological aspects of the environment.

Bétrancourt et al., (2003), define enhanced learning environments as spaces that provides enhanced learning outcomes for the users. People in enhanced learning environment are encouraged to costruct knowledge individually and learn together with others. According to De Jong & Pieters (2006), an enhanced environment promotes constructive and active learning through collaborative interactions. In such spaces, children are allowed to take initiative and make there own decisions on what and how to learn. Primary goal of an enhanced learning environment is to enable learning through practice by improving the skills on a particular developmental domain. For this purpose, instructions provided have to be perfectly aligned with the user identities and cognitive abilities depending on mental processing capacity (De Corte et al., 2003). User mental processing capacity can be developed by certain types of support provided that facilitates the acquisition of knowledge on multiple skills (Linn et al., 2004; Quintana, et al., 2004). An enhanced learning environment has to bear certain features on sociocultural qualities (De Corte et al., 2003; Bredekamp & Copple, 1997), as well as being individually appropriate (Veenstra et al., 2009). As a summary of the information presented, it is possible to define an enhanced learning environment as spaces in which constructive and active learning approaches are regulated and promoted by respective diversities on playful learning related to ludic value. Most digital or analog edutainment product is designed with a ludic value quality and is positioned in an edutainment setting in order to enhance spatial perception and learning outcomes.

3. INTERACTION DESIGN

Interaction design is a method used for developing digital products that communicate with users by the aid of interfaces. Depending on the interaction created, interaction can be classified as listed below as mentioned by (Shedroff, 1994).

a) Direct interaction: Dragging, dropping and controlling an object through physical manipulation.
b) Indirect interaction: Gesture-based manipulation.
c) Accidental interaction: Being an observer or getting involved with the interaction coincidentaly.

In his research, Shedroff combines different fields of design in order to obtain the appropriate content for interaction to occur. Collaboration on the fields of design that is used for the elaboration of interactive content are sensory, information and interaction design approaches. Sensory design refers to the design qualities of the content centered on perception. Information design refers to the structural architecture of the content presented and interaction design defines the methos in which the content is conveyed to the user.
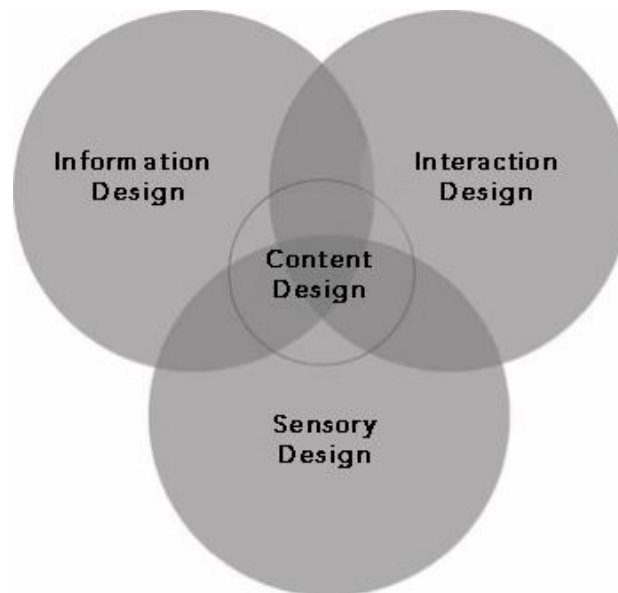

Figure 2: Content centered interaction design

Content design is a combination of information, sensory and interaction design approaches that constitutes the overall experience. Information design provides the structure and organization of the data presented. This approach forms the structure that allows values such as graphics and other visual content to be expressed. Interaction design merges multiple methods on storytelling in order to convey the content to the user. Every interactive system creates an interaction in which the product communicates the content through sensory narrative approaches related to design and compatible with user identities. Naturally, every interactive product communicates with the user through a digital or a virtual interface allowing the control of the content. The quality of the interactions taking place provides various degrees of experience depending on the expectancy, success and interest of users. In the aquarium project, gesture recognition products provide visual communication, kiosks and videos present visual content enriched with audio cues. Sommerville (1986) has created a classification on the interface properties of interactive products as presented below.

a) Consistency: Ability to present consistent information and service.
b) Minimum surprise: Ability to perform and prepare users.
c) Recovery: Ability to recover from wrong usages.
d) User guidance: Ability to guide user through the content.
e) User diversity: Ability to satisfy all user identities.

