Treasure the Moment
Communication as a Scaffold for Mobile Learning Activities

Author: Rotem Israel
Supervisor: Prof. Miky Ronen
Co-supervisor: Dr. Dan Kohen-Vacs
Examiner: Dr. Nuno Otero
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Abstract
Communication is a fundamental social component of human life and constitutes an indispensable factor in the learning process as it allows the transfer of information between people. Communication supports the interactions that take place in different learning stages and settings and can encourage involvement and cooperation.

The "Treasure-HIT" platform, a dedicated environment for designing pedagogical mobile location-based games, encourages social interaction and collaborative learning. This platform, which is social at its base, has limited communication capabilities. Adding such capabilities can overcome this difficulty by providing a more supportive and interpersonal interaction among the involved stakeholders. This thesis explores the users' communication needs for the preparation and enactment of "Treasure-HIT" activities. A design based research was used to analyze the needs in terms of design and technological specifications and develop and implement communication features. Three such features were developed in the course of this thesis: (1) Activities based map, (2) Social media sharing feature (Facebook tasks) and (3) Image gallery. All of those aimed at supporting communication between learners, instructors and their community, before, during and after the activities. Findings show that the developed capabilities enabled new means of communication and contributed to the user experience and learning process. Users appreciated the functionality and ease of use and positively adopted the new features.

Keywords
Communication, mobile learning, location based games, treasure hunt, CSLS
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1 Introduction and Motivation

During the past few decades, the accelerated development of technology has changed the learning environment and extended it far beyond the traditional boundaries of classroom and school schedules (Hwang, Wu, Tseng, & Huang, 2011). The learning experience is no longer confined to a certain space or time and can exist in a wide range of situations, indoors or outdoors (Hung, Lin, & Hwang, 2010). Technology, plays another significant part in making learning more efficient and productive (Hung et al., 2010). It provides various forms of pedagogical support and scaffolding for collaborative learning (Stahl, Koschmann, & Suthers, 2006). Computer-supported collaborative learning (CSCL) is a pedagogical approach that harnesses the technology in favor of the collaborative learning process. It proposes the development of new software and applications that encourage creative activities of intellectual exploration and social interaction of learners. The learning takes place through social interaction using a computer or through the Internet, synchronously or asynchronously. The learning is characterized by the sharing and construction of knowledge among learners using technology as their primary means of communication or as a common resource (Stahl et al., 2006). Web 2.0 technologies and cross-platform environments can play a role as a mediator for enriching peer learning as they provide various opportunities for sharing information, retrieving information, and active interaction with other learners and instructors (Su, Yang, Hwang, & Zhang, 2010). These environments encourage learners to participate, exchange ideas, share information and use previous knowledge (Su et al., 2010).

Mobile technologies extended those capabilities even further as they were built on the inherent advantages of technology and allowed users to use them in any environment and place across different contexts (Jones, Scanlon, & Clough, 2013). The proliferation and availability of mobile technologies has created the bridge necessary to embed technology into the outdoor learning environment. Thanks to their wireless connection, those technologies can support the various ways of learning that occur spontaneously in daily activities inside and outside the classroom (Valk, Rashid, & Elder, 2010). A variety of qualities and functions such as web browsing, photography, audio recording, text messaging, navigation (via GPS), and multimedia production (Woodcock, Middleton, & Nortcliffe, 2012), enable them to support inquiry-based activities in authentic environments (Jones et al., 2013).

Communication capabilities, which are also offered by mobile devices, provide a more supportive, interpersonal and dynamic environment that helps learners be engaged, motivated and successful (Finkelstein, 2009). Those capabilities expand the interaction between instructor and students and could improve the classroom dynamics in a less formal context. They encourage collaboration but nevertheless allow independent investigation and development of ideas and concepts, according to the students' capabilities and level of understanding (Genossar, Botzer, & Yerushalmy, 2008).

Different teaching and learning strategies are offered by the use of mobile technologies (Huizenga, Admiraal, Akkerman, & Dam, 2009). Mobile games are an example of such a strategy. The games allow learners to develop various social and cognitive skills obtained by a range of activities. Such activities may include: cooperation, spatial orientation, data mining, inquiry and problem solving (Spikol & Milrad, 2008).

Games which provide these core skills have existed long before technology came into our daily lives. One such game which integrates the outdoor space in learning is Treasure Hunt. Treasure Hunt is a location-based activity which represents a classic and playful approach that was traditionally performed without digital technological
means (Baden-Powell, 1926). Treasure Hunt games challenge players to identify specific locations according to clues and reach them. They can be played in different settings, individually or in groups, with or without a competitive component.

Treasure Hunt games can benefit from mobile technologies as they enable leveraging those games by utilizing the devices’ features such as GPS, camera and voice capture. A plethora of mobile Treasure Hunt games were developed using those features with different end goals in mind. However, they were not necessarily designed for pedagogical use. Consequently, the department of Instructional Technologies at the Holon Institute of Technology developed a dedicated platform called “Treasure-HIT”, tailored to the instructors’ needs, for designing educational location-based games supported by mobile devices. The platform currently allows instructors to create and control Treasure Hunt activities, share the activities and be notified on who finished the game (Kohen-Vacs, Ronen, & Cohen, 2012). Nevertheless, the platform is still lacking the ability to support communication and social capabilities between stakeholders.

This study aims at further expanding the pedagogical capabilities of the Treasure-HIT platform by supporting communication aspects. These capabilities will be used by instructors in creating meaningful and enjoyable learning activities. The following document describes in details the effort to achieve these goals.
2 Literature Review

2.1 Mobile Learning
The rapid development of mobile technologies amplified their penetration rate into all aspects of our lives including the field of education (Woodcock et al., 2012). Consequently, mobile learning has become a widespread pedagogical tool scaffolding instructors and learners (Liaw, Hatala, & Huang, 2010).

Various researchers have defined and described mobile learning. Mcconatha & Prual (2008) defined it as learning accomplished by the use of portable computational devices such as smartphones, PDAs and similar handheld devices. Likewise, (Quinn, 2000), and many other researchers, have provided a definition that sees mobile learning as learning associated with portable devices. On the contrary, Laouris & Eteokleous (2005), discussed that focusing on mobile devices as the sole definition of mobile learning omits its essence. The term mobile learning is composed of two words and therefore we must treat both. O'Malley et al. (2005), for example, proposed a broader definition according to which mobile learning is any kind of learning that takes place when the learners is not bound to a specific location and utilizes the opportunities offered by mobile devices. Sharples, Taylor, & Vavoula (2010) addressed in their definition of mobile learning both the portable devices through which the learning takes place, and the environmental settings of learning. According to them, mobile learning is the accumulation of knowledge through interactions by technological means.

The literature on this subject points to a variety of advantages in its use. The first relates to the fact that mobile technologies have become an integral and essential component in students' life (Song, 2014). Low prices and improved hardware and software capabilities have increased their popularity and led to rapid market penetration (Sambasivan, John, Udayakumar, & Gupta, 2011). Their use has become so common making it difficult to find a student without a smartphone (Gimenez López, Magal Royo, Laborda, & Garde Calvo, 2009). Today's students have been born into a technological world where mobile technologies are an inseparable part of their day-to-day activities and their way of communication with their peers (Huizenga et al., 2009). With mobile learning, students can seamlessly access learning resources, perform administrative actions, and practice course materials without being bounded to a specific location or fixed set of times (Upadhyay, 2006).

Mobile learning expands the boundaries of traditional learning by allowing access to students who cannot physically attend. Additionally, it supports the various ways of learning that occur in daily activities outside the classroom. Students can update their knowledge according to their preferences, needs and customized schedule. By using those mobile technologies, students can take greater responsibility for their learning process rather than being passively fed by educators (Valk et al., 2010). Mobile technologies allow the expansion of the interaction between the instructor and students and amongst the students. They enable a more supportive and less formal form of communication that can help the learners' engagement and motivation (Finkelstein, 2009; Woodcock et al., 2012).

Another advantage is dependent on the physical qualities of mobile devices, particularly smartphones. They are distinguished from other ICT devices by their connectivity, mobility and abundance of functionalities. Despite their small size, the smartphone can store a vast amount of data (Woodcock et al., 2012). Their ability to gather data which is unique to the current time and place, make it appropriate for learning. Other qualities that turn mobile devices to valuable educational tools involve
their portability, connectivity, social interactivity and customizability (Huizenga et al., 2009).

For these reasons mobile devices are considered an appropriate tool to foster different innovative pedagogies and promote communication and interaction, anytime and anywhere (Woodcock et al., 2012). Educators who have become familiar with the advantages of these pedagogies began to embrace mobile learning in their practices, inside and outside the classroom.

2.2 Mobile Location Based Games

The rapid development of Web 2.0 technologies and mobile technologies has offered educators opportunity to build advanced and innovative learning environments and activities that can help increase the motivation of learners. Interactive learning activities, such as mobile games, can be considered as a good didactic tool for learning because it indirectly achieves various educational goals and enriches personal skills. Learning through play provides challenge, competitiveness and desire to win and thus can increase the motivation to learn and improve educational achievement. Games enable to practice social skills as they evolve interaction and communication with others (Lee & Hammer, 2011). Furthermore, mobile games can improve cognitive and social skills through various tasks such as problem solving, collaboration, content generation and investigation (Spikol & Milrad, 2008).

In contrast to traditional learning methods which separate the learner and the outside world, mobile technologies create a bridge between them. Two main advantages of mobile devices create this bridge, the ability to take them anywhere and the capability to gather information about these places. These capabilities give us an added benefit in the form of the location of the user which creates a context that is then used to provide the user a better experience. Mobile devices both connect the user to the world around him and accentuate the connection to his surroundings. Mobile location based games are one of the possibilities for such a hybrid approach (Holden & Sykes, 2011). These types of games exploit the mobile device in a way that the gameplay evolves in accordance with the position of the player. The game turns into a learning experience when it incorporates interaction with an information-rich environment and physical objects that interwoven around (Ardito, Sintoris, Raptis, Yiannoutsou, & Avouris, 2010). In addition, the content of the game is abundant and depends on the geographical context (Barak & Ziv, 2013). The game can incorporate different activities in the physical space of the player. Such activities are inspecting artifacts, finding landmarks, generating information, taking pictures and recording videos or sounds (Avouris & Yiannoutsou, 2012).

Physical and social experience, mental challenge and immersion are four characteristics that engage the player and create emotional attachment. Physical experience is formed during the interaction of the players with real, tangible and virtual objects. Social experience is created when the players interacting and forming social connections to increase their effectiveness in the game. Emotional stimuli achieved while solving problem, tasks and riddles. All those qualities promote involvement of the player (Ardito et al., 2010).

Additionally, mobile location based games can provide real time support and scaffolding for the players. With advanced location sensing capabilities, some of those games can track the players’ position and provide them with advice when route divergence occurs. This way enables to reduce the fear of students and ensure they do not get lost (Brown et al., 2011).

Such mobile location based games can be played in varied places and contexts and also in different time periods. Those games modified to certain events such as
conferences or alternatively certain locations such as museums, tourist sites, and other venues. Each game designed for different purpose, enjoyment of the players or rather for learning objectives which can be achieved implicitly or explicitly (Ardito et al., 2010).

2.3 Treasure Hunt Games

"Treasure Hunt" is a location-based game which represents a classic and playful approach that was traditionally performed without digital technological means (Elliot, 1926). It was originally an outdoor activity for children who required finding hidden objects. The winners were the first team to find all the objects. Over the years different versions of the game have evolved. Instead of hidden objects, players challenged to discover specific landmarks according to clues, solve riddles, and reach the landmarks. Additionally, the technological advancement has changed the game settings and led to the creation of both online and mobile versions (Kim & Yao, 2010). Treasure hunt games can benefit from mobile technologies as they enable utilizing the devices’ features such as GPS, camera and voice capture. A plethora of mobile treasure hunt games were developed using those features with different end goals in mind. Examples of such games are presented below:

**Skattjakt** (Treasure Hunt in Swedish) is a game designed to encourage physical activity by practicing navigation skills and collaborative problem-solving through mobile phones. The game examines map-reading skills, and knowledge about the local history. Furthermore, it promotes investigative and cooperative-based learning. Participants encourage thinking like historians and solving a mystery. The players’ mission is to find six locations according to the markings on interactive map given within the game application. Text and audio clues provided to support the participants find the locations. Once they find the location, they need to solve puzzles, decipher numbers and find landmarks (Spikol & Milrad, 2008).

**GeoCaching** is a social contemporary version of a GPS based treasure hunt game. Participants challenged to find hidden caches using GPS coordinates and general information which is provided through a dedicated website. Mobile devices, incorporating GPS capabilities, enable participants to access the cache description and connect the coordinates with the physical location of the cache. The Geocaching website provides different informal learning opportunities. It constitutes a community framework for inquiry based learning in which participants can search information regarding the caches or rather create new caches. Participants can interact with each other and share their experience, without revealing the exact location of the caches (Jones et al., 2013). Communication component, which supported by the mobile application and the website, allows them to see where their friends are, comment, collaborate, and share different resources such as clues, pictures and general text during the game (Hooper & Rettberg, 2011).

**Wandering** is a location based environment, designed to facilitate outdoor, authentic, and interactive learning through the creation of location-based interactive learning objects (LILOs). Moreover, it designed to encourage students to explore new places outside of the classroom, as they "wander around", investigate their new environment and interact with each other. The Wandering environment incorporates web application with mobile technologies which enables users to participate and play or rather to create their own LILOs. Users can define a location they want to visit (city, street, park, museum, etc.) and see all the existed LILOs in this area, as a list or as a
visual representation on a map. In addition, users can choose to display only the LILOs approved by experts. Users can decide to explore individual LILOs or, alternatively, a specified route consisting several LILOs. Wandering is not defined as a treasure hunt game, however, in the selection of specified route the users are playing this kind of game. Each LILO has four components: a map with directions to the LILO specific location, interactive learning activity related to the location, additional information regarding the LILO'S creator and the discussed topic, and a social media feature which enable to comment, rate and share the activity. Users can share the LILO via Facebook, Gmail, Google+, or Twitter, write their comments and experiences using a Facebook comment system and rate the LILO on a scale of 1 (horrible) to 3 (excellent). When creating new LILOs, users need to define the location of the station on a digital map and add the station's name and description. In addition, they need to define how participants will reach the station - using coordinates, address, or by performing a certain action. Then, users are required to write a dedicated activity that involves answering a question, or sending an image, sound or video. Upon completion, the LILO receives a unique URL and uploaded to the game web environment (Barak & Ziv, 2013).

