

Proposing the Model of a Storytelling-based Smart Board Game for Children – Case Study of the Game Development Process for *Go! Space Express*

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ABSTRACT

This paper aims to propose the educational concept and design model of a Smart Board Game appropriate for lower elementary grade students. The Smart Board Game refers to a hybrid, or ‘convergent’, game format based on the offline format of the conventional board game augmented through the use of smart devices. The substantive aspects of this game format utilize the procedural deduction and problem-solving skills applicable in storytelling methodologies and games, in order to generate and propose contents ideal for the educational environment. The development of the Smart Board Game is conducted through the following stages. First, the study analyzes a number of Smart Board Games currently popular in Korea and abroad, based on identification of the key components and processes of the board game format. The subsequent review of the science curriculum for lower elementary grades aims to determine the aspects conducive for application to Smart Board Games. Lastly, the theoretical framework outlined through the previous stages is used as the basis for the proposal of a detailed model of contents for the smart board game concept.

Key words: *Smart Board Game, Storytelling, Board Game Design, Gamification, Edutainment*

1. INTRODUCTION

The purpose of this paper is to design and develop a “Smart Board Game” for children to be used as a model for multimedia contents convergent across different platforms [1]. The Smart Board Game combines the physical layout of conventional board games with the characteristics of online mobile games, while the concept itself revolves around the offline board game augmented through the use of smart devices such as smartphones and tablet PCs, thereby combining the tangible and static characteristics of the board game with the expansiveness and fluidity of the mobile game.

The process of converting gaming elements for educational purposes obfuscates the boundaries between learning and playing. Subsequently, the Smart Board Game concept contains elements of both imaginary fiction and objective information. The idea of the story value is significant in the establishment of the locational setting and characters within a game, while at the same time, the process of fulfilling in-game quests features prominent use of educational information. This amalgamation of contents is intended to be effective in the simultaneous pursuit of recreational enjoyment and didactical benefits. Particularly considering the trend of rapid changes in media, Smart Board Games can provide an effective model of convergence in relation to positive learning and problem solving, thereby surpassing the two-dimensional purpose of conveying information and actively encouraging children to learn the virtues of cooperation, competition and storytelling.

The discourse regarding convergent education in Korea has recently brought the value of storytelling methodologies

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into focus. For example, the STEAM education program currently under trial in Korea [2] is designed to foster creativity among future talent by combining the theory-oriented curriculums of mathematics and science with technological, engineering, and artistic aspects. In this regard, storytelling methodologies have proven effective in the procedural conveyance of mathematical and scientific principles. However, the convergence between the sciences and storytelling methodologies remains an endeavor in its relative infancy, and therefore attempts such as the aforementioned program have yet to yield a sufficient range of case studies and applicable models. Moreover, since research and development into the contents aspect is also in the early stages, the application of storytelling methodologies has been implemented incorrectly in many cases. For example, the inclusion of characters, events and background settings unrelated to the educational contents often presents an obstacle in terms of cohesion and coherence between the informative and storytelling purposes. Storytelling methodologies must not be applied in a tentative extent as a simplistic supplementation of the overall synopsis; instead, contents designed for the purpose of convergent education must offer a seamless arrangement of information and narrative as well as the opportunity for children to discover points of empathy within the story and to actively strive to gain knowledge from it. To this end, the aforementioned theoretical facets must be materialized through proposals for a variety of content models.

The Smart Board Game concept illustrates a platform appropriate for the simultaneous education of scientific principles and the development of the capacity for creative imagination. In practice, the ability of storytelling methods to stimulate imaginative and procedural thinking creates a potent synergic effect in combination with the compositional traits inherent in games such as rules, outcomes and rewards. Contents that merge the aspects of gameplay and storytelling offer children the natural opportunity for immersion in the content through the fictional universe and emotional empathy towards the featured characters. Furthermore, the process of fulfilling quests and gaining rewards at each stage provides users with the motivation to continue to obtain knowledge. Subsequently, this paper applies storytelling methodologies in terms of the content and combines the ‘gamification’ of the format to create and propose a model of educational entertainment for the science curriculum across lower elementary grades in the form of the Smart Board Game, which is expected to offer children a new experience in terms of gaining knowledge through the combination of scientific information and artistic fiction.