The most important aspect of interactive products is the ability to adapt to changing user identities. User identity related properties determine the characteristics of interfaces as does the content. The interactive products designed for the aquarium carry qualities such as consistency, user compatibility, avoiding surprises, recoverability and guidance that are explained in the case study project evaluation section.

3.1 Interactive Features of Industrial Products
Products of interactivity have to be considered as objects of daily use and service. Interactive product design and interaction design are two neighbouring disciplines structured under user experience. Even though industrial product design works on tangible objects and interaction design works on virtual objects, the cross-section of these disciplines can be considered as user experience design products that are tangible and virtual. As stated by Kolko (2009), a sequence of factors should be considered when designing a product, function, form and usability. Kolko suggests that products of interactivity should carry these attributes listed below.

   a) Products encourage a natural dialogue between the user and the product.
   b) Products encompass some form of technology-centered advancement.
   c) Products become cohesive when a person interacts with a product.

Designing an interactive product is very similar to designing an industrial product as both products are centered on user experience values. The perception of both products may differ, but users mainly focus on the functionality aspects of products. Even on interactive products, users relate to the functinality and service quality in order to achieve certain goals depending on the service-based orientation.

Davis et al., (2008) state that design entails multiple modalities of reasoning and representation. In all areas of design, designers build up ideas with visual representations such as sketches, modelling or diagrams. Interactive product design require a new set of criteria compared to objects used in daily life due to their complicated nature. The primary difference and quality of interactive objects is the fact that they evolve over time depending on the requirements of content, technology and people. In order to develop the right product for a specific situation, Vogel (2005), requires a response for the questions below.

Interaction: What kind of interaction does the system support? The answer to the question may vary between direct or indirect interaction, as accidental interaction may not be considered as a design-centered quality.
Input: What external device input does the system require?
Information: Who does the system target on service-centered goals?
Usage: Does the system support single or multiple uses?
Location: Where is the location of the product?
Spatial Properties: What are the qualities of the space?

Answering the questions above presents an insight and orientation about the product, presenting guidelines for the design process. In order to design a product that provides solutions regarding service and user experience, there are certain factors in which to consider. According to Kolko (2009), the qualities of interactive products are can be explained as follows. Interactive products should support the communication between the user and product, reinforcing technological development and enabling adaptation of the product to the user and viceversa.

4. ISTANBUL AQUARIUM
'Istanbul Aquarium' has been designed by a company partnered by the author in accordance with the edutainment design business model opening in 2011.

Figure 3: Istanbul Aquarium main tank and 70m long visual.

Main attraction in the structure is the aquarium and consists of a mall and a shopping center. With the world's biggest main tank, the aquarium has become a point of interest attracting many visitors every year. Contributions of edutainment design can be listed as presented below.

    a) Increasing spatial interaction and communication.
    b) As physical contact with the species is not possible, it presents alternative communication strategies between the center and visitors.
    c) Themed areas present high degree of originality.
    d) Edutainment ensures integrity by establishing relationships between fields of design.
    e) Edutainment carries high qualities on marketing making it a dependable business model.
    f) Edutainment products offer high educative values.