SCVNGR is a location-based game where players required to complete challenges and treks through their mobile devices. The challenges display over a map interface and must be performed at a specific location. Challenges include posting comments and check-in through social media platforms, answering text based questions (open or multiple choices), scanning QR codes, or capturing images. After completing the challenges, players can earn points or gain rewards. The rewards are things players can redeem after earning enough points at a place. Everyone can create challenges easily by using a web-based interface. Each challenge requires definition of its exact location, title, type, the challenge itself, the correct answer and the given points for completion. Image, audio and video are possible additions. Adding a reward to a challenge is licensed to everyone. However, activating a reward requires the approval of SCVNGR team member (Wetzel, Blum, & Oppermann, 2012).

LEMONADE is a "Learning Environment for Mobile Network-Able Devices", dedicated to field trips. Although it is not a classic example of a treasure hunt game, this environment has similar characteristics as it allows the creation of outdoor activities (field trips) with different tasks. LEMONADE offers an authoring interface that supports the full cycle of the field trip. It enables advance planning of the trip, defining student groups and creating the tasks to be performed during the trip. Finally, it supports follow-up activities which includes data processing and reflection at the end of the trip. Tasks are location-based and support the objectives of the trip. The teacher can set geographic locations where the tasks will be carried out. It is possible to set up multiple tasks at any location. Tasks include data collection by taking pictures or videos, sound recording and note taking. The collected data is kept alongside the predefined keywords and the specified locations using the GPS sensor of the students' mobile devices. The student or rather the teacher can query the activity repository and present the collected artifacts in a convenient graphic mode (Giemza, Bollen, Seydel, Overhagen, & Hoppe, 2010).

These games represent a good example of technological utilization, however, they were not necessarily designed for pedagogical use. Pedagogical considerations, such as game settings, level of learners' control, substantial feedback and knowledge transfer, have great importance in designing mobile games for learning. Integration of both game design and instructional design approaches can lead to a successful development
of games-based learning environments (Zaibon & Shiratuddin, 2010). Social communication is an important aspect of "old school" treasure-hunt games. Some of the location-based games are missing this crucial component which both enhances the learning experience and adapts to current technological trends.

2.4 Social Media Communication

Social media, which is built on the ideological and technological foundations of Web 2.0 (Kaplan & Haenlein, 2010), has become in recent years an essential part of everyday life (Selwyn, 2012). The term refers to mobile and web-based technologies that allow users to communicate and interact with each other; to create, modify and share new forms of textual, visual and audio content in digital environments (Kietzmann, Hermkens, McCarthy, & Silvestre, 2011; Selwyn, 2012). Social media, as opposed to traditional one-way media (e.g. Radio), are multi-way interactions where all participants control the conversations which can be explored by numerous users (Barczyk & Duncan, 2013). It focuses on user-driven content and highlights the way in which people converse and share knowledge with each other (Ractham & Firpo, 2011). Social media is reflected in diverse configurations, which vary in their functionality and scope (Kietzmann et al., 2011). Kaplan & Haenlein (2010) identified six types of social media which are classified into two dimensions according to their level of self presentation and social presence/media richness (see Table 1).

Table 1. Classification of Social Media

<table>
<thead>
<tr>
<th>Social presence/Media richness</th>
<th>Low</th>
<th>Medium</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Self-presentation</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>Blogs</td>
<td>Social networking sites</td>
<td>Virtual social worlds</td>
</tr>
<tr>
<td>Low</td>
<td>Collaborative projects</td>
<td>Content communities</td>
<td>Virtual game worlds</td>
</tr>
</tbody>
</table>

Note: Adapted from Kaplan & Haenlein, 2010

Social networking sites (SNS), such as Facebook and Twitter, are located in the middle level of the mentioned classification as they allow high level of interactivity and sharing of rich media (Kaplan & Haenlein, 2010). These platforms are web-based applications that enable users to connect and collaborate through computer mediated communication and to form online communities around shared interests and causes (Brennan, 2006). SNS were designed primarily to facilitate conversations among individuals and groups, and there are various ways to conduct them. For example, Facebook, which is perceived as the prominent social media network, enables users to send messages and write on friends' walls (Davis III, Deil-Amen, Rios-Aguilar, & Gonzalez Canche, 2012).

The reasons for their popularity are many and vary significantly, but one main reason is that they allow an unprecedented openness for social interactions, without limitations of time or place (Fischer & Reuber, 2011). Social network sites provide multiple daily opportunities for sharing information, ideas and experiences with friends, classmates, and others acquaintances with shared interests (Safko, 2010). Unlike other forms of social interaction, social networking sites encourage participants
to generate content rather than consume it passively. They promote collaboration among users and constitute a platform for self-expression and creativity (Brennan, 2006). The enormous amount of social data gathered from these sites can facilitate the understanding between people, organizations and communities and consequently improve their communication and interaction (Hansen, Shneiderman, & Smith, 2010).

Social network sites also have a remarkable potential to enhance learning and teaching practices and re-shape the way students learn as they promote keen involvement and engagement of students in their learning eco-system (Barczyk & Duncan, 2013). The social nature of the web nowadays and its underlying technology is the basis for individual and group interactions and act as a fertile ground for a new learning environment (Barczyk & Duncan, 2013). Today's students are "digital natives" (Prensky, 2001) as they have been surrounded by communication technologies from a very early age. They have taken up computer abilities as one of their core performance skills. Creation of social ties with peers constitutes an important aspect in the formation of a personal identity during adolescent years. Social networks meet the need of teenagers to communicate and allows them to meet and interact with others comfortably, similar to real world interactions (Brennan, 2006). They create a space for collaboration between students and instructors and amongst the students themselves (Rasiah & Ratneswary, 2014). Furthermore, they enable to establish online groups around common issues and goals, as well as to raise issues that are difficult to talk about in person (Brennan, 2006). Therefore, social networks are important in terms of emotional support, but also in terms of decision making and autonomy as they provide more opportunities, choices and power (Brennan, 2006; Davis III et al., 2012).

Some scholars, however, claim that the use of social networks distorts social interactions and changes our relationships and identity. Social networks can discourage face-to-face communication and thus hamper the acquisition of social skills which are necessary for everyday life. Although they make communication easier and more flexible, social networks isolate the users from their surroundings while creating an illusion of companionship and togetherness. They make it possible to recreate a virtual image of ourselves and our social relationships, although it does not necessarily reflect reality. As opposed to real life, social networks allow users to connect and disconnect whenever they want (Turkle, 2011).

Different studies conducted in recent years have investigated the use of social media in educational context. For example, a study of nearly 8,000 faculty members conducted by "Pearson" at October 2013 examined how higher education faculties use social media sites. The findings indicated that 41% of faculty members have used social media for teaching purposes during their class sessions (Figure 1). In-depth analysis revealed that blogs and wikis found to be the most in use with over 80% of faculty members required their students to create such content. Over 70% required students to comment on created content, and about 60% required their students to read blogs and wikis. Twitter, LinkedIn, and Facebook were not extensively used by faculty members for teaching purposes. Creating, commenting or viewing was used by less than 20% in individual or group assignments (Tinti-kane & Seaman, 2013).
There is an abundance of social media available for pedagogical use, which can be integrated into an educational context. They can contribute and empower the learning process. Social media has great potential to provide rich opportunities that can upgrade learning to be more meaningful, collaborative and socially relevant (Greenhow, Robelia, & Hughes, 2009). The following section will examine the pedagogical use and opportunities offered by Facebook as a tool for enriching teaching and learning.

2.4.1 The Social Facebook Network
Facebook, one of the well-known sites worldwide in all age groups, was initially founded in 2004 as a social network for students at Harvard University. Later it expanded to other educational settings, including high schools and colleges around the world, and then, in 2006, opened its doors for the benefit of the general public (Hew, 2011). People who would like to become Facebook users are required to register and create a self-descriptive profile that includes their real name, birthday, gender and email address. In addition, users can add a profile picture and other personal information such as interests, hobbies, relationship status and religious orientation (Grosseck, Bran, & Tiru, 2011), as well as other types of content such as photos, videos and audio files. Every user has two primary pages. The first is the profile page, known as the "wall", where users can post status updates, upload and tag photos and write comments on other users' wall. Friends of the users can also interact with the posted content by commenting or "liking" it. The second, is the home page, known as the "news feed", where users receive updates about their friends' status, activity and shared content (Caers et al., 2013; Lampe, Woon, Vitak, Ellison, & Wash, 2011). Facebook also enables users to invite other people to access their profile and send instant or private messages between each other (Kaplan & Haenlein, 2010). Additionally, they can create polls and dedicated pages for special events (Grosseck et al., 2011). Users can identify and label with whom they have a relationship and define the type of this relationship (Boyd & Ellison, 2007). They can also subscribe or create fan pages and join groups with common interests (Hew, 2011). This permits the users to build a network of personal connections and interact at different levels (Brennan, 2006).

Over the years the popularity of Facebook has increased significantly, and as of March 31, 2014, it has exceeded 1.28 billion monthly active users, an increase of 15% year-over-year (MarketWatch, 2014). This popularity made its mark in many areas including entertainment, commerce, industry and education. However, the use of Facebook in the field of education is still in its infancy and its pedagogical value has only been partially implemented (Manca & Ranieri, 2013). Facebook has many features and applications that can foster and promote a positive learning experience and improve the relationship and interaction between teachers and students (Mazer et al., as cited in Rasiah & Ratneswary, 2014). Its interactive nature and the built-in
mechanism for sharing information allowing students to create, share and consume information actively, while creating cross-border dialog between peers (Barczyk & Duncan, 2013). In order to take advantage of these capabilities, educators must adapt themselves to the new technological landscape and acquire teaching skills and techniques that fit this era (Rasiah & Ratneswary, 2014).

In the past years, different studies investigated the use of Facebook as an instructional tool for teaching and learning while others examined the perceptions of students towards its usage and its impact on the students' learning outcomes. These studies highlighted Facebook's great potential and benefits for learning.

Racatham et al. (2012) conducted a study among 75 students in introductory management information systems (MIS) course to examine Facebook as a pedagogical tool for building and fostering a constructivist learning environment. Facebook was chosen mainly because of its popularity among the students, ease of use and enjoyment it provides to its users. Four Facebook's features were utilized and incorporated into various pedagogical activities inside and outside the classroom in an attempt to enrich social interaction and communication between the students and the instructor. The features were: (1) Social Playground (Facebook Wall), (2) Social Discussion (Facebook Discussion), (3) Social Roll Call (Facebook Photos), and (4) Social Tube (Facebook Videos). These features enabled the students to voluntarily post statuses, write comments and upload and tag photos and videos they took during their class activities. Students also were able to discuss and comment on issues raised in class. The results of the study led to the conclusion that there is a great potential for learning environments that utilize Facebook as the central space for communication and collaboration between the instructor and the students. It was found that 55% of the students felt that Facebook helped them in their learning. Better yet, 78% of the students felt that Facebook was a useful supplementary learning tool. Facebook Discussion and Facebook Photos were perceived to be the most effective in achieving learning objectives, while writing statuses, messages and comments were perceived to be effective for communication and collaboration. Other features such as tagging and uploading videos were perceived to be effective in enriching the learning experience in terms of fun. A feedback remark that the students made was to include different "edutainment activities" such as quizzes, games, and mobile features to turn the class more appealing (Racatham et al., 2012).

Wang, Lin, Yu, & Wu (2013) conducted a study with 134 students, from two classes of Advanced English, in order to examine the impact of Facebook on the students' learning engagement and academic grades. Dedicated Facebook groups were opened for each of the classes and used as a supportive learning tool. The students were able to participate in group discussions, ask questions, comment, and share wall posts including their presentations, media production and external resources. The study results showed that the use of Facebook led to high student engagement as well as a better learning experience during the course. Furthermore, it was found that the outcomes of the students have improved (Wang et al., 2013).

In a sample of 106 students from two large U.S. universities, Barczyk & Duncan (2013) found that students perceived the integration of Facebook in their business curriculum positively. Facebook was used by the course instructor to post various messages associated with university announcements, course assignments and related matters. Furthermore, the instructor posted YouTube videos related to the content being taught and encouraged the students to comment and discuss those posts. Over
time students' participation increased and their reaction time to posts decreased. Students voluntarily "liked" and commented on posts, raised questions and responded to them, creating an active dialogue with peers. 74% of the students agreed that Facebook integration in the curriculum enhanced their learning experience and promoted the sharing of knowledge. About two-thirds of the students agreed that Facebook enabled them to find and share educational materials. Over 60% agreed that Facebook is a convenient platform for class discussions. 87.4% of the students found the Facebook's "comments" function as the most useful because it encouraged communication between the participants and created a sense of community (Barczyk & Duncan, 2013).

In a study designed to evaluate the effectiveness of social media to improve team-based learning among first-year business students, Rasiah & Ratneswary (2014) found that Facebook was perceived as a tool that contributes to the learning experience. Furthermore, it is considered a good platform for discussions and debates with peers and the instructor. Students reported that Facebook allowed them to easily post and share ideas, articles, and videos related to the course material. The learning environment created by utilizing Facebook enhanced students' engagement and made them feel more responsible for their learning process. Facebook has also strengthened their sense of belonging and helped them achieve higher cognitive levels and deeper knowledge construction (Rasiah & Ratneswary, 2014).

The findings presented above concur with those of Hew (2011); Roblyer, McDaniel, Webb, Herman, & Witty (2010) which claim that Facebook has a great potential to enrich and leverage learning environments, both for students and instructors.