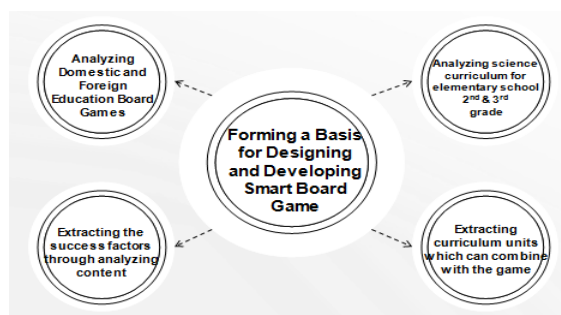


Fig. 1. Smart Board Game Design Process

2. RELATED STUDIES

The widespread use of smart devices has actively vitalized research towards the utility of digital media in didactical methodologies, leading to the presentation of articles such as “Effects of Digital Textbook’s Interactivity on the Learning Attitude” [3]-[7]. Other entries in the debate, such as “Interactive Storytelling of Visual Encyclopedia Applications,” focus on the inclusion of storytelling elements in digital educational contents [8]-[10]. Subject matters in previous studies can be generally divided into educational games and serious games, the difference between which consists of whether a child perceives the intended purpose of the material as entertainment or education on the surface value. Although the content of the Smart Board Game proposed in this study corresponds to the elementary school curriculum, it transcends its basic utility as an ancillary tool to teaching materials such as revision books or reference books. In essence, it is important for the Smart Board Game to be perceived by children as a beneficial content format at face value, which differentiates the Smart Board Game concept as a type of edutainment content as opposed to a form of teaching material. The research conducted by Cha et al. on educational games for lower graders and similar studies have additionally focused on educational games targeting preschool children and lower graders at stages unfamiliar with the written alphabet [11], [12].

The conception of material existence and multisensory cognition are important aspects of learning in early elementary grades [13]. Numerous studies have been conducted through a variety of approaches on utilizing game-specific characteristics in education [14], [15], including the work of Mark Allen, which suggests and defines the concept of the ‘smart toy’ as those with embedded electronic hardware, a degree of computational capacity, and the appearance of adaptive interactivity in correspondence to the abilities of the user [16]. According to Allen, tactile sensation assists children with the identification of objects and is considered one of the least understood senses; a more comprehensive understanding and application of the principles of tactile interactivity in educational utilization may yield invaluable contributions to the field of educational entertainment research. Meanwhile, T.L. Taylor discusses the use and effects of modifications (mods) created by players to enhance gameplay in the popular massively multiplayer online role-playing game (MMORPG) *World of Warcraft* [17], which suggests the inferred potential to encourage children to employ their creative capacity to self-generate rules and texts through the use of games for educational purposes.

Preceding studies have notably suggested the concept of augmented reality (AR) as a technological aspect with the potential for application towards the educational gaming platform, focusing on the inherent interactivity of smart devices in the expectation that the high degree of user participation inherent in the medium would contribute to transforming the role of children from passive recipients to active primary consumers [18], [19].

However, preceding studies on educational content and games are limited by two problems in general. First, studies focusing on the analysis and assessment of content display the

inclination to overemphasize the educational benefits of the subject matter, and subsequently fail to identify and examine the fundamental characteristics of the content itself. Second, works of research focusing on presenting a contents model in the relevant area are largely limited to discussing the compositional aspects of the subject matter, such as the user interface and the actual implementation of the technological elements. For the latter case, confining the viewpoint of the study to the implementation of new technology poses an obstacle on the evaluation of whether the inclusion of educational contents is congruous with the narrative. In summation, existing studies are hindered by the failure to achieve a sufficient degree of convergence between the educational contents and the gameplay format from the perspective of the end-users.

Therefore, this paper will analyze previous efforts in the field in order to propose a detailed model by incorporating the theoretical strengths and overcoming the limitations of prior studies. More specifically, this study aims to present storytelling methodologies that may be used in conjunction with science education in lower elementary grades along with case studies of the practical application of the proposed model.

3. ANALYSIS OF REPRESENTATIVE CASES

Firstly, the proposal for a research model presented in this paper relies upon the analysis of existing Smart Board Games, the scope of which extends to smart-device-based board games in circulation across domestic and international markets, with the purpose of identifying the significance and limitations of each case study. Currently, board games are used as a creative instrument of recreational sessions in afterschool classes. Among Korean board games currently in market circulation, the main subjects of analysis include those involving the elementary school curriculum as the main content. The aim of this analysis is to identify the prevalent characteristics of previous board games on smart device platforms in order to infer and create a suitable framework and design a new model for the Smart Board Game concept, further assisted by the utilization of interactive features inherent in smart devices. First, this paper analyzes the contents of domestic and foreign educational board games to identify potential factors for success. Second, it analyzes the science curriculum for 2nd and 3rd grade classes in Korean elementary schools, and extracts elements of the curriculum which are suitable for convergence with games and storytelling.