As any enterprise aims to obtain gains on an investment as complicated as edutainment design, the reliability of the design method has the potential to produce various values on marketing, communication and social awareness making them precious assets. Features listed above can be adapted to different business strategies depending on the direction of the bussiness model. The aquarium has an effective bussiness model based on communication and social awareness. The unique interior design of the center has a valuable marketing quality with its attractive ocean, sea, gorge, strait, canal representations and underwater species. Analog and digital edutainment products used within the scenario offer unique experiences with consistency assisting visitors from entrance to exit. Apart from daily visitors and tours, school trips are regularly organised on a daily basis.

4.1 Edutainment Products
Edutainment design is based on a scenario created by the combination of many different products. The most important factor for this type of hybrid design approach is the relationship between the elements used in an integrated sequence and storytelling qualities of products. Apart from interior design elements, the edutainment scenario of the aquarium is based on touch applications, gesture recognition system, graphic products, models, videos and architectural projections. Rapeepisarn et al., (2006), state that edutaiment techology depends highly on computers. Interactive products are digital systems that require the usage of computers and screens. Print and model products do not have interactive qualities in the sense of digital interaction. Within the different spaces that make up the aquarium, spatial and service products are designed, produced and positioned in accordance with the interior properties of the structure. This strategy has been used in order to deliver edutainment content at all times keeping interest and engagement constantly high.

4.2 Conceptual Edutainment Design

Conceptual design for the edutainment scenario of the aquarium has been presented below in order to show the design-centered progress that has been made. Between the concept design and implementation stages, some changes have taken place based on client feedback, design constraints and financial regulations.

Figure 4: The Aegean Sea

The area consists of small tanks, mythological models and objects. Kiosks and video screens provide information on history, geography, ecology and biology.

Figure 5: Black Sea

The shipwreck designed in the primary conceptual design stage has been replaced by another model. Video and graphic content presents information on history, biology, ecology and geography. Touchscreen application placed inside the shipwreck presents a content regarding the salinity of the black sea.

Figure 6: Dardanelles Straits

The area presents information on the historical Çanakkale victory with images and video content shown on the wall embedded screens.

Figure 7: Underwater Observatory

Underwater observatory, presents information on species that live in the depths of the oceans with two multitouch tables and screen light boxes. The species shown are the viper fish and the angler fish presented with visuals, an animated 3d model and physical models. Edutainment produts in the aquarium are presented in the next section.

4.3 Digital Kiosks
Rapeepisarn et al., (2006), state that edutaiment techology depends highly on computers. Kiosks are interactive products that transfer the content to the public through multitouch interaction.

32 Touchscreen kiosks are located in the aquarium presenting locations of diverse species. The system interface provides information with its touch features. Communicating via a touch interface presents the fish database information to the public with a gaming experience due to its realtime generative content, implying to the fact that rotating the 3D world animation and picking any spot presents various species living on the selected location. Each unit consists of a touch screen, computer and software, providing access to the fish database in terms of content.

Figure 8: Interactive fishbase kiosks.

The database automatically updates itself when new fish information is added. As physical content with the species is not possible, the application bridges the interaction between the visitors and the species. Custom made ergonomic kiosks present an upright standing position for usage.

4.4 Noah's Ark
Touchscreen application placed inside Noah's Ark presents experience on the salinity levels of the Black Sea. This implementation provides informative content in order regulate the salinity level presenting the social awareness quality of the product. The ark is real life model designed and produced based on mythological stories that enhances spatial perception of the area.

Figure 9: Black Sea region and Noah's Ark.

All graphics and videos present informative content regarding history, geography, ecology and biology. The Black Sea area creates a strong effect being the first area in the aquarium route.

4.5 Virtual Habitat
Virtual Habitat application is a realistic simulation of the life of creatures living below sea level in their natural environment. Designed by 3D modeling of different species, the interface enables the fish to move in the most natural way through artificial intelligence that manages the system. The most important feature of the artificial intelligence software allows the fish to react as a result of an increase or decrease in stress levels of fish as a result of guest movements within the active area. The increase in the stress levels causes the fish to accelerate out of the interface area or to hide under the rocks. The decrease in the stress level causes the fish to calm down and slowly re-enter the active area. This interaction provides a valuable visual experience for adults as well as attracting the attention of children due to the lack of physical contact with the species.