2.4.2 Social Media Privacy Concerns
Social media applications and the internet in general are environments which eliminate behavioral inhibition and encourage exposure of personal information (Mesch & Beker, 2010). Facebook, as noted above, necessitates people to create a self-descriptive profile, which includes extensive personal information in order to join its service (Grosseck et al., 2011). Additionally, information disclosure over Facebook is considered normative and acceptable. Users can publish personal information, as well as thoughts and feelings (Kietzmann et al., 2011). The traditional boundaries of privacy are challenged when people and especially teenagers are encouraged to expose themselves, consciously or unconsciously, to a broad audience which may include millions of people. As use of social networks intensifies the willingness to disclose information increases (Mesch & Beker, 2010). The problem is that there is not enough awareness among teenagers regarding privacy settings and the associated risks (van der Velden & El Emam, 2013), such as deviant sexual behavior and cyber bullying. Facebook has taken various steps to protect children and reduce those risks (Livingstone & Brake, 2010). For example, Facebook has signed the Principles of Safer Social Networks, formulated by the European Commission, under which it commits to identify and block illegal or inappropriate content and behavior (European Union, 2009). Furthermore, Facebook has adopted in its Terms of Service (ToS) the regulations set by the Children’s Online Privacy Protection Act (COPPA) under which children 13 years old and younger are prohibited from creating an account without parental permission (O’Keeffe & Clarke-Pearson, 2011). Despite these measures, designers and developers, as well as instructors, should give greater emphasis to aspects of privacy and age restrictions in order to effectively utilize Facebook and protect children and teenagers.
2.4.3 Communication and Sharing via Social Networks

As previously mentioned, social media networks enable sharing of personal information, opinions and experiences. All of the above can be accompanied by images or other media formats.

Image capturing is considered a special way to document and commemorate significant events in our lives. It enables us to re-experience events, such as birthdays and fun school trips, at later points of time, and share these moments with those who attended the event or not (Yang, Luo, Yu, & Huang, 2011). In recent years, along with the tremendous development of technology, there has been a significant increase in the use of mobile phones for photography purposes (House, 2007). Many people around the world have made their mobile device their primary means of photography (Vartiainen & Väänänen-Vainio-Mattila, 2010). Phone cameras allow people to capture images and record events in their lives anywhere and at any given time, including during the events themselves (Toledano, Sawada, Lippman, Holtzman, & Casalegno, 2013). Furthermore, phone cameras allow different people, which do not necessarily know each other, to record the event they participate in, from different viewpoints (Yang et al., 2011).

Social networking sites such as Facebook, Twitter, Pinterest, Flickr and Instagram enrich this experience by allowing users to upload their images and share them with family, friends and acquaintances through the internet. Moreover, these sites enable users to interact with the images by adding comments, tags and descriptions (Rabbath, Sandhaus, & Boll, 2010). Facebook, for example, has a public image storing and sharing service which allows users to title, tag, and describe images, and organize them into albums.

Social networks and their communication capabilities have been found to support daily interactions and interpersonal relationships. Augmenting the pedagogical aspects of a mobile location based game with these capabilities can be instrumental in expanding the benefits of such games. The addition of image capturing can further complement player involvement and connect the learning experience to the learners daily lives.
3 Introduction to The Treasure-HIT Platform

The “Treasure-HIT” was previously developed as a dedicated platform for designing pedagogical treasure hunt activities using mobile devices. The platform includes two different components: an authoring web environment allowing instructors to create treasure hunt activities and a mobile application that being used by players during the activity (Kohen-Vacs et al., 2012). The following will describe these two components in detail.

3.1 The Authoring Environment (for instructors)

The authoring environment is a simple web based application enables instructors to create, update and share pedagogical treasure hunt activities. First, instructors required to login the platform and create a new activity/game. A created activity is stored in the game repository (Figure 2). The instructor can view all the games he created and share them with others who can replicate the games and modify them according to their own needs.

The activity settings (Figure 3) include the game's name, welcome and ending messages, location settings for each station, and the route type which determines the order of the stations for the players.

The edit station screen (Figure 4) includes four panels which define the different attributes of each station. The instructor needs to define the location, verification method, clues, feedbacks, and the pedagogical tasks that will be given during the game.

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**Figure 2. Game Repository**

**Figure 3. General settings of the activity**

**Figure 4. Edit station screen**
The location of a station is set by a simple web interface that embeds a Google Map API, by positioning a marker anywhere on the map. It is also possible to set the minimal required distance from the site (tolerance) and thereby determine the radius which the players should be in order to find the station (Figure 5). Since pointing a precise location on a regular two-dimensional map may be difficult, the environment enables to set the location using a Google StreetView Interface, whenever available (Figure 6).

![Figure 5. Setting station's location and tolerance](image)

![Figure 6. Setting station's location using Google Street View](image)

The instructor needs to define the arrival verification method for the player - whether by activating the GPS sensors to check the position or alternatively by scanning a barcode which previously placed on the site by the instructor. Furthermore, the instructor required to define at least one clue (hint) that would direct the players to the station. The clue can be simple text, an image, and link to a website. In addition, this environment enables to specify pedagogical tasks to be performed by the players at each station, as a condition for advancing in the game. The tasks may include single/multiple selection question and/or free text question.

3.2 The Player Environment

The Treasure-HIT mobile application constitutes as the gaming framework for the players. For activating a Treasure-HIT game for the first time, the player is required to install the application according to his mobile operating system on his personal device. Then, the player can access the game in two different ways: by selecting a game located in the player's surroundings or by entering a unique code given by the instructor (available only for Android operating systems).

The player is presented with the initial instructions about the game and receives the clue/s, which are displayed as text, picture or video, directing him to the first station. The player is challenged to identify and reach the station according to the clue/s (Figure 7 and 8). When the player assumes he reached the station he is required to verify his location by pressing a "check location" button. This action triggers the GPS location tracking. If the detected location is within the tolerance range from the defined site, a confirmation message will be provided and the subsequently pedagogical task (in the form of single/multiple selection/open text question) will be displayed (Figure 9). After completing the task the player will receive the clue/s for the next station. Once the players reached all the stations and completed all the tasks, they will receive a final feedback, defined by the instructor, accompanied by a picture of a treasure.
3.3 Treasure-HIT Architecture

The Treasure-HIT platform is comprised of two environments, the authoring environment and the player environment. The environments are used by game instructors (authors) and learners (players) respectively. The Treasure-HIT server mediates between the two environments which also communicate with other services. An example of the use of the different environments and services can be seen in the creation of a new game on the platform. The instructor, within the authoring environment, defines the stations of the game while using the Google API service. If a Barcode station is created, the third-part QR-Code generator is used. All the game attributes, which have been created by the instructor, are stored on the server. When a learner plays one of the games, the player environment calls to the Treasure-HIT server and retrieves the game data (stations, tasks, images, clues etc.) which is saved on his mobile device. Device sensors, such as GPS or camera, are used during the game to determine and validate the player's location. Figure 10 demonstrates the connection between the above mentioned environments and components.
The following sequence diagram (Figure 11) represents the full data flow of the current Treasure-HIT platform from both instructors' and players' perspectives:

Figure 11. Data flow of the web and mobile Treasure-HIT applications

The Treasure-HIT platform is founded on the "Service Oriented Architecture", the "Three-Tier Architecture" and "MVC design pattern". The following section will elaborate on each of these and will be the basis to understand the Treasure-HIT structure and functionalities.

3.3.1 Treasure-HIT as a Service Oriented Architecture

Service-oriented architecture (SOA) is an architectural approach, according to which a system should provide services to end-user applications or other services through one or more published interfaces (Endrei, Ang, Arsanjani, & Chua, 2004). Rosen, Lublinsky, Smith, & Balcer (2012) claimed that the real value of this architecture lies in the ability of services to reuse other applications logic and functionality, as well as the ability to integrate these services to create agile and flexible business processes. The SOA approach is consistent with the architecture of the Treasure-HIT platform for several reasons:

1. Separation of concerns - according to the SOA approach, the system should combine different services but nevertheless allow its components to remain independent. A distinction should thus exist between the system entities (eg.
interface and implementation) and changes in one service would not negatively affect the other (Rosen et al., 2012). The Treasure-HIT has two independent, yet interconnected, environments:

a) The authoring environment - used by instructors to create, manage and publish activities.

b) The player environment - used by end-users to launch the activities.

Further information regarding the separation of concerns of the Treasure-HIT components can be found in the "Treasure-HIT MVC Design Pattern" (section 3.3.3).

2. Compartmentalization - The two environments communicate with the server that contains their logics. The logics sit in a separate compartment, separating them from external interfaces.

3. Reusability - each component or service is defined as a separate piece of code, allowing the reuse of code by the various services (Rosen et al., 2012). The "Treasure-HIT API" (a part of the system's logic), which defines various functionalities, is reused and utilized by different services.

4. Flexibility and Elasticity - The SOA approach can assist in developing effective educational services due to its ability to respond quickly to changing needs and accordingly modify or add new services without damaging the core architecture (Pasatcha & Sunat, 2008). The Treasure-HIT platform has evolved over time and new components were implemented in accordance with the pedagogical needs of the various stakeholders. In the future, it will be possible to insert additional services and functionalities and even upgrade the existing one.

3.3.2 Three-Tier Architecture in Treasure-HIT

The Treasure-HIT platform is consistent with the "three-tier architecture" which is a client-server architecture pattern. The system is organized, according to this pattern, into three distinct and independent tiers/layers where each layer has its own role. The upper layer, named "presentation tier" / "client tier", handles the user interface (UI) and the visualization of data to the user. The middle layer, known as "application tier" / "service tier", is the business logic layer (BLL) which controls the functionality of the system by performing detailed processing. This layer mediates between the client and the database. The lower layer, named "data tier" / "data access layer" (DAL), contains the database and the program which stores and retrieves its information (Schuldt, 2009). This UI-BLL-DAL layer separation allows to maintain and upgrade each layer independently, according to the requirements or evolving technology, without damaging other layers. This separation increases the flexibility and efficiency of the development process (Hirschfeld, 1996). The Three-Tier architecture is a linear model. Requests transferred from the user through the three tiers to the database and responses are communicated back in the reverse direction to the user (as illustrated in Figure 12).

![Figure 12. Three Tier Architecture - Data Transfer](image)
The three-tier architecture is reflected in the Treasure-HIT platform as can be seen in Figure 13:

![Figure 13. Treasure-HIT Three-Tier Architecture](image)

**Presentation Tier** – This tier provides the application's user interface (UI) which displays information related to the system's services and obtains input from the users. Tier-to-tier communication enables requests processing and response retrieval between the presentation and application tiers, using web based technologies. The platform includes two different interfaces that enable interaction with its users:

- **The Web authoring environment**, which was designed for instructors, includes different web forms that enable the creation and management of Treasure-HIT activities.

- **The Mobile application**, which was designed mostly for the players, enables them to launch and perform the activities.

**Application Tier** – This tier represents the business logic of the Treasure-HIT platform and controls its functionality by performing detailed processing of the data retrieved from the presentation tier. This tier forms the core of the platform as it mediates between the presentation tier and the data tier and is responsible to validate the inputs before passing them on. As the Treasure-HIT platform is consistent with SOA, the business logic holds independent components which are utilized or reused by other components or services.

The Business Logic is based on Business Entities and the Treasure-HIT public API.

- **Business Entities** include the two following core entities of the Treasure-HIT platform:
  - Editors - set various properties such as identification information, organizational affiliation, editor type, used language, etc.
  - Activity - sets various properties such as name, type, number of stations, route type, etc.

- **Treasure-HIT Public API** facilitates the interaction between the different platform services. Using the API, the platform receives the data and presents it in the user interfaces (mobile & web applications). The API potentially provides external developers with access to the Treasure-HIT platform and incorporate its logic.
**Data Tier** – This tier includes the database and the data access layer which reveals the stored data to the application tier using SQL queries and communicates them using an API.

- **The Treasure-HIT Database** is located on an MSSQL server. The database is organized in tables containing data regarding the different entities (e.g. Editors, players, activities, stations). It also includes a local File System which contains the assets uploaded by the users. (Further information regarding the Treasure-HIT database can be found in Appendix A.3).

- **The Data Access Layer (DAL)** is responsible for mediating the application tier and the database. The DAL provides an API that enables the application tier to store and retrieve information from the DB and the file system. The DAL is also responsible for managing the CRUD commands (Create, Read, Update and Delete) to the DB. The data access layer acts as a buffer which protects the information stored in the database. It enables the execution of changes without disruptions to the database or other tiers.

### 3.3.3 Treasure-HIT MVC Design Pattern

The Treasure-HIT’s authoring environment was built on ASP.NET MVC framework which is aligned with the **Model-View-Controller** (MVC) design pattern. MVC represents an approach whereby a system is divided into three types of distinct components: model, view and controller. In this division MVC implements the **Separation of Concerns** (SoC) principle, according to which each of the distinct components has a different role and a different responsibility. The **Model** encapsulates the storage mechanism and concerns with the data processing. It is separated from the **View** and **Controller** components. The **View** represents the user interface which includes different web forms. The **Controller** concerns the system's logic (Chadwick, Snyder, & Panda, 2012). Despite this separation, there is an interdependency between those components as illustrated in Figure 14 below:

![Interdependency Between Model-View-Controller Components](image)

**Figure 14. Interdependency Between Model-View-Controller Components**

When using the pattern, an end-user approaches the **View** with a request and it is sent to the **Controller**. The **Controller** processes the request and transmits them to the **Model**. The **Model** stores the retrieved data from the request and returns a response to the **Controller**. The response is finally transferred from the **Controller** to the **View** and presented to the end-user.

A simple example of such a mechanism can be seen in a login attempt into the Treasure-HIT authoring environment. An instructor enters his credentials in the Treasure-HIT homepage (**View**) which are communicated to the controller. The controller fetches the credentials and inquires with the database (part of the model). The model returns a response to the controller in the form of a correct/incorrect login.
and an editor ID when relevant. The controller updates the view of the instructor whether by presenting the authoring environment or by showing an error message.

3.4 Treasure-HIT Development Aspects

3.4.1 Agile Development

Agile software development is a methodological approach which assumes that the development process of a product or software is iterative, incremental and led by product features. This approach has been developed as an alternative to traditional development methodologies in order to provide a better product rapidly. The end-user provides invaluable feedback and reflections during the development process and code refinements are accordingly performed (Dingsøyr, Nerur, Balijepally, & Moe, 2012). The involvement and participation of the end-user in the development life cycle is perceived as very important and even imperative. It can significantly contribute to the work of developers and designers in producing an optimal product that meets usability principles and changing requirements (Akinnuwesi, Fiddi, Olabiyisi, Omidiora, & Uzoka, 2013). The Treasure-HIT platform implements this development approach. The platform was not developed as a single unit but as a continuous process which incorporated new components and features. As an educational platform especially designed for instructors and learners, the stakeholders were greatly involved in the design and the needs analysis process. Additionally, they were involved in the testing and evaluation of each new feature. They have provided feedback and raised new needs and requirements. Changes to the code were made in order to accommodate the given feedback and deliver a better product.