Table 1. List of Smart Device Board Games

Title	Developer	Characteristics
Table Soccer	SONY	Extract marker cards by element. Augmented reality is used for the visual aspect of the gameplay.
Pit Strategy	Beyond Reality	Augmented reality visualizes the players' manipulation of virtual data and the results.
Monopoly	EPFL, CVLab	Tokens and dice are rendered in 3D format after video capture

		through the webcam.
Darkling Plain\	Nocturnal Media	The fantasy world and characters are realized through augmented reality. Uses markers available for printing.
Monopoly zAPPed	Hasbro	The role of the game host is played by the application itself. Chance and event cards are provided through virtual mini-games.
AR Magic Card	Hanul Neotech	Players learn through narration by voice actors, with the fantasy animal characters serving as learning assistants.

The analysis of prominent Smart Board Games in Korea and abroad confirms the notion that offline games attempt to capitalize on the use of smart devices as a factor of enjoyment. Existing Smart Board Games can be largely classified into those focusing primarily on the entertainment factor and those oriented towards educational purposes. Particularly in the case of the latter, mobile smart devices are utilized in a diverse range of aspects in edutainment contents due to the broad potential for children to interact with the devices and to stimulate their interest in the subject matter. Smart devices are suitable for encouraging physically engaging and self-directed learning. However, some of the games listed in Table 1 have implemented the use of smart devices without due consideration of the outcome reflected on the game, and the composition of the contents are limited to focusing on the results rather than the process, and simplistic understanding of the information rather than stimulating cognitive thought, thus raising the necessity for greater cohesion in the linkage between the gameplay experience, educational experience, and the use of smart devices.

The analysis of gameplay and storytelling elements across existing cases allows the following conjectures: 1) Storytelling principles should remain consistent throughout the entire game; 2) The protagonist must be sufficiently developed to allow children playing the game to empathize with the character; 3) Settings for the fantasy world should be dramatic in composition; 4) Factors of enjoyment should be utilized with the active use of in-game items; 5) Players should be encouraged to collect items and play the game continuously. Based on these results, this paper develops a specific Smart Board Game model in Chapter 5.

4. COMBINING STORYTELLING AND GAMIFICATION

Storytelling is a method of reasoning and expression based on problem-solving. Problem-based storytelling is a popular model in literature, in which the central challenge must be evident; a question, a problem, an obstacle, an opportunity, or a goal [20]. Games intrinsically impose challenges on players and encourage the independent and procedural discovery of solutions, which is a facet shared by the medium of storytelling.

Therefore, the inducement of educational benefits from the gameplay experience requires the cautious balance between the structured regularity of games and the fictionality of storytelling.

The convergence point between storytelling and games lies in the concept of ‘quests’. According to Howard Jeff, the concept of quests can serve as a ‘middle term,’ a conceptual bridge that can help to adjoin the gameplay and storytelling aspects [21]. Quests lead users through the incremental steps required to solve problems, which is procedurally relevant for combining gameplay with the science curriculum for lower elementary grades. Primarily for this reason, this research paper designed the game proposal in relation to the science curriculum for lower elementary grades, with the application of storytelling methodology to determine the contents and format of the game.

4.1 Gamification

The preceding years have witnessed the emergence of a new academic field concerning games and learning, which hypothesizes the premise that games (including video games) can engage players with in-depth and productive forms of learning in a highly motivational context [22]. The Smart Board Game is primarily based on the conventional offline board game in terms of the format. This type of mobile gaming application is overlaid onto an offline board game in order to combine fantasy and reality, online and offline aspects, gameplay and in-depth learning. Smartphones can be used effectively for this purpose in gameplay; for example, upon completing quests, the player receives rewards using the relevant mobile phone application, through which the game aims to enhance the player’s enjoyment in collecting items and event cards. The use of smart devices can intensify interest and encourage continued usage among players and overcome the limitations in continuity in conventional board games.