Figure 10: Virtual Habitat gesture recognition system.

The system consists of Kinect motion-capture product, projection and computer hardware and is placed in the Atlantic region. Fish selected for this application are real life species, their movement patterns are replicated and transferred to the software.

4.6 Touch Table

2 touchtables consoles located in the underwater observatory area control simulations of 3D fish that live in the depths of the oceans. The fish selected for this application are the viper fish and angler fish. As it is not ecologically possible to visually see these fish due to preassure differences, designing an application that presents photos, information and observing the 3D model creates a unique educative experience from an edutainment point of view. 3D models are based on gaming software that can be manipulated by the user. The consoles and light screens in the underwater observatory illuminate the area providing a real sense of being underwater.

Figure 11: Underwater observatory touchtables.

Real life models of the presented species decorate the area in order to provide an insight on the dimensions of the species as well as supporting the digital content.

4.7 Projections

Architectural mapping specially designed for the entrance area of underwater imagery provide an enhanced experience. The content has been produced according to the curvatures that consitute the inner walls, allowing the video content to be projected without deformation. Visuals of jelly fish, shark, whale and swarms of fish constantly move in all directions creating a dynamic feeling as to what the aquarium promises to offer.

Figure 12: Architectural mapping.

5000AL projectors provide a wide-angle visual to be painted on the walls of the entrance area. The captivating visual experience allows many visitors to spend time without moving towards the Black Sea region.

4.8 Videos
Video content that has been an elaborated production consists of the informative content focusing on the various regions of the globe. The content presents information on the myths, ecology, biology, trade routes and geography of regions as a compilation of real life footage, motion graphics and animations. Most materials have been produced inhouse and reallife footage has been supplied by underwater biologists.

Figure 13: Video content in the Aegean region.

Screens have been placed inside the wall overlay graphics presenting information on the region. The narrated videos attract visitors of all ages.

4.9 Graphics
Graphics present content in a direct and easy to understand communication in order to support knowledge construction within the edutainment scenario. Each region has its own

decorative graphic language and content designed according to the regional guidelines. Colors and typography used are specific to a region. Graphic designs are print productions in different sizes, visual and textual content provides information on the hosting region. The dimensions of graphics are specifically designed in accordance with the spatial dimensions and are applied at the required position within the overall scenario.

Figure 14: Wall graphics

Graphic designs provide integrated communication within the structure in all the regions according to the spatial order of indoor areas. Video displays have been placed inside the graphic overlays creating a unique texture for spatial experience.

4.10 Mock-Ups

Besides digital products, physical mock-up models are a part of the edutainment scenario. Models of historical figures have been placed in relevant regions in order to increase the educative and informative effect of the content offered. Mock-ups manufactured for the aquarium consist of the fish models at the underwater observatory, global warming area iceberg model, Piri Reis and Poseidon at the Aegean region.

Figure 15: Piri Reis mock-up.

Apart from being noticeable objects, models also serve as objects of orientation with the perceivable spatial references they provide.

5. DISCUSSION
In the discussion section, edutainment products presented are evaluated according to the literature based criteria list in order to examine the design related qualities of products, define certain features and determine the interdisciplinary qualities as well as answering the research questions.

5.1 Evaluative Criteria
The section evaluates the case study project products in line with the concepts presented in different parts of the research. Keywords presented are explained by associating with the concepts within the study. The concepts related to the title, keywords and fundamental notions are explained in order to create an association among integrated concepts. Some of these integrated concepts such as 'user experience' are design approaches that effect the overall service quality of products. In a setting such as the aquarium, designing digital products shifts design orientation towards service-centered aspects and experience rather than the form of objects.