3.4.2 The Technology Used

In order to design and develop communication components for the Treasure-HIT platform, there is great importance to understand the technical structure of the current platform and its components.

3.4.2.1 The Authoring Environment (for instructors)

The Treasure-HIT authoring environment is a web based interface which is built on top of ASP.NET MVC 4 framework and implements HTML5, JavaScript, AJAX and jQuery libraries for providing an enhanced user experience. This environment communicates with the Treasure-HIT API in order to create, store, edit or delete activities by the instructor. Additionally, the environment is using third party APIs such as Google Maps API and Google Street View API, in order to allow the instructor to set the location of each station within the activity. (Detailed information regarding the technology used in the Authoring Environment can be found in Appendix A.1).

3.4.2.2 The Player Environment (for users/learners)

The Treasure-HIT player environment is a mobile application which was built on top of AngularJS MVC and PhoneGap frameworks using HTML, CSS and JavaScript. The PhoneGap is a cross-platform framework which enables the development of mobile application tailored to multiple platforms and devices, without writing any native code. Various plugins, supported by the framework, provide access to the device's sensors and features (e.g. GPS, camera, etc.), enhancing the user experience (Myer, 2011). This environment is also communicating with the Treasure-HIT API in order to retrieve data from the database. (Detailed information regarding the technology used in the Player Environment can be found in Appendix A.2).
3.4.2.3 The Treasure-HIT API
Treasure-HIT uses a dedicated API service which is built on top of the “Web API” feature provided by the ASP.NET MVC 4 framework. The Treasure-HIT API provides the developer easy and secure access to the database and mediates between the business logic and the client side. This API is used by both the authoring environment and player environment. The API is HTTP based and supports different methods (e.g. GET, POST). Requests to the API are presented in a JSON data structure.
4 Research Questions

This study focuses on the following research questions:

- Which features are required in order to facilitate and support communication aspects which are involved in the preparation and enactment of Treasure-HIT activities?
  - What are the design implications of the additional features?
  - What are the technological implications of these features?
- How were the features evaluated and adopted by users (game creators and players) and how did they enable a richer and more effective use of the platform?

5 Methodological Approach

This study is constructed on Design Based Research methodology which was found, according to Wang & Hannafin (2005), appropriate for the research and design of technology-enhanced learning (TEL) environment. Design Based Research is a systematic methodology aimed to improve educational practices through iterative analysis, design, development, and implementation, in real pedagogical settings. This methodology moves beyond a simple observation and involves the learning environment investigation while considering the role of the social context in the game design and implementation. It enables to generate evidence-based claims about learning and thus further improve the final design (Barab & Squire, 2004). Design Based Research is significantly associated with additional research methodologies. For example, it involves literature review, formative evaluation and utilization of mixed method approach for gathering and analyzing qualitative and quantitative data (F. Wang & Hannafin, 2005).

According to Reeves (2006), Design Based Research is an iterative process consisting of four phases (Figure 15). The study begins with problem analysis which includes identifying the problem in its local context, and establishing research questions, the preliminary design and the scope. The second phase is the design and development of the solution, based on new set of strategies or principles from previous researches. The third phase includes iterative cycle of testing and refinements. The solution is being tested in its natural settings and re-designed accordingly as necessary. The last phase of the process includes reflection and documentation of the research so that it can be used and applied by others (Amiel & Reeves, 2008).

![Figure 15. Design Based Research Phases (Reeves, 2006)](image-url)

This study was constructed in the Design Based Research methodology characteristics and phases. It includes the following phases which relate to the research, development, analysis and validation processes.
6 Development and Evaluation Plan

Phase 1 - Research and Analysis of Practical Problem
The initial stage included a literature review and investigations of similar platforms and technical approaches for supporting communication capabilities. In addition, a background research was performed in order to gain knowledge about the current users of the "Treasure-HIT" platform (both learners and game creators) and identify their additional needs of the platform. This was achieved by performing interviews with "expert users" - editors who are familiar with the platform's functionalities and conducted location-based activities with students. A survey was conducted with a group of teachers who took part in Treasure-HIT activities. The findings were analyzed in order to define the scope of this work.

Phase 2 - Design and Development
Based on the research findings, a design of the new communication features, in terms of both user experience aspects and the technological approach, was developed. In the first stage a mock-up of the user interface was designed for each feature. A prototype was developed according to the frameworks defined in the research phase. This stage included a QA stage to ensure optimal functionality of the platform.

Phase 3 - Iterative Cycles of Testing and Refinements
Several iterations of testing and refinements were performed. The test entailed a pedagogical Treasure-HIT activity created by an instructor and given to a sample group of students. The activity involved the implementation of the new communication and social features. Data was gathered and analyzed using a mixed method approach which included both qualitative and quantitative methods. The results presented the contribution of the new feature and the needed improvements and usability modifications required in the next refinement. Another cycle of testing and refinement followed (if required) to implement further needed changes. This methodology enabled the evaluation of the design of both the authoring and player environments, in terms of usability and user experience aspects, in order to empower the learning experience via “Treasure-HIT” platform.

Phase 4 - Reflection and Documentation
Data gathered from all the previous phases was analyzed and documented. The research process and findings were summarized and further expected work to improve the platform and achieve new pedagogical results was recorded.
7 Implementation

7.1 Phase 1 - Research and Analysis of Practical Problems

As a part of the initial stage, a background research was held in order to gain background knowledge about the current users of the Treasure-HIT platform (both learners and game creators) and to identify their needs from the platform. Based on the findings of this phase, the scope of the work and the additional enhancements to be developed in terms of user-interface and functionality were defined.

The preliminary research was performed in three stages, basic perceptions of the platform, interviews with key expert users and a field test of suggested modifications. Data was gathered and analyzed using a mixed method approach which included both quantitative and qualitative methods.

7.1.1 Basic Perceptions

On June 2014, 45 instructors took part in a dedicated Treasure-HIT activity as part of a supplementary training in Tel-Aviv. The instructors were in charge of leading the implementation of educational technology in their institutes. The training activity included a practical session on the authoring environment and participation in a real setting activity at the Jaffa port. A short survey conducted following the activity and included five questions regarding the participants' experience, perception of and satisfaction from the platform. The survey was carried out using the SMS-HIT platform, a personal response system which enables real-time assessment activities via mobile devices (Kohen-Vacs, Ronen, Bar-Ness, Milrad, & Kurti, 2012). Quantitative data was collected from the responses of the participants. Findings indicated satisfaction with the Treasure-HIT platform by the instructors with such comments as "a fascinating experience", "big pedagogical potential" and "creates high involvement in studying". 97% of the participants have noted that during the activity they have gained new information about the activity's topic. Looking at their future interest in creating such activities, 75% of the activity's participants have noted that they are interested to create such activities for their students. A similar percentage is interested in creating such activities for their peers as well as family and friends (Figure 16).

![Figure 16. Interest in creating activities for new audiences](image-url)
7.1.2 Interviews with Key Expert Users

Since the Treasure-HIT platform reached a substantial user base, it was decided to carry out interviews with "expert users" in order to identify additional needs of the platform. The sample group included users who act as editors and are familiar with the platform’s functionalities and recently conducted location-based activities with their students. The interviewees were questioned in regards to the current functions of the Treasure-HIT platform and their additional needs and requirements from it. In addition, we were approached by game developers who wish to use the platform for marketing purposes and activities with sports fans. They too have been questioned about their main requirements of the platform. All interviews were conducted face-to-face and lasted approximately 20 minutes. With participants consent, handwritten notes were taken throughout each interview, in order to keep track of what was being said. After performing all the interviews, the collected qualitative data was analyzed. I reviewed the notes, highlighted the main ideas and key points and identified the following main requirements:

1. **Location based map presenting all Treasure-HIT activities**
   Currently, the Treasure-HIT platform allows instructors to create activities freely everywhere. When using the player environment (through mobile application), players can access published activities either by entering a five digit code given by the instructor or by selecting a game in their vicinity. By contrast, the authoring environment does not allow instructors to see or access the activities created by others. Therefore, instructors who wish to create a new activity in a certain location cannot know if a previous activity already exists there. Thus, instructors requested to know where activities have been created and obtain information about them and their creators.

2. **Digital and social activities**
   The Treasure-HIT platform, in its current version, provides three types of pedagogical tasks that can be modified by the instructor: single selection question, multiple selection questions and open text question. Additionally, three types of clues are provided: simple text, image, and website link. The platform, however, does not support interactive tasks that incorporate digital content production and social media interaction. Expert users noted that such support is necessary for them to enrich their activities and adapt them to the expectations and skills of the 21st century. In effect, the expert users reported that today they perform varied interactive activities (that are not provided by the platform) such as image capturing alongside an object or posting of answers to Facebook. The results of these activities have to be physically examined by a local instructor who needs to be on the ground with the participants. Game developers working with sports fans have also strengthened the call for social media interactions as an important feature for user involvement. Therefore, the inclusion of such features as digital content production and social media interaction will provide instructors with the tools they require.

3. **Real-time communication capability between the instructor and the player**
   In its current version, the Treasure-HIT platform enables instructors to access general data regarding the players' performance, such as: time for completing the game, reaching station results, and the winners' identity. However, this data
is observable only after the game ends. Interviews' findings revealed that instructors wish to access up-to-date information regarding the performance of the players. They want to track players' locations in real-time and be able to communicate with them during the game. Such capabilities can improve the experience for both the end-users (players) and the instructors.

7.1.3 Field Observation
After examining the requirements which were indicated in the interviews, it was decided to perform a field observation focused on the users' recommendations on adding a social component to the platform. In mid-July 2014, a designated Treasure-HIT activity was held as a part of the Learning Technologies Conference at the Holon Institute of Technology. 40 people took part in the activity, including training developers, instructional designers, managers and consultants from educational institutions, training companies and public entities. Following a brief explanation about the game, the participants were divided into groups of 3-4 people and began to play. Each group had three different stations and a common station in which the participants were asked to take a "selfie" (a self-portrait photograph taken with a smartphone) with a designated rollup. Later, they were requested to share their pictures on the conference's Facebook event page using their own account. In order to progress in the game, participants needed an instructor to ensure that their task was carried out properly. If the "selfie" was shared on Facebook as requested, the instructor gave the group a code which, when entered in the Treasure-HIT application, enabled the group to proceed.

According to the editor of this Treasure-HIT game, the "selfie" task greatly contributed to the experience of the game. The participants expressed their willingness to perform the task, and even argued from which Facebook account they will share their pictures. However, the task involved logistical and technical preparations which interfered with the usual gameplay. A physical presence of the instructor was required for the entire duration of the game. In addition, performing the task forced the participants to exit or minimize the game interface, take pictures with their smartphone camera, open the Facebook app, share their pictures and then return to the game interface. It was thus concluded, also in accordance with the results of the interviews, that there is high importance of embedding the social component in the platform.

7.2 Phases 2 and 3 - Design, Development and Testing

Proposed solution
Based on these preliminary research findings, this study aimed to address the main problems and requirements which arose by the majority of the platform's users (section 7.1.2). As the requirement to develop a real-time communication between the instructor and the player have feasible alternatives, such as a phone call or sending a text message, it was decided that this work will focus on providing solutions for the other two requirements. The solution is comprised of the following three features:

1. Activities based map - a location based map presenting all the created activities.
2. Social media sharing feature - enabling players to upload media and share statuses with others through social media platform during the game.
3. Image gallery - enabling sharing and distribution of images captured during the games.
These additional features will be developed to facilitate and support the communication aspects involved in the preparation and enactment of Treasure-HIT activities. This communication framework, will try to improve and optimize the user experience of the various stakeholders and leverage the educational capabilities of the platform. Table 1 lists the considerations and rationale for the development of the additional features.

Table 2. Additional Treasure-HIT Features Reasoning

<table>
<thead>
<tr>
<th>Activities Based Map</th>
<th>Social media sharing</th>
<th>Image Gallery</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Why</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- The platform does not allow instructors to see or access activities created by others and in their vicinity</td>
<td>- Enrich existing pedagogical tasks within the Treasure-HIT platform</td>
<td>- Activities’ exposure to external parties</td>
</tr>
<tr>
<td></td>
<td>- Enhance group cohesion</td>
<td></td>
</tr>
<tr>
<td><strong>What</strong></td>
<td>- Location based map which presents graphically all activities in the platform and allows direct communication with the activities’ authors</td>
<td>- Social media publish-based activities (publish images and statuses to the user’s wall)</td>
</tr>
<tr>
<td></td>
<td>- Interactive map based on Google Maps API which retrieves activities’ data from the Treasure-HIT API</td>
<td>- External activity gallery with sharing capabilities (via mail, Facebook, Twitter)</td>
</tr>
<tr>
<td><strong>How</strong></td>
<td>- Implementation of third party PhoneGap plug-in</td>
<td>- Unique image databases per activity collected from social tasks</td>
</tr>
<tr>
<td></td>
<td>- Communication between Treasure-HIT API and Facebook JavaScript SDK</td>
<td></td>
</tr>
<tr>
<td><strong>When</strong></td>
<td>- Before creating a new activity</td>
<td>- During the activity - while performing a given task at the station</td>
</tr>
<tr>
<td></td>
<td>- Before registration to the platform</td>
<td>- Following an activity which includes a social media task</td>
</tr>
<tr>
<td><strong>Who</strong></td>
<td>- Authors</td>
<td>- Players</td>
</tr>
<tr>
<td></td>
<td>- Potential users</td>
<td>- Authors</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- External parties</td>
</tr>
</tbody>
</table>

The following sections will detail the design, development and testing of each feature separately. Several iterations of development and testing have been performed according to feedback from user evaluations and QA testing. The sections will be structured in the following order: first it will describe the "Activities Based Map" feature, followed by the "Social Media Sharing" feature and finally the "Image Gallery" feature.
7.2.1 Activities Based Map Feature

7.2.1.1 Design
This phase began with defining the requirements for the feature to be developed, in terms of user interface design and functionality. It was decided to develop a map which will present all the published activities created within the Treasure-HIT platform according to their location. Each activity will be represented differently on the map according to one of three publish definitions: public, temporary and private. Public activities, which are readily available to all players, will be marked using the most noticeable icon. Furthermore, explanatory window with the necessary information regarding the activity will accompany the icon of the public activities. This information will include the editor's name, editor's email address, total number of station, number of stations per group, route type (same, different with same ending point or random), stations' type (GPS, QR code, or both), average time of activity, target audience, description and comments. It was decided to present the map in the landing page of the authoring environment (before verifying the details of the editor). This will enable anyone who entered the landing page of the platform (authors and potential users) to see the map and the arsenal of the existing activities created. Based on these requirements a high-fidelity wireframe mockup design was created (Appendix B, Figure 34) in order to facilitate the development process.