A relevant model may include the application of marker recognition or augmented reality technology using QR codes in a board game. Augmented reality technology using QR codes can be applied to existing board games and its use can be learned with ease by elementary school students. The Smart Board Game consists of missions and quests which give players rewards, which can be visualized through the augmented reality system. With regards to the concept of gamification, players choose their characters based on the specified rules and worldview presented by the game, and progress through the game’s narrative by accomplishing quests. This process leads children to experience ‘flow’ as the psychological concept of deep immersion and enhanced focus. As a result, children are led to recognize science as an interesting challenge. Furthermore, the Smart Board Game is designed to encourage the participation of more than a single player in order to enhance the positive effects of competition and group activity.

4.2 Storytelling

This paper applies procedural, problem-solving methodology of storytelling in developing a model of Smart Board Game content. Storytelling methodology builds a

worldview, settings, characters and scenarios. The locational backgrounds and dramatic conflicts stimulate and expand the children’s capacity for imagination and fantasies. Based on such elements, the process of designing the Smart Board Game attempts to intertwine stories with scientific principles.

For the purposes of storytelling, the game’s setting must compel the curiosity of early elementary students, since younger children are able to exercise the capacity for imagination far more freely within the context of a fictitious domain as opposed to reality. Children in the concrete operational stage prefer the fantastical in terms of time and space, which is physically impossible to experience in the real world; for example, the timeframes of the future or the past, and the spatial domains of outer space or the deep sea. Since the delivery of scientific knowledge through the medium of a fictitious universe is a useful stimulus for creativity among children, presenting them with imaginary spatial and temporal settings may be constructive for educational purposes, provided that the extent of the fantastical distortion does not contravene the fundamental confines of scientific principles.

Furthermore, introducing characters that evoke sentiments of empathy or sympathy allows students to project themselves onto the characters as a form of mirror image and to experience the archetypal hero’s journey from a first-person perspective. Therefore characters must be created in an image that is desirable and worthy of emulation to children [23], thereby indicating that characters of high mimetic mode are more desirable than those reflecting reality. In this respect, the introduction of a hero who explores fantastical realms of space and time may be effective in providing motivation and inspiration among the players, who are encouraged to perform quests and gain rewards, thus naturally attaining a sense of achievement in the process of following the hero’s journey.

5. DEVELOPMENT OF SMART GAME STORYTELLING

This particular Smart Board Game incorporates the storytelling structure in encouraging children to solve problems regarding planets in the solar system with the narrative aim to become an official engineer aboard Space Express Zenuri. Through the effects of gamification, children are led to perceive the scientific lessons as an interesting chain of challenges. This game applies a QR code system as a technological point of interest for elementary school students in order to combine fantasy and reality, online and offline, gameplay and in-depth learning. The following table shows the outline of *Go! Space Express*, the Smart Board Game model proposed by this paper.

Table 2. Smart Board Game *Go! Space Express* Summary

Title	Go! Space Express
Genre	Smart Board Game
Study Goals	To assist early elementary students to study science
Target	Lower elementary grades (Males in particular)

Operating System	Android
Game Components	1 game board 30 Question Cards 10 Chance Cards 4 Playing pieces 1 mobile application

The storytelling elements applied to layers within the game such as the background settings, characters and events are designed through the humanities-based analysis of the characteristics prevalent among the target demographic. Primarily aimed towards early elementary grades, this paper sets the proposed game in outer space, a setting conducive to stimulate curiosity and fantastical elements. The timeframe occupies the near-future setting of year 2013, while the locational setting involves the fictional location of the 7th Planet of Cosmo Galaxy. Among subjects of scientific study, the domain of outer space is arguably the greatest in terms of inspiring the imagination of the humanities. The fantastical nature inherent in mankind’s conception of the outer space stimulates the capacity for fiction and imagination among the children players, thereby encouraging the recognition of scientific learning as entertainment activities and voluntary participation towards such activities

Go! Space Express places the player in the role of the protagonist ‘Garam Go’, an aspiring crewmember aboard the Space Express Zenuri, who must pass engineer’s exams at various levels. Such settings encourage the child players to project their sense of adventure and resourcefulness for the cathartic experience of emotionally empathizing with the character of ‘Garam Go.’ As the primary target demographic of *Go! Space Express*, male children in lower elementary grades are at an age to acquire social role models and experience strong desires to “become” someone. This characteristic is connected to the proclivity to form direct emotional engagement with the heroic narrative and a strong interest towards vehicles as the means of transportation to a new, unfamiliar space. Based on this notion, the stipulation that the protagonist will earn the engineer status upon collecting three badges as rewards for satisfactory exams provides the player with a sense of purpose.