In order to examine the abovementioned features of products in the aquarium edutainment scenario, 7 products are evaluated based on certain literature-centered qualities. These qualities are composed of hardware information, interaction types, data content, design orientation, experience type and location. The presentation of the provided information for every one these products, creates a sense of orientation within the edutainment scenario and relates the products within the user experience framework. The evaluation of products are shown in the chart below.

Table 1: Product evaluation chart

Product	Hardware	Interaction	Data Content	Design Orientation	Experience	Location
Kiosk	Touchscreen Pc	Active,SingletouchPsycho-motor	Fish Data Base	Digital Interaction, Product Design	Single User	All areas
Touch Table	Touchscreen Pc	Active,Multitouch, Psycho-motor	Angler Fish, Viper Fish	Digital Interaction, Product Design	Multi User	Underwater Observatory

Virtual Habitat	Projector, Pc	Active, Gesture Recognition, Psycho-motor	AI Fish Swarms	Digital Interaction, 3D Visual Design	Multi User	Atlantic
Noah's Ark	Touchscreen Pc	Active, Singletouch, Psycho-motor	Salinity App.	Digital Interaction, Visual Design	Single User	Black Sea
Videos	Screen, Player	Passive, Cognitive	Regional Content	Motion, Visual Design	Multi User	All areas
Graphics	None	Passive, Cognitive	Regional Content	Graphic Design	Multi User	All areas
Arch. Mapping	Projector, Pc	Passive, Cognitive	Underwater Visuals	Motion, Visual Design	Multi User	Entrance

The results of the evaluation process are explained in the next section.

5.2 Evaluation Process Results

Kiosks are single-touch interactive products. They are spread around the aquarium structure presenting information on the species as well as monitoring user experience. The experience depending on physical manipulation and control implies to the fact that the application triggers cognitive skills and psycho-motor skills. Touchtables create a unique experience within the underwater observatory and enhance spatial perception. Lightboxes simulating an observatory dashboard provide support on the overall experience. Fish content presented in the application are two 'depths of the ocean' species that attract visitors with its gaming features and interactive qualities. Virtual habitat is an application that is noticeable at first glance, inviting and highly marketable in terms of communication. Children can play individually or collectively inside the active area. Families spend large amounts of time watching their children interact with the system and others. Noah's Ark is placed in the Black Sea region, the first area on the tour route. The shipwreck model attracts many visitors and forms unison with the video and graphic content. Salinity application presents social awareness content for everyone and the application triggers active interaction, playful learning and congitive skills. Videos are contents produced from real life footage, animations and motion graphics. The geographical and biological content is related to the real life footage. Historical and mythological content is produced by motion graphic animations that render a story visible for the public, reaching high levels of collective experience. Graphics enhance spatial experience as well as presenting information on the region they are placed in centered on cognitive abilities. Architectural mapping creates a sense of awe at the aquarium entrance area with 2D and 3D motion graphics blended with real life footage. Gesture recognition and touch tehnologies are applications that create higher interaction and attract attention compared to graphic posters. In an edutainment setting, a single product does not provide the desired experience, the collective, constant and integrated tone of all implementations form a united scenario, therefore a unique experience.

5.3 Findings

Edutainment is a meaningful experience for young children as stated by Rapeepisarn and develops cognitive, psycho-motor and affective skills as mentioned by Piaget. The Istanbul Aquarium edutainment project has been realised by the company partnered by the author, has reached its goals regarding entertainment, education and knowledge construction. The themed areas are still experienced by many visitors on a daily bases and school trips are regularly organized. Properties and preset goals concerning the interactive products in the Aquarium can be listed shown below.

a) Attract and engage visitors.
b) Address the individual preferred learning styles of its diverse audience.
c) Be sturdy enough to withstand vandalism and environmental damages.
d) Transmit the content effectively.
e) Create a unique experience.