7.2.1.2 Development (technical aspects)
The activities based map feature was built on an MVC architecture using the following web technologies: HTML5, CSS3, jQuery and AJAX. In order to allow optimal viewing experience, across a wide range of devices, a responsive design approach was implemented using the Bootstrap front-end framework. The following section will provide detailed information regarding the implementation and realization of this feature, while addressing the different MVC aspects.

The first step was the addition of a partial view (loginActivitiesMap.cshtml) for defining the layout and design of the activities based map feature. This partial view calls the Google Maps JavaScript API for the implementation of a ROADMAP map type. Using this API the markers layer, which represents the Treasure-HIT activities, is displayed on top of the map, using information retrieved from the Treasure-HIT API controller. An AJAX "GET" request (Figure 17) is sent to the Controller API (ActivityController.cs) for retrieving a list of the published activities, in a JSON format.

```javascript
function getAPI(url, callback) {
    $.ajax({
        url: "http://treasure-hit-dev.telem-hit.net" + url,
        cache: false,
        type: "GET",
        dataType: "json",
        contentType: 'application/json; charset=utf-8',
        success: callback,
        error: function (data) {
            alert("Error - " + data.status);
        }
    });
}
```

Figure 17. GetAPI Request
In the Controller API, a List <Activity> function (GetAllUnlimitedPublicationActivities()) was created for returning a list of the published activities. In order to distinguish between the three definitions of the activities (public, temporary and private) a "switch" statement with three case labels was added. Then, a new instance of the Activity model was created for containing all the required data regarding each activity, in accordance with the activity definitions. The data returns in a JSON format with all the requested data, including the latitude ("ActivityLat") and longitude ("ActivityLng") values.

The function unlimitCallBack (data) is used for displaying the markers of the activities in the partial views, according to their definition. By using the "ActivityLat" and "ActivityLng" values (Figure 18), the marker of each activity is located on the Google map, representing the main region of the activity.

```javascript
for (var i = 0; i < data.length; i++) {
  var a = data[i].ActivityLat;
  var b = data[i].ActivityLng;
  var ActivityName = data[i].Name;
  addMarker(a, b);
}
```

Figure 18. Retrieving the latitude and longitude of the activity

This function is also used for defining the data to be presented in the displaying the explanatory window, which presents the necessary information regarding the public activities, using a "click" event. Figure 19 presents the activities based map and Figure 20 presents the explanatory window which accompanies the public activities.

7.2.1.3 Testing and Refinements
Following this development, QA and usability testing were performed by a number of stakeholders (including existing editors, players and the platform's developers). These tests have raised the need for several improvements, mainly in the design. Following the suggestions of users, it was decided to add more information within the public activities' explanatory window and also to update the overall design of the landing page. Three main reasons have led to this new design (Figure 21):

- To better cater to new users of the platform
- Improve the platform marketability
- Insinuate the platform compatibility with diverse computerized devices

![Updated Design of Landing Page](image)

Figure 21. Updated Design of Landing Page

After completion of the necessary amendments and their implementation in the real platform environment, we received updates from users who have used this new feature. Instructors have used the feature in order to identify and access activities created by others using the provided information in the activity's explanatory window in the activity based map. Instructors approached other activity editors by email in order to request access or a copy of their activity. The instructional technologies dept. at HIT has also received similar requests for the activities they have created. The map thus constitutes a basis for communication and promotes content sharing among editors without brokerage. From the quick way the feature was embraced by the users it is evident that it was needed and is appreciated by the users.

### 7.2.2 Social Media Sharing Features - "Facebook Tasks"

#### 7.2.2.1 Design

This phase began with analyzing the "expert users" requirements which arose from the interviews and the experiment conducted in the previous phase. On the basis of those, the requirements for the feature to be developed were defined, focusing on its functionality. When examining the various social networks and their capabilities, it was decided that Facebook would be the most suitable one. While there are other CSCL tools and environments which promote social communication, Facebook maintains an active broad community and supports collaborative learning. It employs tools for content sharing and facilitates communication among peers. It was thus decided to develop a Facebook feature that will constitute an interactive task that would incorporate digital content production and social media interaction. Such a feature will enrich the variety of the existing pedagogical tasks in the platform. Instead of answering questions, the user will be required to perform one of two tasks:

1. Facebook status task - in which the user writes a status and publishes it on his Facebook wall.
2. Facebook image and status task - in which the user captures a picture that documents his position, writes a status and publishes it on his Facebook wall. The expert analysis pointed out the difficulty in performing the task of uploading a picture to Facebook. It required the use of a secondary capture application and the Facebook application as well as the involvement of an on-site instructor to provide the code to progress in the game. In order to eliminate the need for secondary applications and an on-site instructor, it was decided to develop a dedicated feature which will allow the player to perform the above mentioned activities in a "one-stop-shop" approach. The feature will enable the player to login to his Facebook account, take and publish a picture and a status and receive a response, all without leaving the application or needing the involvement of an instructor.

7.2.2.2 Development (technical aspects)
Incorporating the Facebook feature in the Treasure-HIT application is a complex task and therefore it was decided to first perform a feasibility test using a dedicated prototype. This prototype will serve as an intermediary between the Treasure-HIT application and the Facebook website. Once the prototype is finalized, it was planned to fully implement it in the Treasure-HIT application.

The prototype was developed using HTML5 and JavaScript languages in order to fulfill four main functions: login authentication, image capturing, storing and sharing it on the user's Facebook wall. In order to provide an optimal user experience for various devices Bootstrap framework which enables the development of responsive websites was used.

In order to allow the communication between the prototype and Facebook, it was essential to create a Facebook app which provided a unique API key. Facebook's JavaScript SDK was used in order to establish different client-side functionalities, such as API calls and login authentication, provided by Facebook.

Once the user attempts to use the prototype, the application checks whether he is logged into Facebook and if he isn't, he can login securely into Facebook using OAuth2.0 protocol. The authentication process enables communication between the user and the different Facebook services. Once the user identifies using his login name and password, an access token is generated and communication with Facebook is enabled.

By default, Facebook apps require access to the public profile of the user. A popup window, requesting the user to approve "publish actions", enables the application to publish on his behalf (Figure 22). Additionally, the user required to choose the post's privacy definition. By clicking the "privacy definition button" the user can decide with whom he would like to share the apps publications, publicly/with friends/privately. At this point the user remains logged in to Facebook for the duration of the game.

In order to allow the user to capture an image, it was decided to use an HTML5 file input tag. This tag enables the activation of the phone camera when using
smartphones. After the user captures an image, .NET HttpPostedFile class decodes the image and saves it on the target server's designated local directory. Every new saved image gets a unique name which is built from a prefix string: a current date and time string that is coming from the server. The saved image is then uploaded to an HTML image tag for previewing.

Once the image has been saved on the server, the user is prompted to write a status to accompany the image during its Facebook publication. The prototype sends a POST request to the server and fetches the image URL. An API call to the Facebook Graph API is being sent, containing the written status alongside the image URL. The status-image bundle is published on the user's wall and the image is saved in the user's photo album.

Once the status and image have been published successfully the user receives feedback in the form of an input code to be entered in the Treasure-HIT in order to progress in the game.

Development Limitations:
1. The first limitation which was witnessed in the initial prototype was related to the approval of the publish action. On the first login to Facebook within the game, the user was able to set the sharing definition for his posts. The user decided whether the image and status were shared publicly, with friends or privately. Once the definition was set, the user could only change it by entering the application settings via the official Facebook website. If the user decided to publish information to a certain group, his new publications using the initial prototype would always be published accordingly, he would not have the option to change his sharing preferences on a per-case basis. This limitation hindered the user experience as they did not have continuous control over their publishing settings. Therefore, it is required to find a solution that will allow the user to specify the sharing preferences for each post individually.

2. The second limitation which arose during the development of the initial prototype was related to tagging. We have added a predefined hashtag (#TrasureHIT) into the status text field in order to indicate that the published post is related to the Treasure-HIT activity. The rationale for this included two reasons: to increase exposure to the Treasure-HIT platform and examine the usage and performance of the specific feature. The problem was that Facebook did not approve the Treasure-HIT Facebook app and thus preventing it from being used for the benefit of the Treasure-HIT game. Facebook demanded to remove the predefined hashtag because it forces the users to publish the advertising content without being able to control or remove it. Only after we omitted the code responsible for the hashtag and sent the application back for reviewing, Facebook approved the application for public use.

7.2.2.3 First Testing and Refinements
After developing the initial prototype, it was tested in a real life setting. In late 2014, two dedicated Treasure-HIT activities were held by the Amal educational network. The activities took place in "Hatachana compound" in Tel Aviv, the first as a preparatory activity for 30 ICT coordinators from different schools. The second activity was a part of a study tour of high school students from Israel, Ukraine and the United States. 30 students participated in the activity, including ninth-grade students and their teaching staff. Prior to the arrival at the site, the participants were given a
brief explanation about the game and its rules. They were divided into mixed groups, as each group had at least one English-speaking Israeli who translated the instructions and questions to the other foreign participants. The activity included nine stations with tasks related to the history of the place. At the last station participants were given a "Facebook task". In this task they were required to enter the prototype's link, log in with their Facebook's account, take a picture of themselves against the background of the placed trailer, send it to their Facebook wall along a short relevant status (Figure 23). After they accomplished the task, they received in response a code from the system. They were required to enter the code back into the Treasure-HIT application in order to complete the task and finish the game. Two groups encountered a problem as they failed to complete the image upload process to Facebook. For this reason they could not get the code from the system and continue the game as planned. To solve this problem and allow the groups to complete the game successfully, they received the code orally from a representative who was present.

During both activities, a field observation and documentation were performed. At the end of each activity, five members of staff and eight students were interviewed in order to get their impressions and opinions regarding the game. The semi-structured interviews included open ended questions on the platform's usability, technical difficulties, overall enjoyment and experience. The interviews were recorded and then were transcribed. Key points were identified from both the recorded interviews and the notes taken during the observation. Despite the above mentioned problems, the students testified that the activity contributed to their learning experience and was "very fun and cool". One coordinator noted that "the students were too engaged in answering the questions on their phone and therefore they have not been able to experience the place with their own eyes".

In late April 2015 a training seminar regarding the integration of social games and technology was held by the "Kibbutz Movement" in Ramat Efal, Israel (Figure 24). 100 youth leaders, aged 20-30, from all over Israel took part in the seminar. The event was comprised of two parts: an interactive activity with a dedicated Treasure-HIT game and a guidance session regarding the Treasure-HIT authoring environment. Before the beginning of the activity, the participants were given a brief explanation about the game and its rules and then were divided into groups of three people. The
activity included seven stations with tasks related to the youth movements and the history of the place. At the last station participants were given a "Facebook task". In this task they were required to enter the prototype's link, log in with their Facebook's account, take a picture of themselves in the background of one of the sculptures placed in the main courtyard, send it to their Facebook wall along a short relevant status. After they accomplished the task, they received in response a code word from the system. They were required to enter the code back into the Treasure-HIT application in order to complete the task and finish the game. All groups successfully completed the game, although several groups had difficulties to complete the task as the process of publishing the images to Facebook last too long.

A field observation was carried out throughout the activity. With the help of two research assistants, the happening in the various game stations (which were far apart) was documented. The documentation included still photographs and video recordings. At the end of the seminar, an interview was held with the executives of the activity. The interview was recorded in a dedicated recording device. The findings indicate that the executives were satisfied with the Treasure-HIT activity. They noted that "The activity was very successful and contributed greatly to the success of the seminar... In the past, we used to think that there is no place for computerized activities during the interaction between children, but it is impossible not taking advantage of such technology..."

![Figure 24. The "Kibbutz Movement" Treasure-HIT activity](image)

Additionally, a short survey, which included four questions regarding the participants' experience, perception of and satisfaction from the platform, was conducted. The survey was carried out using the SMS-HIT platform. 90% of participants indicated that the activity was interesting. All participants have noted that during the activity they have gained new knowledge. Looking at their future interest in creating such activities, 95% of the participants noted that they are interested in creating such activities for their apprentices. 63% of the participants indicated they are interested in creating such activities for their peers as well as family and friends.

**Challenges and Further Requirements:**
The various user testing and field observations have raised a number of problems to be solved. The first round of tests in "Hatachana compound" revealed a problem in the process of login and publish to Facebook. After completing the authentication process, Facebook presented a popup window in which the user is required to approve the application to publish on his behalf. Some of the smartphones' browsers are blocking popup windows by default in order to prevent unnecessary content that hiders the user experience. Users can only disable this option manually. As a result of these browser settings, some devices have blocked the popup window and therefore some users couldn't confirm the "publish actions". In practice, users were able to take an image,
but were not able to publish it to Facebook and complete the task successfully. Therefore, it is necessary to find a solution that would bypass the browser settings which block the pop-up windows.

Further to this problem, another issue that came up is the need to make sure that the players can successfully complete the game, even if they failed to complete the Facebook task, either because of a problem with the Treasure-HIT server or rather because of a problem with the Facebook API.

The field experiment conducted in Ramat Efal revealed another problem with the images' uploading mechanism. It took a long time to upload and save the captured images to the Treasure-HIT server and then to publish them to Facebook. System testing carried out indicated that the sizes of the images captured were too large. The reason for this lies in the fact that the quality of the phones' cameras increases and accordingly the weight/size of the images. Hence, it is required to reduce the size of the images before they are uploaded to the server.