In practice, scientific information is presented through questions within the context of the episodes constituting the game’s narrative, which allows the player to naturally encounter the subject of learning on the level of context-specific stories and events. Meanwhile, items are intermittently acquired throughout the course of the game, and smart devices are used when badges and licenses are rewarded for the completion of quests, in order to maximize the dramatic outcome. The following is the structure of the game expressed in a flowchart:

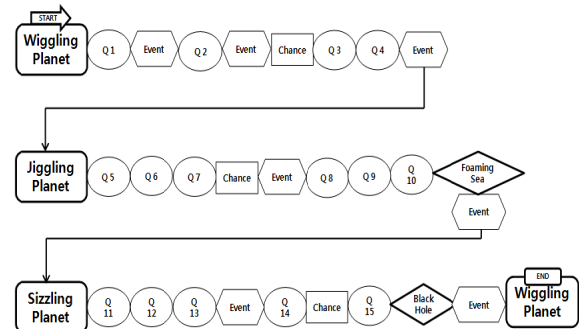







Fig. 2. Flowchart of Narrative and Gameplay Progression

5.1 Characterization

Male children in lower elementary grades tend to prefer the protagonist to be a curious and vibrant child hero who is led upon a journey to complete a wide range of quests, which progresses parallel to the educational function. Other characters, such as antagonists or allies, should serve as the source of conflict at each stage. Given that the player is a low grade student in elementary school, however, the presentation of allies must be friendly and non-threatening, while the presentation of antagonists must be a formality, rather than an attempt to maximize a hostile response, since the portrayal of an overtly powerful and threatening antagonist may weaken the sense of competition as an educational motivator, and instead encourage the players to focus excessively on the enemy. Therefore, the presentation of characters in the Smart Board Game as a form of educational content must consider the following: 1) the pursuit of a heroic narrative in keeping with conventional stories aimed at children; 2) the introduction of capable allies to assist in problem-solving; and 3) the introduction of a different antagonist for each quest in order to undermine the significance of the roles and functions of antagonists throughout the entire narrative. The following table demonstrates the characterization in the game designed in line with aforementioned theories.

Table 3. Main Characters of *Go! Space Express*

Character	Role
 Garam Go	Protagonist. A brave ten-year-old boy, Garam wants to be an engineer on Space Express Zenuri 2013.
 Moon Rabbits	Helpers Owner of the snack bar named "∞" to symbolize the mathematical symbol for infinity, who provides item cards.
 Blue Dog	Antagonist Engineering test supervisor A resident of Jiggling Planet with blue-black hair. A cold-hearted character that does not accept mistakes.

 Yellow Dog	Engineering test supervisor A resident of Sizzling Planet with red-blond hair. Optimistic, but has a fiery temper.
 Space Worm	Engineering test supervisor A resident of Wiggling Planet and a large, multicolored space worm. Enjoys presenting challenging questions to test candidates.

The protagonist ‘Garam Go’ begins the story in the senior year of Zenuri Normal School, and faces an important engineering test in order to become the pilot of Zenuri 2013. Players progress through the board game to develop a degree of empathy for Garam, who is assisted by allies such as the Moon Rabbits, three creatures with beautiful, starry eyes, each of whom manages a snack bar in proximity to each planet stage. Additional characters include ‘Blue Dog’, ‘Yellow Dog’ and ‘Space Worm’, engineering test supervisors that feature as antagonists purposefully weakened for reasons discussed previously. Players can identify the augmented image through marker recognition on the board.

5.2 World Concept




Boys in lower elementary grades prefer the plot structure of conventional adventure stories, in which the protagonist traverses between real and fantasy worlds, by entering a world of fantasy and adventure, completing the hero’s mission and returning to the real world. While the location of the hero’s adventure must be fictional, the characters featured in the Smart Board Game narrative should be fictional to a degree that remains closely related to the educational information featured in the textbook. The sciences are particularly conducive to the creation of contents with motifs such as exploration, investigation and travelling, due to the convenient convergence between the process of spatial transition and the phase-based comprehension of the curriculum.

At present, convergent thinking is considered the most important quality in the education of young scientific talent. Convergent thinking refers to cognitive flexibility and the capacity to integrate different abilities such as scientific reasoning and humanities-based imagination. Therefore, the fictional problems to be solved by the fictional characters in the fictional world must nonetheless contain information based on reality in order to develop the above capabilities.