Within the Istanbul Aquarium, themed areas and interactive products are developed in accordance with Piaget's approach presenting an up-to-date alternative communication strategy on learning and knowledge construction. Interactive systems offer dynamic content that is practical to up date, renew and change when deemed essential. Considering edutainment an active adventure, interactive products are the tools designed specifically for every individual to live this experience. As every individual does not interact with the aquarium in the same way, especially young children may be dissapointed due to the lack of physical contact with the species. In such cases, edutainment strategy bridges the gap between the content and the individual, providing a variety of interactive methods. This approach ensures an enhanced experience with an enduring interest as well as longevity on the memorability of the experience. Educative content can be developed and shaped according to individual interest with the aid of graphic and video design techniques. This quality provides support for the creation of a bond between the visitor and the center. Visitors interested in the content may spend more time on a product and those who are not interested sufficiently, have the possibility to locate a more adequate content.

6. CONCLUSION & FUTURE SUGGESTIONS

Interactive products are a part of our daily lives. From smart phones to digital kiosk, products ease daily operations, enhance communication and provide various other solutions. The Istanbul Aquarium project is a prominent example of an edutainment scenario in a public structure. The most important quality of edutainment is related to knowledge costruction through entertainment. Apart from educative goals, the approach offers practicality on marketing, communication and security with its updateable, renewable and customizable nature. As mentioned previously, aquarium implementations provide an alternative and efficient educative service that enhances the results of knowledge construction and learning at recreational centers. Informal educative centers such as museums, aquariums and zoos often incline towards interactivity in order to render their exhibits highly attractive and enable more engagement. In cases such as the aquarium, contact with the species being unadvisable and impractical, coming up with strategies related to edutainment design offer alternatives in order to create a connection between the visitor and the center.

The practicality presented by interactive products encourages and motivates the centers to take advantages such as the products occupying less space, more tailored and updateable information and usage frequency monitoring. These applications also allow the distribution of content to products from a centralized point. The interdisciplinary qualities of edutainment products provide alternative communicative ways in order to convey a message. Interactive products are objects with a certain degree of charm, referring to the fact that initially they attract visitors for an experience and support an intuitive self-guided activity. While designing an edutainment scenario, conceptualizing the structural qualities in terms of experience provides a chance to access the effect of design components related to attraction and engagement of visitors. Visitors are initially attracted to the exhibit then to be engaged as participants only if the content is presented correctly. In order not to transpire a feeling of a repetitive experience creating disinterest, edutainment design offer possibilities regarding individual experience, free choice learning and updateable content. Only if sufficient time is dedicated to the content, can learning and knowledge construction occur efficiently.

The main goal of designers is to prolong the engagement time, connecting content with good intention of visitors in order to obtain a positive experience. If learning outcomes of visitors on cognitive and behavioral domains can be assessed and evaluated efficiently, results and findings may help in developing a more sophisticated progressive model on knowledge construction and learning. Interactive systems, videos and graphics provide

educative content in order to obtain a higher level of education compared to traditional museology techniques. In classical museology used in many centers, a tag under the exhibited item does not present any level of educative interaction. Edutainment products and material are evidence that enhanced learning can be obtained just by examining the log files provided by the systems increasing the overall education within the exhibit. These systems are capable of measuring and calculating the interaction created by user frequency data and video recording feedback statistically. Based on user-friendly interfaces, usability aspects of the products can provide a successful experience in delivering information to the visitors.

For future studies, effects related to virtual and tangible interfaces on learning, has the potential to lead the argument towards the psychology, sociology and pedagogy domains on experience and knowledge construction. Edutainment strategies in recreational centers such as museums, zoos and botanical gardens may also be investigated in order to determine the contextual diversity effect of centers. The implementation of an online edutainment application approach may provide results especially in times of pandemic, extending the experience beyond an actual visit. This way, the center may develop stronger connections with the public, inspiring for a life-long knowledge construction opportunity.

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