The field experiments led to the conclusion that the continuity of the user experience is crucial in maintaining the flow of the activity. In order to perform the Facebook task the users had to manually enter the address of the initial prototype through their browser. This forced them to leave the Treasure-HIT application. Additionally, users were forced to reverse the process and paste the retrieved code back in the application. Thus the conclusion was reached that the initial prototype cannot be stand alone and must be incorporated in the Treasure-HIT application.

**Refinements:**

The second development iteration was carried out in order to tackle the above mentioned challenges. As a first step, it was attempted to implement the initial prototype within the Treasure-HIT application. The implementation was not successful since the Treasure-HIT platform prevents the launch of popups from external services (e.g. Facebook). Therefore, a new approach had to be considered.

The solution which was explored used PhoneGap, a cross-platform framework for developing native mobile applications using HTML, CSS and JavaScript. The Treasure-HIT platform already uses PhoneGap for the implementation of the player environment and for enabling access to the device's features such as camera and Geolocation. Additionally, PhoneGap supports third-party plugins allowing extra functionality and capabilities. Facebook Connect is a third-party plugin which provides a JavaScript Software Development Kit (SDK). This SDK allows developers to integrate and implement the various Facebook services, such as login authentication, show a dialog and post-to-wall. Therefore, it was concluded that the PhoneGap framework was the suitable solution to overcome those challenges. Further implementation of PhoneGap will be detailed in the following section.

**7.2.2.4 Second Iteration Development**

In order to meet all the requirements and implement the Facebook tasks ("publish status" and "publish image and status") in the Treasure-HIT platform changes were required in both the authoring and player environments. Within the authoring environment, changes were required in order to allow the instructor to create one of the Facebook tasks. Within the player environment changes were required in order to present the Facebook tasks as an integral part of the treasure-HIT application, without
Exiting to another interface or service. The following sections will describe the changes and updates in both environments, including the changes made in their MVC structure.

**Development in the authoring environment**
The first step was the addition of the button "Facebook task" to the "Tasks" pane, where the instructor creates the pedagogical task to be performed at the station (Figure 25).

![Figure 25. Addition of Facebook task button to the tasks pane](image)

In the partial view (partialQuestions.cshtml), which represents the "Tasks" pane, each button has an Ajax Action that defines the type of the task. Therefore, a new Ajax Action has been set for the Facebook task. This Ajax Action sends a call to the controller (PointsController.cs) which sends the relevant parameters to the partial view of the task's setting window (FBTaskDialog.cshtml). In this window (Figure 26) the instructor can choose between a "publish status" task and a "publish images and status" task. Depending on his selection, predefined instructions for the player are displayed. These instructions can be changed or edited. The addition of the Facebook task is conditional on the instructor's approval that the players are older than 13 years (the rationale for this is rooted in the privacy concerns mentioned earlier). By clicking the "Add" button the data (including the type of the task and the instructions) is stored in the "Activities" table in the Treasure-HIT database.

![Figure 26. Facebook task setting window](image)

**Development in the player environment**
Firstly, a new HTML Div for the Facebook tasks has been set in the view (question.html). Instead of the default header for open and close questions, which included question counter and a question mark icon, a new header has been set with the caption "Facebook Task" and an icon of Facebook. Later, the controls for each of the Facebook tasks have been set accordingly, including the instructions, the "Connect
to Facebook” button and in the case of the "publish image and status” task, also the controls for capturing and previewing an image. Finally, another HTML Div has been set for the task's feedback.

In the controller (questionCtrl.js) several modifications were made. Two new cases ("FBStatus" and "FBImageStatus") have been added in order to load and present the appropriate view. "FBStatus" represents a case when the user publishes a status to his Facebook's wall. "FBImageStatus" represents a case when the user publishes a status and an image to his Facebook's wall. The first step, when the user clicks the "connect to Facebook” button, the FBLogin function is executed. A call to the Facebook plugin is made for enabling the login authentication process. The Facebook login window opens within the Treasure-HIT application and the user required to enter his credentials. If the login failed, a call to the connectionFailed() function is made and the user receives a "Connection Failed" response. If the login succeeded, another window requests the user's approval for the application to publish on his behalf.

Following this stage, the controller checks whether the defined task is "FBImageStatus" or "FBStatus". In the case of a "FBImageStatus" task, the user first captures an image, by clicking the "capture image" button (Figure 27), which is then presented on screen (Figure 28). The image is then saved to the Treasure-HIT server using a dedicated handler. The handler also defines the image orientation and dimensions (as further detailed in the challenges section below).

Due to variations between the iOS and Android operation systems a slightly different approach had to be adapted for capturing and saving the image. On iOS a call is made to sendImageToHandler() function. The image is taken from the input tag and is sent to the handler by an AJAX request. The handler saves the image to the server and a call to the FBImageStatus() function is performed. On Android, the savePhoto() function is called. The function calls the PhoneGap camera plugin which enables the capturing, saving and encoding of an image taken by the user. The function then calls on the PhoneGap File Transfer plugin which transfers the image from the smartphone to the handler. The image is saved on the server and a call to the FBImageStatus() function is performed. In both cases, should the saving of the image to the server was not successful, the user will receive a "Connection Failed" response and a note "connectionFailed" will be written in the database log.

At this point, the process converges once again for both operation systems. The FBImageStatus() function activates the PhoneGap Facebook plugin which creates the ShowDialoge window (Figure 29). The ShowDialoge fetches the image URL, link to the Treasure-HIT platform, a set caption ("Treasure-HIT + [Game Name]”) and description. The user is given the option to add his personalized status to accompany the image. Before posting the status and image, the user can decide with whom he would like to share the post, publicly/with friends/privately.

Once the user publishes the post, a call is made to the checkAnswer() function. If the function returns a success, the user is transferred to a new view screen where he receives an acknowledgment of his success and can continue to his next task/clue. At the same time, the post will be published on his Facebook wall (Figure 30). If the function returns an error for the first time in that task, the user receives an acknowledgement of the mission's incompleteness and is called to retry the task. The note "connectionFailed" is written in the database log. In case the user fails to publish the post a second time (or failed to connect to Facebook a second time), the user sees a
"connectionFailed" popup message and he can skip the task or try again. If the user skips the tasks, the note “wrong answer” is written in the database log and a mistake is added to his score.

In the case of a "FBStatus" task, a call is made to the FBpostStatus() function which activates the PhoneGap Facebook plugin which creates the ShowDialog window. The user is given the option to write his personalized status in the presented ShowDialog. Before posting the status, the user can decide with whom he would like to share the post, publicly/with friends/privately. Similar to the process in the FBImageStatus task, once the user publishes the post, a call is made to the checkAnswer() function and the user receives a response accordingly.
Challenges and ways to overcome them:
PhoneGap has allowed us to overcome the limitation related to the users' sharing definition by allowing the users each time to choose with whom they would like to share their publications. Unlike the initial prototype, where the privacy definition button appeared once when the user first logged in to Facebook, in the new prototype, the privacy definition button is located adjacent to the status text field. This solution has thus provided the user with better control and more flexibility, improving his overall user experience.

In addition, the initial prototype required the use of a confirmation code which was provided to the user following each posting on Facebook. This code allowed the user to progress in the game. Using PhoneGap, this redundant step has become automatic in Treasure-HIT. The application checks whether the publication succeeded and automatically moves the user to the next phase of the game. The code word step is no longer necessary, improving once again the user experience.

During the tests of the new version an issue with the image orientation was observed. When taking an image, users often rotate their smartphones. Built-in orientation sensors detect the orientation of the image and log it in the EXIF metadata of each image. The image, taken by the participants, is presented correctly in the task preview component (an HTML5 image tag), but is wrongly oriented when published on Facebook. Images are stored on the server with their original orientation, as taken by the phone's camera. Facebook API loads the image from the server and presents it as it was stored. In case the users tilted their phone while taking the image it will be presented tilted on Facebook.

To solve this problem, the image orientation is checked prior to saving the image on the server. The EXIF orientation flag (Figure 31) indicates the orientation in which the image was taken and used to determine the correct orientation. The image is then rotated, saved correctly on the server and presented properly on Facebook.

Another problem which arose during the test of the new version is related to the image dimensions. Facebook dictates that the dimensions of shared link thumbnails should fit 470*246 pixels. The dimensions of images taken by phone cameras do not necessarily correlate to those of Facebook. Due to this discrepancy, Facebook cuts oversized images to fit its allowed dimensions. A dilemma thus arose whether to allow Facebook to cut images automatically or rather manipulate the images' dimensions so they will fit the constraints. The latter option meant the adoption of the letter-box format which preserves image proportions and adds white margins to the image. The disadvantage of this option is that not the whole Facebook preview box is used and some might see it as less aesthetic. Finally, despite the disadvantage, the second option was preferred in

Figure 31. EXIF Orientation Flags
order to not hinder the user experience and reflect the activity as it was truly experienced.

7.2.2.5 Testing and Evaluating
After the development completion of the Facebook tasks within the Treasure-HIT platform, QA tests were performed. These tests were conducted on a variety of devices with iOS and Android operating systems. In order to test the functionality, user experience and perception of the Facebook task by real users, an evaluation research was held. The research process and its results are detailed in section 7.2.3.3.

7.2.3 Image Gallery Feature

7.2.3.1 Design
During the development of the Facebook task, a need arose to consolidate the images published during the activity and allow viewing them outside the Facebook network (as the images are published on the personal wall of the player and can only be viewed by those who were defined during the Facebook task). Therefore, it was required to create an external gallery which will be accessible to the various stakeholders. To accomplish this, it was decided to develop a gallery which will be accessible from the authoring environment, but will not be contingent upon registration to the Treasure-HIT platform. In other words, the gallery would be a part of the platform, but detached from the profile of the instructor who created the Facebook task. It will be possible to share the gallery through social networks (Facebook and Twitter) and by sending a link via e-mail. In addition, it was decided to update the parameters of the FBImageStatus showDialog to include a link to the image gallery which was created.

7.2.3.2 Development
In order to meet the above requirements and add an external gallery which gathers from the Facebook task, it is mandatory to add data to the database. Thus, a new model (imageGallery.Cs) was added and includes the following variables: ID, ActivityID, GameCode, PointID and ImageName. The GameCode has been added in order to allow the creation of non-linear URL for image gallery. This creates another privacy element which allows for selective access to the gallery. In accordance with the model definitions the table that contains the data for the gallery was created in the database. Next, it was required to build a new API for adding the images and the related information to the database. The construction of the API consists of two phases. The first phase updates the db.writer file which is responsible for additions and updates to the database. The second phase defines the new API in the questionController.cs with expected attributes of a new image gallery to be saved in the database. A call to this API is performed from the player environment (questionCtrl.js), after the image has been published on Facebook. In this call, the API provides the db.writer with attributes for a new image gallery. It is important to note that a gallery will only be created for an activity that includes a Facebook task and to which an image has already been uploaded.

The visual representation of the gallery (Figure 32) requires the opening of a new view named ImageGallery. The db.writer retrieves a list of images attributed to a specific game code. The loginController.cs requests the list from the db.writer and defines the image gallery view. A loop creates the <li> tag for each image in the list. PrettyPhoto, a jQuery based plugin, is used for the design of the images' lightbox window. Using the <li> tag, prretyPhoto and CSS3 values the layout of the gallery is completed.
Facebook and Twitter sharing buttons were added to the gallery page using predefined code provided by the services. In order to enable the user to share a link to the gallery through email, a Div tag was added to the gallery view (THGallery.cshtml) for designing the "send link to gallery" window (Figure 33) and the message for successful sending (Figure 34). Within the controller (THGallery.js) a function is used to open the present the "send link to gallery" window on click. In addition, an API call is made for handling the design and process of sending the mail and adding the correct gallery link from the database.

Figure 32. Image Gallery View

Figure 33. "Send link to gallery" window

Figure 34. Message after successful sharing of a link to the gallery
As a final step, a new column has been added to the game repository in the "My Games" page (Figure 35). A function in the Activity.cs file checks whether the image list in the db.writer for specific game code includes more than one image. In case it does, an icon is added to the gallery column of the specific game. The icon leads to a unique URL which is accessible to non-registered users.

![Game Repository with Gallery Column](image)

**Figure 35. Game Repository with Gallery Column**

### 7.2.3.3 Testing and Evaluation

In order to evaluate the new features in terms of user experience and functionality, three field observations were performed. These evaluation sessions were held with different sample groups in different settings: the first and third were held as a part of a learning activity and the second was held as a part of a leisure activity. The research process and results are described below.

#### 7.2.3.3.1 Field Observation #1:

The first field observation was conducted in late November 2015, as a part of the course “New Media Technology” at the Holon Institute of Technology. 52 first-year students, aged 25-32, from the Instructional Technologies Department took part in the activity (Figure 36). Following a brief explanation about the activity, the students performed the activity in pairs. Each pair used two smartphones, one was used to perform tasks in the Treasure-HIT application and the second was used for information search. The activity included five stations with a random route for each pair. All the questions and tasks during the activity were related to the topic “networks” which is part of the course’s curriculum. As part of the activity, the participants were required to perform a Facebook image and status task. They were requested to find the IP of the Google website, capture an image of them with the IP and post the image to their Facebook wall, all in order to show that a website might be located on different servers and therefore produce different IPs. All the images posted to Facebook by the users have been saved and displayed in the game image gallery (Figure 37).
Following the activity, participants were asked to answer a short online questionnaire (Appendix B), created using Google Forms. The questionnaire included questions regarding the user experience (in terms of usability and performance), their perception and satisfaction from the Treasure-HIT activity and the Facebook task. After the students completed answering the questionnaire, the lecturer who created the activity, held a brief summery. In order to obtain a broader picture about the activity and the user experience, open interviews were conducted with the course’s lecturer and with a group of students. The first part of the questionnaire dealt with the users’ perception of the activity. The second part inquired about their impressions of the Facebook task and usage patterns. The following section will present the analysis of data collected from questionnaires and interviews.

**Perception and satisfaction from the Treasure-HIT activity**

In the first question in this section, participants were asked to rate the difficulty level of the activity by five point Likert scale from: *very easy* (1) to *very difficult* (5). The results of this question, according to which the average is 3.1 (SD = 0.66), indicate that the level of difficulty of the activity was moderate. The next question examined whether participants enjoyed the activity, rated by five levels from: *did not enjoy at all* (1) to *I enjoyed very much* (5). The results, according to which the average answer is 3.96 (SD = 1.04), show that the activity was perceived enjoyable. The last question in this section examined whether participants learned new things during the activity.
Results indicate that the majority of participants did. Their comments point toward new terms and concepts they have learned on the topic of networking.