Maintaining relevance to the curriculum is necessary to allow the systematic and gradual acquisition of knowledge by children, while the in-game quests themselves need to represent specific cases based on real life. However, in the case of early elementary school science, the storytelling approach must first and foremost serve to intrigue the learners. Therefore the use of storytelling must emphasize fantasy elements and feature a heroic character as the protagonist for the players to project themselves onto, which aims to allow children to seamlessly associate daily life and educational knowledge by revising the contents learned through the gameplay or through role-playing

as the characters featured in the game. The following table shows specific examples based on the theories above.

Table 4. Examples Questions on In-game Planets

Space	Examples	Curriculum
 Wiggling Planet (Biology)	Garam accompanies his friend Gangsan to watch the fish and tortoises in a pond. Tilting his head, Garam asks, “Gangsan, how do these animals breathe under water?” Gangsan replies, “All aquatic animals breathe through their gills!” Is Gangsan correct?	3. Life Cycle of Animals (Third year, second semester) 2. The World of Animals (Third year, second semester)
 Jiggling Planet (Physics & Earth Science)	Garam is changing the color of the lights onboard the Space Express Zenuri. “If you have the three colors of red, blue and green, you can create any color! Then what color does the even combination of red, blue and green produce?”	2. The Characteristics of Magnet (Third year, first semester) 4. Weather and Our Living (Third year, first semester) 4. Light and Shadow (Third year, second semester)
 Sizzling Planet (Chemistry)	During exam period at the Zenuri academy, Gangsan becomes hungry after hours of hard study and boils water in a pot to make ramen. Engrossed in reading, he finally realized that much time had passed and hurriedly turns off the stove. When the boiling water cools down, is the amount of water in the pot smaller than before?	1. Volume of Liquid and Gas (Third year, second semester) 3. Separation of Mixture (Third year, second semester)




As discussed previously, the outer space represents a domain of the unfamiliar and the extraordinary, which is ideal for the realization of children’s abundant capacity for imagination. Moreover, since outer space is a prominent scientific subject, it lends itself to association with information contained in scientific curriculums. Within this context of *Go! Space Express*, outer space features three distinct planetary environments, each of which is an imaginary realm at face value, but the concept behind each planet nonetheless represents a branch of natural science and therefore the names of the planets are designed to remind players of biology, physics and chemistry respectively. Traversing between the

planets, players undertake an adventure that leads to a natural convergence between theoretical knowledge contained in school curriculums and aspects of fictional imagination.

5.3 Items and Rewards

The enjoyment factor in edutainment contents encourages children into constant usage and interaction, thereby playing the essential role of enhancing the players’ familiarity with and immersion in the fictional world. Items and rewards featured in the Smart Board Game are among the key factors of enjoyment that motivate children to continue playing, and serve to imbue a sense of accomplishment by providing tangible outcomes of the gameplay and educational progress. Items and rewards, however, must correspond to the context of the content, while in-game statistics or objects irrelevant to the educational context do not hold significant meaning. Conversely, the subsistence of the fictional world is contingent upon the relevance of the outcomes of the gameplay in the form of rewards and items to the overall setting of the established universe. The following table shows specific examples based on the theories above.

Table 5. Functions of Fictional In-game Locations

Space	Function
 Snack Bar	Official rest area operated by Moon Rabbits. Players can buy Item Cards (Starfish Jelly and Milky Way Soda) using mileage earned by collecting Space Tickets.
 Foaming Sea	Space ocean comprised of multicolored foam. Players can escape if the results of three dice rolls add to produce an even number.
 Black Hole	Final hurdle for becoming an engineer aboard Space Express Zenuri. Players must rest one turn upon entering the Black Hole, and can escape only when two dice rolls produce a number higher than four.

Items and rewards suggested in this paper are closely related to the fantasy world and serve to perform a narrative function in context of the fictional universe. Items carry the function of escalating a falling narrative curve. Therefore, in penalty spaces, such as the Foaming Sea and the Black Hole, players are compelled to make active use of items, as a means of conflict resolution and problem-solving. This context of items in relation to space may promote both narrative enjoyment and educational effect.

Factors of enjoyment naturally prolong the duration spent playing the Smart Board Game, while encouraging players to greater depths of immersion and to continue playing and interacting with other users. Such effects are particularly enhanced by the use of smart devices, which must be used more effectively in dramatic scenes such as the player encountering serious problems or receiving rewards for solving

problems. The following flowchart shows a specific example based on the theories above.