**Impressions of the Facebook task and usage patterns**

The purpose of the second part of the questionnaire was to examine the participants' usage patterns on Facebook and their perceptions towards the Facebook task which performed during the activity. The first question examined which Facebook account was used to complete the Facebook task. The data show that in all cases, the users who run the Treasure-HIT application on their phones were those who logged in to their Facebook account for completing the Facebook task. Afterwards, the participants were asked to answer with whom they usually share their statuses on Facebook (Figure 38). Most of the students (71%) reported that they usually share their statuses on Facebook with their friends, while 17% share their statuses publicly and 10% do not tend to share their statuses with others.

![Figure 38. With whom do you usually share your statuses on Facebook? (1st Evaluation)](image)

Additionally, the participants were asked with whom they shared their Facebook task during the activity (Figure 39). The majority of the players shared their Facebook task either publicly or with their friends. In addition, approximately a third of the players were not aware with whom the status was shared. According to the analyzed data, those who were not aware of the sharing setting were those who did not run the Treasure-HIT application on their phones.
Figure 39. With whom have you shared your Facebook task during the activity? (1st Evaluation)

The participants were also questioned about their normal practice of sharing on Facebook and their preference in sharing content during a Treasure-HIT activity. According to the results (Figure 40) it can be seen that those who usually publish publically continue this sharing preference in future activities. However, while the majority of the participants generally share content with their Facebook friends, in the case of Treasure-HIT activities half of those would prefer their posts to be private. Comments made by the users shed light on the reason for this as most of those who have changed their preference mentioned privacy concerns as the reason for their different preferences. Some quotes by the students include: “Not everyone wants the exposure”, “hurts privacy”, “I don’t like publishing pictures on Facebook” and “Facebook is used mostly for private/personal matters”.

The above results strengthen the decision to implement the user’s capability to choose with whom he/she would like to share their Facebook task. The instructors need to take into account that not all users are willing to share content publicly.

In contrast, users who prefer to share their Treasure-HIT statuses publicly noted that: “Everyone uses Facebook. There is no reason why it should not be used for educational purposes”, “When posts are distributed on Facebook others can learn from them”, “This is a creative way to learn”.

Figure 40. General practice of Facebook sharing vs. Treasure-HIT sharing preference (1st Evaluation)
In order to examine the performance of the Facebook task in term of usability and ease of use, participants were asked to rate the difficulty of the task execution by five levels: from *very easy* (1) to *very difficult* (5). According to the results (Figure 41), 71% of users found the tasks to be easy to perform. Of the 20% who have provided negative feedback on this point, all have encountered a technical problem related to their iOS version.

![Figure 41. Ease of use of the Facebook task (1st Evaluation)](image)

In the last question participants were asked where would they prefer to publish their Facebook task - on their Facebook wall or alternatively on the wall of a certain group. The majority of participants (92%) noted they prefer to publish the Facebook task on a certain group's wall.

**Open Interviews**

In addition to the analysis of the data gathered from the questionnaires, open interviews were conducted with the course lecturer and with five students who participated in the mentioned activity. Both the lecturer and the students provided their impressions and suggestions related to the administrative and pedagogical aspects of the activity. The lecturer noted that the activity enabled her to communicate the learning material in an experiential and unique way. She further noted that the activity enabled a switch from a passive frontal based learning to an active inquiry based learning. The students needed to research topical terms through the activity in a way that had, according to the lecturer, a "cool effect" and was fun and creative. Regarding the Facebook task, it was noted that because the image and status task was posted on the students' personal wall, it wasn't possible to see the posted statuses. It was proposed that participants are able to post the images and statuses on a public group wall. The image gallery was perceived to be an excellent way to overview the activity's artifacts. It was suggested to include the posting group's name below each image posted. Finally the lecturer was highly satisfied and expressed willingness and to use the Treasure-HIT platform in future educational activities.

The students have all greatly enjoyed the activity. Two of the students noted that because of the activity's competitive element they felt that their learning process was not complete. They suggested that the activity will summarize previously learned...
content and not replace the first learning phase (which happened in this instance). Another student raised the privacy issue, which also came up in the questionnaire, and his reluctance to post things on their personal wall. An important comment which was raised is the need to clarify the purpose and added pedagogical benefit of the Facebook task during the summary of the activity. "It was not clear what was the rationale of the Facebook task. Clarifying why we took a picture with Google's IP address would have helped make it clear".

7.2.3.3.2 Field Observation #2:
In early December 2015 a second field observation was conducted in order to examine the new features developed. The observation was held in Ramat Yishai climbing wall as a part of a training activity of the regional youth climbing team (Figure 42). 26 participants attended the activity, including 24 team members aged 14-18, their coach aged 28 and the team manager aged 36. Following a brief explanation about the activity, the members were divided into groups of two, three and four members. Each group used two smartphones, one for performing the tasks in the Treasure-HIT application and the second for searching relevant information. The activity included six stations with a random route for each group. All the questions and tasks during the activity were related to climbing and the surrounding area. At the ending point of the activity, all groups were required to perform a Facebook image and status task. They were requested to capture an image of them on the climbing wall and post the image to their Facebook alongside a status marking their participation in this activity. All the images posted to Facebook by the users have been saved and displayed in the game image gallery (Figure 43).

![Figure 42. Treasure-HIT activity in Ramat Yishai climbing wall](image1)

![Figure 43. Image gallery of the activity held at Ramat Yishai climbing wall](image2)
Following the activity, the coaches held a wrap-up discussion with the team and then continued with the regular physical training. At the end of the training, all the team members and the coaches were also requested to answer the short online questionnaire used in the previous field observation. In addition, open interviews were held with the couches and the manager of the climbing team.

The following section will present the analysis of data collected from the questionnaires and the interviews.

**Perception and satisfaction from the Treasure-HIT activity**
Similar to the previous evaluation, the first part of the questionnaire included questions regarding the participants' perceptions of the activity. First, they were asked to rate the difficulty level of the activity by five point Likert scale from: very easy (1) to very difficult (5). The results, according to which the average is 2.53 (SD = 0.79), indicate that the activity was quite easy. The next question examined whether participants enjoyed the activity, rated by five levels from: did not enjoy at all (1) to I enjoyed very much (5). The results, according to which the average answer is 4.57 (SD = 0.63), show that the activity was perceived very enjoyable. The last question in this section examined whether participants learned new things during the activity. Results indicate that the majority of participants (77%) did.

**Impressions of the Facebook task and usage patterns**
The second part of the questionnaire examines the participants' usage patterns on Facebook and their perceptions towards the Facebook task (Figure 44). The majority of participants (69%) reported that they usually share their statuses on Facebook with their friends, while 19% share their statuses publicly, 4% do not tend to share their statuses with others and 8% don't have a Facebook account.

In the following question the participants were asked with whom they shared their Facebook task during the activity (Figure 45). The majority of participants noted they shared the task either with their friends or publicly. In addition, 27% of the participants
were not aware with whom the status was shared. The collected data indicate that those participants were those who did not run the Treasure-HIT application on their phones.

![Figure 45. With whom have you shared your Facebook task during the activity? (2nd evaluation)](image)

The participants also were questioned about their preference in sharing content during a Treasure-HIT activity. When comparing these preferences with the participants' general sharing habits (Figure 46), it can be seen that in most cases there was a discrepancy between the answers. Those who usually publish their statuses publicly continue this sharing preference in the case of Treasure-HIT activities. However, while the majority of the participants usually publish their statuses with friends, in the case of Treasure-HIT activities a third of those would prefer their posts to be private. Comments made by the users shed light on the change in their sharing preferences of Treasure-HIT activities. Some of those comments include: "I don't like to share on Facebook" and "I don't share photos on Facebook". Additionally, two of these users do not have a Facebook account at all.

In contrast, users who prefer to share their Treasure-HIT statuses publicly or with friends noted that: “We live on Facebook”, “It is cool that others can see what we did”, “Facebook task makes this game cooler”, "We are always on Facebook so it's fun that we can also post what we did in this activity", "I publish everything on Facebook". 
Also in this study, participants were asked about the ease of the Facebook task execution. According to the results (Figure 47), 92% of participants found the tasks to be easy to perform. The rest of the participants mentioned the execution was moderate. Data analysis indicates that those participants have encountered a technical problem related to internet connection.

In the last question participants were asked where would they prefer to publish their Facebook task - on their Facebook wall or alternatively on the wall of a certain group. The majority of participants (69%) noted they prefer to publish the Facebook task on their wall. The data show that participants who prefer to publish the Facebook task on a group's wall are those who reported they do not like to share things on Facebook.

**Open Interviews**
In addition to the questionnaire answered by the participants, open interviews were held with the coach of the team and its managers. Both the coach and the managers of
the team noted their great satisfaction from the Treasure-HIT platform. The coach explained that he decided to create a Treasure-HIT activity in order to enhance the training session of the climbing team. "I wanted to create an experiential activity that will serve as a warm-up exercise to the training session, but also will bring an added value to it. All the team members practice here three times a week, but not necessarily know the history of our climbing wall, which constitutes a memorial site". In addition, he noted that: "This activity has allowed us to train the team physically in a unique way, but also to teach them some things about climbing and the surroundings in which they climb".

The team managers stated that: "We are very pleased with the use of the Treasure-HIT application, and we intend to incorporate it in our future activities". In addition, when they asked about the Facebook task, the managers expressed their satisfaction from the integration of this task in the activity. "Our team members constantly post their pictures on Facebook. The ability to post pictures during this game, especially those related to their main hobby, is amazing. It enriches the game since it's very cool and they love this exposure. It is also good for us. Their posts increase the visibility of our activities to the public and consequently contribute to us greatly in terms of marketing and advertising".

7.2.3.3 Field Observation #3:
Another field observation was conducted in late December 2015, as a part of a learning activity at Kfar Silver Agricultural High School (Figure 48). 120 tenth grade pupils, aged 15-16, took part in the activity. The activity was designed by one of the school teachers and was aimed to encourage the "school spirit" and strengthen the relationship between the pupils and their teachers. The pupils were divided into groups of six while each group consisted of pupils from different classes. The game included 16 stations representing various sites of interest around the school, and each group was directed to eight of these stations with a random route. Six school teachers accompanied the groups in order to support them whenever necessary. All the questions and tasks during the activity were related to the school's curriculum, atmosphere and surroundings. As part of the activity, the participants were required to perform three Facebook image and status tasks. In the first Facebook task they were requested to locate their science teacher and take a picture with him. In the second Facebook task, they were asked to take an amusing group picture, and in the third task they were asked to take a picture of four teachers holding the sign "we love you". Then, the pupils were asked to post each of the pictures to their Facebook wall (Figure 49). Once all groups have finished the activity, there was a wrap-up discussion with the pupils and their teachers. The activity was documented using still photographs and video recordings.

Figure 48. Treasure-HIT activity in Kfar Silver
Following the activity, open interviews were conducted with the creator of the activity and the teachers. All the interviewees mentioned the activity was very enjoyable and successful. One of the teachers added that the activity allowed the pupils to learn new things in a fun and experiential way. The creator of the activity reported that the pupils expressed their great satisfaction with the activity and their will to take part in similar activities in the future. As for the Facebook tasks, both the pupils and teachers have shown great willingness to participate and perform them. The teachers reported that the Facebook tasks were easy to perform, however, two groups have encountered a few technical problems in uploading the images due to a low WIFI signal. These groups have decided to skip the Facebook tasks in order to continue the game and complete the activity. The creator of the activity concluded by saying that "despite the problems with the internet, it seems that all groups have benefited greatly from the activity and those who managed to accomplish the Facebook task were even more pleased with it". 
8 Discussion

The purpose of the evaluation was to examine the new Facebook task feature while in use by the platform's real users. The feature was assessed on two levels: functionality (ease of use) and the users' perception of the Facebook task. In order to understand the users' perceptions we questioned their Facebook usage habits, the way they have performed the task and the users' preferences in performing the task. The following section will discuss the data and the conclusions drawn from the three observations carried out: the first which was conducted with students as part of an academic course, the second, which was conducted with climbers as a part of their leisure activity, and the third which was conducted with students as a part of a learning activity.

Regarding the feature's functionality, participants of the first two studied groups recalled the ease of use of the Facebook task. The few technical problems that did arise were related to OS compatibility in the students' group and to a weak internet connection in both the climbers' group and the pupils' group. These findings show that the implementation of the feature was good and the interface is easy to use. The internet signal is an external factor that should be taken into account when creating Treasure-HIT activities, with or without a Facebook task, but it is not in the editor's control. The Treasure-HIT application was not designed in native, but rather as a cross-platform application using PhoneGap. It is thus necessary to periodically update the code in alignment with new OS versions.

Sharing habits: The first two evaluated groups showed similar Facebook usage patterns. Most users are used to share their posts only with their friends. Among the students the share was 71%, while among the climbers 69%. Furthermore, among the climbers a higher percentage of participants do not have a Facebook account. Their young age, most are 14 years old, might account for this as it is only possible to open a Facebook account from 13 years old.

Usage patters: Between the first two evaluated groups, the majority of participants shared their statuses during the activity with either their friends or publicly. In these groups, if the participant’s phone was not used, they did not know the sharing preferences. This finding shows that during a Facebook task some users might be less involved in the task. Keeping this fact in mind, Facebook tasks need to be designed to be as inclusive as possible to allow all of the groups' members to benefit from the task.

Sharing preferences: Most users reported that they prefer to share a Facebook task during the activity with their friends or publicly. Among the students this preference amounted to 60%, while among climbers as high as 80%. The findings show that students are more sensitive to their privacy and 40% of them prefer to share their Facebook task privately. Climbers perceived the sharing aspect of the task as one of the fun characteristics of the activity and saw it as a good experience they can share with their friends. The difference between the climbers and the students groups might result from the age difference between the groups as the climbers have grown up in a world where Facebook exists and extensive sharing is the norm.

When provided with the options of sharing their Facebook task post on their own wall or on a the wall of a dedicated Facebook group, climbers were interested to continue using their own wall while students preferred the dedicated group. These results are once again in line with the discrepancy between the two groups, the students putting an
emphasize on limited sharing and privacy and the climbers wanting to share their activities with their whole network.