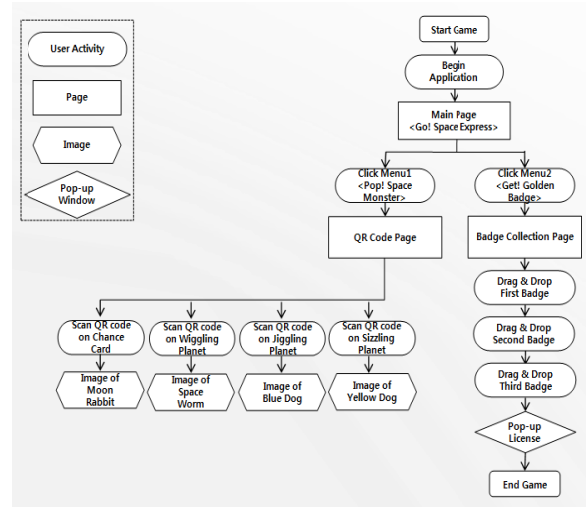


Fig. 3. Application Flowchart



Fig. 4. Main User Interface of Mobile Application

Research and development of the Smart Board Game was primarily based on the smartphone device ‘Samsung Galaxy Note 2,’ which utilizes the Android mobile operating system, due to its popularity.

As for the previously discussed factors of enjoyment, the use of smart devices can induce a multisensory experience for children to encounter in-game characters—space monsters and allies, such as Moon Rabbits, Blue Dog, Yellow Dog and Space Worm, which can be visually augmented by scanning QR codes. Through the process of merging offline games and online devices and embodying fictional characters, children are led to recognize the content as entertainment. Furthermore, the provision of fantasy items with narrative function in the game context, such as Golden Badges, Starfish Jelly and Milky Way Soda, can give children a sense of accomplishment as the sentiment of active leadership regarding the narrative as opposed to passive consumption of a linear synopsis.



Fig. 5. Completed version of Smart Board Game Go! Space Express (Tangible Board, Mobile Application, Question & Chance Cards, Guide Book)

6. CONCLUSION

In summation, this paper claims four purposes. First, this paper identifies important factors for board game design through the case study of Smart Board Games. Second, the analysis of science curriculums in Korean elementary schools aims to extract information suitable for inclusion in a Smart Board Game. Third, this paper develops the design model for the actual development of Smart Board Game. Finally, this paper provides creative smart media content in a readily playable format and identifies directions for further utilizing and developing the Smart Board Game.

Edutainment content, characterized by the combination of education and entertainment, requires even balance between the two factors. Educational information should be provided in such a way that children can continue to strive for further knowledge and self-directed learning without losing interest. Conventional Smart Board Games attempt to use technological implementation through the use of smart devices as an enjoyment factor in order to preserve interest among child players. This approach, however, has its limitations in the failure to present the actual flow of the games, the implementation of the technology through devices, and the subject of learning in an organic combination.

To overcome these limitations, this paper seeks to use the methodology of storytelling and gamification to elicit voluntary immersion and procedural exploration from the players. The Smart Board Game model proposed by this paper is the end result of reconstituting an engaging experience from scientific concepts that children might otherwise find tedious and repetitive, by applying the participatory characteristics of gamification and the procedural methodology of storytelling. Meanwhile, the distinction from other game-based learning systems is evident in the formulation of a narrative based on characters, backgrounds and events designed specifically for male children in lower elementary grades. Moreover, the use of smart device technology is designed to facilitate an organic relationship with actual in-game experiences, thereby maximizing the effects of learning.

Following the development process conducted on the basis of this paper, a total of 100 copies of the Smart Board Game *Go! Space Express* has been distributed across the country to Infinite Imagination Rooms operated by the Korea Foundation for the Advancement of Science and Creativity. The Infinite Imagination Rooms use the game to offer storytelling-based science programs catering to lower elementary grades, which contributes to the provision of after-school programs demonstrating high levels of participation and satisfaction. The use of *Go! Space Express* as a means of providing creative activities in relation to school curriculums for lower elementary grades additionally allows students the opportunity for learning as more active and self-directed recreation. Smart Board Games have proven particularly effective in enhancing psychological stability based on the physicality of the tangible board game format and invigorating the attentive capacity among male children in lower elementary grades that frequent Infinite Imagination Rooms.

The utilization of smart devices proposed by this paper, however, has its limitations in that technology unique to the

smart device platform is applied only through visual augmentation through QR code recognition. Further research is henceforth required towards the convergence of various device-related technologies such as augmented reality in the area of the Smart Board Game, in order to generate positive effects through efforts such as the aim to enhance the continual captivation of the users' attention, improving the substantive and material aspects of the board game, as well as promoting greater immersion in the educational aspect. This study examines games as a positive literary experience, thereby offering a creative direction to contribute to the promotion of science education. Furthermore, the model presented in the study offers a positive value of content based on smart media.

The ultimate goal of this study is to propose a model of smart content and future prospects for the fusion of education and entertainment, fantasy and reality, educator and educatee, developer and end-user, offline and online, literary gaming and storytelling, with the ultimate purpose to provide new educational experiences through interactive participation by children.

REFERENCES

- [1] Korea Foundation for the Advancement of Science and Creativity, <http://steam.kofac.re.kr/>
- [2] S. K. Yoon, M. J. Kim, and J. H. Choi, "Effects of Digital Textbook's Interactivity on the Learning Attitude," KCA Thesis Journal, vol. 14, no. 2, Mar. 2014, pp. 205-222.
- [3] Y. R. Lee and Y. H. Lim, "HTML5-based Mobile Web Capture Video Learning System," KCA Thesis Journal, vol. 13, no. 2, Jun. 2013, pp. 8-18.
- [4] S. H. Ahn and S. M. Song, "Edutainment Contents' type & development view," KCA Thesis Journal, vol. 6, no. 3, Sep. 2008, pp. 72-86.
- [5] Z. Q. Ziang and D. H. Lee, "Exploring New System of China Digital Media Design Related Undergraduate Education," IJoC, vol. 6, no. 1, Mar. 2010, pp. 35-40.
- [6] J. M. Yang and J. C. Park, "A Study on Platform Development for Web 2.0-based e-Learning," IJoC, vol. 5, no. 1, Mar. 2009, pp. 1-8.
- [7] S. H. Yun and S. H. Ahn, "Designing storytelling of edutainment using animation," Proc. KCA Symposium'07 Fall, vol. 5, no. 2, 2007, pp. 622-626.
- [8] H. W. Han and M. S. Ryu, "Analysis of Story-Retelling Structure in Digital Storytelling Applications for Infants," KCA Thesis Journal, vol. 13, no. 5, May. 2013, pp. 146-158.
- [9] H. W. Han and M. S. Ryu, "Interactive Storytelling of Visual Encyclopedia Applications," Journal of Korean Society For Computer Game, vol. 26, no. 4, Dec. 2013, pp. 49-58.
- [10] M. H. Cha, "The Elementary course Mission Adventure Education Game Development the Creativity Improvement," Journal of Korean Society For Computer Game, vol. 19, Dec. 2009, pp. 227-233.
- [11] E. S. Cho, "Design & development of e-learning game contents in elementary math class," Proc. KCA Symposium'06 Spring, vol. 4, no. 1, 2006, pp. 35-38.

- [12] K. M. Kapp, *The Gamification of Learning and Instruction*, Wiley, USA, 2012, pp. 9-12.
- [13] C. G. Park, *Development of Board Games on Learning Biology and Evaluation of its Educational Effects*, Master's Dissertation, Korea National University of Education, 2010.
- [14] S. J. Lim and J. W. Lee, "A Model of an Educational Board Game for Young Children," *The Children's Media Studies*, vol. 4, Dec. 2005, pp. 205-221.
- [15] M. Allen, "Tangible Interfaces in Smart Toys," *Toys, games, and media*, Routledge, London, 2004, pp. 179-180.
- [16] T. L. Taylor, "Does World of Warcraft Change Everything? How a PvP Server, Multinational Player Base, and Surveillance Mod Scene Caused Me Pause," *Digital Culture, Play, and Identity*, The MIT Press, Cambridge, 2008, p. 187.
- [17] H. S. Lee, *A Study of Education Game Platform Based on Augmented Reality*, Master's Dissertation, The Graduate School of Sejong University, 2008.
- [18] M. R. Kwon and J. I. Kim, "Using Augmented Reality Programs For Children Proposed Research Model," *Journal of the Korea Academia-Industrial cooperation Society*, vol. 13, no. 2, Feb. 2012, pp. 866-871.
- [19] B. Alexander, *The New Digital Storytelling*, Praeger, Connecticut, 2011, p. 8.
- [20] J. Howard, *Quest*, CRC Press, Florida, 2008, p. 11.
- [21] J. P. Gee, *Good videogames and good learning*, Peter Lang Publishing, New York, 2007, p. 130.
- [22] N. Frye, *Anatomy of Criticism (Updated edition)*, Princeton University Press, Princeton, 2000.



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