Another reason for the Facebook task perception difference between the groups, both in regards to the share location and the share target audience, stems from the task’s context. During the first evaluation, the students were requested to post an image that directly ties them to the learning material. On the other hand, in the second evaluation, the climbers were requested to post an image of themselves in an instance when they are performing their main hobby. During both activities, learning has occurred, however, it should be noted that the Facebook task itself does not have to necessarily have an educational purpose by itself but rather support the overall learning process. From the inclination of the climbers to post their images versus the reluctance of the students to do so, we learn that the context of the Facebook task and its purpose are of great importance. A Facebook task that provides added value to the participants, be it a representation of success or participation in a social activity, is needed in order for the participants to want to post their images and statuses on their own wall.

Nadkarni & Hofmann (2012) found support to this claim by which people tend to post on Facebook content that provides them with added value, strengthens their self esteem or their self presentation. Safko (2010) added that social networks are a platform for self expression and thus Facebook tasks should enable the users to exhibit content they are proud of rather than content which is forced upon them.

Brennan (2006) further expanded that social networks act as virtual IDs for people in general and teenagers in particular. Social networks have become a part of teenagers' socialization process. Creation of social ties with peers constitutes an important aspect in the formation of personal identity during adolescent years (Brennan, 2006). This strong correlation between the teenagers' real-world self and their virtual self increases their urge to post on their daily activities. The students on the other hand do not relate their virtual personna to their real-world self and are thus less eager to post every aspect of their lives on Facebook in particular for academic purposes (Grosseck et al., 2011).

To conclude, the Facebook task constitutes a means of communication for the participants with their peers out of the activity. It allows them to document their experiences and share the meaningful moments. For the activity creator/instructor, the Facebook task brings an added layer of communication since the gallery produced during the activity gathers all the posted images and can be used to summarize the learning activity and be used for future activities. Another added value is seen in the marketing potential of the Facebook tasks which propagate the existence of the Treasure-HIT platform among new potential users and also promotes the organizer of the activity as indicated by the manager of the climbing team.

Location based activities must be contextually related and have an added value and not simply move people from one location to another (Israel, Ronen, Kalderon, & Shoham, 2015). Similarly, an activity that involves the usage of social networks, whether within an academic framework or not, must have social characteristics and present an added value to the participants. Facebook acts today as a display window to peoples' lives and is part of their self expression and presentation. It is thus necessary to use the new Facebook task feature in a way that will synergize with the participants’ Facebook usage habits.
9 Summary and Conclusions

The research conducted in this thesis, studied the addition of a communication layer within the Treasure-HIT platform in order to meet the needs of its users and enrich its capabilities. Design based research was carried out to analyze the requirements of the users and to develop suitable communication features to support communication between the learners, instructors, their personal community and new potential users.

The first research question examined which features should be developed in order to facilitate and support communication which are involved in the preparation and enactment of Treasure-HIT activities. To answer this question, a preliminary research was conducted with current Treasure-HIT users in order to thoroughly understand their needs. Using several research methodologies, a survey, interviews and field research, the main needs of users were identified. Addressing the identified needs, it was decided to develop a communication framework which is composed of the three following features: (1) activities based map, (2) social media sharing feature (Facebook status task and Facebook image and status task) and (3) image gallery. These new features were to support and facilitate communication among the various stakeholders. In order to create the most suitable components in terms of user needs and design, it was decided to initially define the requirements of each feature (in terms of interface design and functionality) and then consider the different possibilities for the development and implementation of these features. The development process itself was iterative. Following the development of each feature, both QA testing and user testing were carried out. Following comments raised by the users, changes and adjustments were made.

The development process of the Facebook task was more complicated than that of the other features. The development required the implementation of a third party service and it was decided to first perform a feasibility test using a dedicated prototype. The testing phase of the prototype raised technical and interface difficulties among which were the inability to present an authentication pop-up window, inability to modify sharing preferences, difficulties in saving large images to the server and finally the need for a physical presence during the activity in order to deliver the code needed to advance to the next level in the activity.

In light of these difficulties, it was decided to choose a new development path using PhoneGap, a cross-platform framework for developing native mobile applications. Embedded and third-party plugins for PhoneGap were used in order to support the defined functionalities, image capture, login and posting on Facebook. The plugins provide an optimal user experience on all used operating systems.

Following the features' implementation in the platform an evaluation research was performed in order to address the second research question on the adoption of the features by the users and their ability to provide a more effective, rich and elaborate use of the platform. Quantitative and qualitative methodologies were used in order to evaluate the ease of use and functionality of the developed features.

Feedback received from the users of the activities based map showed that the information presented for each activity on the map, which includes a summary of the activity's attributes and structure, allowed them to quickly identify its relevance to their needs. The users were able to directly contact the creators of activities that interest them without the need for mediation by the platform's administrators.
Additionally, the users appreciated the ability to use existing activities, as it saved time and allowed them to invest that time in ameliorating the activity and adding new depths to existing or new tasks.

The developed Facebook task saved the need for an instructor to be present in the field in order to complete the task (as seen in the preliminary research) and enabled easy interface with applications external to the system. The solution developed is based on a "One Stop Shop" approach, meaning that all actions are performed within the platform without the need to open other external applications. This solution improved the user experience, the platform's effectiveness and eliminated interfaces, which might be prone to compatibility issues (due to updates of other applications for example).

In addition, the three performed evaluations shed light on usage patterns of the features. The first and third evaluations were performed in academic settings while the second was performed during leisure activity. In all groups, the users expressed high satisfaction from the functionality and ease of use. It was also clear from all evaluations that the Facebook task was perceived as improving the overall user experience and enjoyment from the activity. It was highlighted that in order for the task to have the utmost impact, it must be contextualized to the educational goals and provide added value to the learners on both a practical and personal level. This value is translated into a better and longer lasting learning experience.

The produced image gallery for each activity was also perceived as having positive value. The gallery allowed both the instructors and participants to collect their images and present them at a later time during the summary of the activity or the sharing of it with their peers. In addition, it provided another communication aspect as it enabled the distribution of the gallery to other groups. The gallery allows the learning to continue beyond the activity for future learning purposes by using the collected images as part of the long-term pedagogical goals.

In regards to the learning experience, the new features evolved the Treasure-HIT platform to match current learning technology trends and basic functionalities expected by learners in today's world. Treasure hunt games have existed for hundreds of years. Their use in an educational context enables to expand the learning experience beyond the physical borders of the classroom. Using mobile devices and implementing social network features allows us to expand the learning activities to the virtual space of the learners. The lack of a communication component in such treasure hunt games limits the interaction between the different groups and other external actors.

Teaching methodologies have to be adapted to the skills and realities of the 21st century in which learners conduct their daily lives. According to Gartner (2015), professionals in the education sector must tap new technologies outside the education realm. Gartner added in his 2015 "hype cycle for education" that mobile learning for smartphones and social media platforms are climbing the slope meaning that they are widely adopted and increasingly used for educational purposes (Lowendahl, 2015). This thesis aimed to update the existing Treasure-HIT platform to the expectations of learners by adapting existing technologies and synergizing them to create a new unique experience. The newly implemented communication capabilities upgrade the mobile learning experience with social media elements in order to support the instructors and learners in creating and experiencing more meaningful and impactful learning activities.
10 Limitations

Although this study achieved its goals, it is important to note the limitations which were encountered during the research process. This section will detail the limitations.

This thesis deals with the development of additional functionalities to the Treasure-HIT platform which was created earlier by other programmers. Consequently, it was necessary to study and understand the architecture of the platform and develop the new components in accordance with it. In some cases, for example, in the implementation of the Facebook tasks, significant development efforts were required to match the existing architecture.

Dependence on third-party services and API that tend to change frequently has been and remains a constraint for the development process. For example, changes that occurred in Facebook's API and in the Phonegap plugins demanded significant alterations in the development and prolonged it. It is important to consider that further modifications may be required due to these circumstances.

The Treasure-HIT platform is an inclusive environment aimed at various audiences, including instructors and learners at different ages. The Facebook tasks which have been developed are restricted to ages 13 and older (as specified in section 2.4.2) thus limiting the use of this feature.

As previously mentioned, the thesis developed features aimed at both the learners and instructors. The final evaluation focused mainly on learners. In addition, among learners, three research groups with different characteristics have been tested and for those, the sample was limited (first group of 52 students, a second group of 24 climbers and a third group of 120 pupils). Therefore, the findings cannot be generalized to the entire population of both learners and instructors. It is recommended to extend the research and examine the perceptions of more users.

11 Future Work

Given the time frame and the defined scope of the project, this study focused on the development of three additional features to the Treasure-HIT platform. On top of the improvements introduced in this study, further enhancements and functionality adjustments can be added in future development.

- A possible addition would be the ability for participants to choose their statuses' sharing location, on their personal wall or rather on a dedicated Facebook group wall. Users have mentioned their interest in this possibility during the final evaluation.

- A new possible communication functionality that can be added is Real-Time Communication (RTC). During outdoor activities, instructors and learners might feel detached from each other due to their different geographic location, making on-site updates difficult. Instructors can use RTC to facilitate the interaction with learners anywhere and overcome this difficulty (Huang, Wu, & Chen, 2012). By adding the RTC ability to the Treasure-HIT platform, instructors will be able to track participants' locations in real-time, communicate with them and deliver messages during the game. These new
capabilities can enable instructors to better manage the activities they have created and boost the learning experience of the learners.

In addition, a more extensive evaluation of the platform would allow us to identify the pedagogical benefits of the enhanced platform. Exploring further users' experiences both on an individual level and on a group one would shed light on the added value they see in the new features. The conclusions would lead to a better product and an improved learning experience.
References


Wetzel, R., Blum, L., & Oppermann, L. (2012). Tidy City – A location-based game supported by in-situ and web-based authoring tools to enable user-created content, 238–241.


Appendices

Appendix A: Detailed Information Regarding Treasure-HIT

A.1 Treasure-HIT Authoring Environment used technologies:

**ASP.NET MVC** - is a framework for designing and developing well-structured web applications, relying on the Model-View-Controller (MVC) design pattern. This framework constitutes as an alternative for the traditional ASP.NET Web Forms while offering benefits for development of different web applications. The MVC proposes to divide the application into three distinct components, thereby allowing better control, maintainability and testability (Chadwick et al., 2012).

**HTML5** - is the fifth version of the HTML markup language used for designing and displaying Web pages. This new standard, defined by the W3C, is designed to improve the language and semantics by adding new tags and setting a more clear page structure. As a result, web pages are supported by more browsers (including mobile browsers) and they are friendlier to search engines. HTML5 provides better media handling and easier creation and implementation of more complex graphics, capabilities which were previously reserved for JavaScript (Gasston, 2013).

**CSS3** - is the third version of the Cascading Style Sheet language used for describing the style and formatting of a web page. It allows the separation between the content and design and provides more flexibility in the page's appearance. CSS3 offers advanced design options by adding extra selectors and various visual elements such as: drop shadow, rounded corners, transparency and gradient effects. In addition, it allows the creation of animation and Roll-over without the need of JavaScript coding (Gasston, 2013).

**JavaScript** - is an object-oriented scripting language which allows developers to embed script segments in HTML documents and thus make the page more dynamic. JavaScript is designed for the client side and does not require compilation before runtime. The language allows user interaction and dynamic content addition which enriches the functionality and user experience (Gasston, 2013).

**jQuery** - is a cross-platform JavaScript library which simplifies the development of web and mobile applications. It enables simple and efficient development using built-in functions and UI components. Hundreds of abbreviated commands with easy to understand syntax, allow the implementation of JavaScript capabilities in a simplified and more straightforward way (Gasston, 2013).

**AJAX** - which stands for Asynchronous JavaScript And XML is a technique for creating interactive and more responsive web applications. The main aim of the technique is improving the user experience and accelerating the loading time of the page. This is possible by updating certain parts on demand, without loading the entire page. In other words, updating content does not require a refresh of the browser. The interactivity of AJAX applications is achieved through running code in the client-side, which prevents unnecessary communication between the client and the server (Holzner, 2008).

**Google Maps API** - The Treasure-HIT authoring environment has been designed in such a way that allows instructors to build outdoor activities, without their physical
Meaning the instructors can determine the location of the activity's stations using the web environment itself. To support these requirements, it was necessary to find a mapping service which provides an API that support this functionality. Google maps API is a free to use, third-party cross platform web service for embedding Google maps into web applications. The Google maps API provides a great selection of options based on various types of maps, such as terrain, road, satellite and etc. Additionally, it supports over 50 languages and is suitable for both web and mobile applications. The "Google Places API" service enabled the ability of instructors to search certain address, retrieve its latitude and longitude coordinates, and set markers for representing the stations. Moreover, the "Google Street View Image API" service enables the instructors to view static images or a panorama of the street view of the selected location (Google Developer, 2015).

A.2 Treasure-HIT Player Environment used technologies:
AngularJS - Similar to the authoring environment, the Treasure-HIT player environment also utilizes an MVC framework. The AngularJS is a client-side JavaScript MVC framework that simplifies the development of single-page web applications which is suitable also for mobile applications. This framework provides various features to ease the development process of different applications. It is particularly useful when creating CRUD (Create, Read, Update, Delete) based web applications. AngularJS proposes a relatively new code styling which extends the HTML language with new attributes and components (directives). This enables easy development resulting rich and powerful web applications (Kozlowski & Darwin, 2013).

PhoneGap - is an open source framework for developing cross-platform application using HTML, CSS and JavaScript (Myer, 2011). Cross-platform development is a novel approach that came to address the challenges rooted in the native development. It enables developers to implement their application once and deploy it simultaneously on multiple platforms, instead of developing for each device and its associated operation system separately. This approach supports generality and facilitates the utilization of specific capabilities of the different devices (Heitkötter, Hanschke, & Majchrzak, 2012). PhoneGap provides various plugins for accessing the device's sensors and features (e.g. Geolocation, camera, etc.). Third-party plugins also supported by the framework allowing extra functionality and connection to external services (Myer, 2011).
A.3 *Treasure-HIT Authoring Environment used technologies:*

Figure 50 below demonstrate the Treasure-HIT tables' relationships and dependencies:

![Figure 50. Treasure-HIT Database Tables](image_url)
Appendix B: Activity Evaluation Questionnaire

Figure 51. Activity Evaluation Questionnaire