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Design and Implementation of a Gamification-based Information System

An Application for Increasing the Motivation of Sport Activities

Master's Thesis

Graz University of Technology

Institute for Information Systems and Computer Media

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Design und Implementierung eines Informationssystems unterstützt durch Gamification

Eine Applikation zur Motivationsteigerung für Sportaktivitäten

Masterarbeit

Technische Universität Graz

Institut für Informationssysteme und Computer Medien

Betreuer: Univ.-Doz. DI Dr. techn. Christian Guetl

Graz, September 2013

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Abstract

Dealing with social media has become a major part of many people's daily life. Posting, sharing or distributing of information are well known processes, which are done by nearly everybody. Game based approaches are a little bit newer and become more and more integrated into social applications nowadays. These approaches are introduced to support different application domains like education, business, health and sport. It means in effect that concepts like *serious games* and *gamification* are using a game design to support non gaming contexts. Social sport, fitness and health applications see an enormous boom these days by using social interaction sometimes combined with game elements. Their major goal is to improve users experience and to increase the peoples motivation to go outside and do sport activities. There are of course many different possibilities, concepts and appendages how these exercises could be solved by a web portal. The social interaction is one of the most important in this connection. Sharing of personal sport performances is probably one of the major motivations for people. Users get motivated by seeing how their friends performed, or which success they achieved. Challenges and collaborative aspects may be interesting as well. People could organize trainings together or simply compare their results to run their own competition. These concepts will always create sub groups and new relationships within the community, what further leads to a positive stimulation of the whole network.

This thesis discusses the design, the implementation and the evaluation of a social community supported by game elements motivating people to do sport activities. The theoretical part handles social media and game play concepts. It researches and evaluates current social fitness applications. The requirement analysis according to the evaluation's issues and findings is made. The implementation of the web portal is supported by a content management framework. This is prior selected after an evaluation of different suitable solutions. The outcome of the project is a social web platform, which is able to combine game play approaches with a serious training analysis, what can act motivating on beginners as well as on advanced sportsmen. The application implements different concepts and themes which were found out by theoretical research. The evaluation confirmed the current popularity of fitness software and described the concept and realization of the application generally speaking very positive. Especially the route planner, game elements and geo-caching features received positive criticism. Only details were mentioned as improvable.

Kurzfassung

Der Umgang mit Social Media nimmt heute große Bereiche unseres täglichen Lebens ein. Das Posten und Teilen von Informationen sind Prozesse welche für jedermann bekannt sind. Spielerische Ansätze sind ein wenig neuer, werden aber immer mehr in soziale Applikationen integriert. Sie werden eingesetzt um unterschiedlichste Anwendungsbereiche wie Bildung, Geschäftsprozesse, Sport und Gesundheit zu unterstützen. Das bedeutet, dass Konzepte wie "Serious Games" und "Gamification" unterstützen "normale" Bereiche des täglichen Lebens mittels spielerischem Elementen. Soziale Sport-, Fitness- und Gesundheitsapplikationen erfahren einen enormen Erfolg Boom diese Tage. Ihr Hauptziel ist es die Nutzererfahrung zu verbessern und die Anwender zu motivieren Sportaktivitäten zu tätigen. Natürlich gibt es unterschiedlichste Möglichkeiten, Konzepte und Herangehensweisen wie diese Aufgabe gelöst werden kann. Eine der wichtigsten ist hierbei die soziale Interaktion. Das Teilen von persönlichen Leistungen ist wahrscheinlich der größte Motivator für Benutzer. Sie motivieren sich gegenseitig indem sie die Erfolge und Leistungen von Freunden sehen. Weiters sind Wettkämpfe und gemeinsame Aktivitäten ein wichtiger Punkt. Benutzer können sich zu Trainingsgemeinschaften zusammenschließen oder an virtuellen Wettkämpfen teilnehmen. Dies führt zu neuen Verbindungen und Gruppenbildung innerhalb des Netzwerkes, was natürlich eine positive Stimulation für die gesamte Community bedeutet.

Diese Masterarbeit behandelt das Design, die Implementierung und Evaluierung einer Sozialen Sport Applikation welche durch spielerische Elemente unterstützt wird. Der theoretische Teil behandelt eine Hintergrundrecherche von Social Media und Spielerischen Konzepten. Weiters werden vorhandene Sportanwendungen untersucht und evaluiert. Auf den Ergebnissen der Evaluierung basiert die Anforderungsanalyse sowie das konzeptionelle Design. Die Implementierung wird unterstützt durch eine Content Management System, welches zuvor mittels einer weiteren Evaluierung ausgewählt wird. Das Ergebnis der Arbeit ist eine Social Web Platform welche spielerische Ansätze mit seriösen Trainingsanalysen kombiniert. Dies soll Anfänger als auch fortgeschrittene Sportler gleichermaßen motivieren. Die Applikation setzt unterschiedliche Themen und Konzepte um, welche vorher theoretisch erarbeitet wurden. Die Evaluierung bestätigte die aktuelle Beliebtheit von Sport-Software und beschreibt Konzept und Umsetzung der Applikation sehr positiv. Im speziellen werden Routen Planer, Spiel-Elemente, und Geo Caching positive erwähnt. Nur Details wurden als verbesserungsfähig bewertet.

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1 Introduction and Motivation

During the last years a huge number of applications successfully used game play elements for none gaming activities. The usage pursues as one main goal to increase the users' motivation for the application's context. This approach appeared under the term *gamification* some years ago and was applied successfully in application domains like education, business, sport, health and general productivity. (Deterding, Dixon, Khaled, & Nacke, 2011) Gamification distinguishes distinctly from *serious games*, which are following a very similar goal within the same application fields. Both concepts, as well as their distinction are explained in the thesis in detail. However, also the latest social sport application started integrating these concepts, what is already confirmed by current press releases like *the New York Times* article *"Don't just map your run, earn points for it"*. The article discusses how a social (web) environment can positively influence the motivation of people. (Sims, 2012) That such applications have a serious background and are not only for fun is also outlined by literature discussing sport and health game approaches, as well as by the *World Health Organization* (WHO). Hardy, El-Saddik, Gobel, and Steinmetz (2011) outline that health issues like cardiac diseases, obesity, diabetes, and muscular atrophy or misbalances are omnipresent, especially in western countries today. They are based on biased food combined with insufficient movement. The WHO published the number of 1.4 billion overweighted people in 2013. (WHO, 2013) All these facts create a demand for new approaches to increase the motivation of people to do sports.

1.1 Objectives of the Thesis

This thesis explains the design, the implementation and the evaluation of a social web community supporting sport activities enhanced with game aspects. The theoretical part aims on finding issues and concepts in order to create a social environment increasing the users' motivation and improve their experience. This happens over three stages of research: background of social media and gamification, fitness or extracurricular applications and psychological motivation theory. In relation to the findings, the motivation of the users to practice sport activities should be increased by the application based on the following concepts:

- Gamification aspects
- Social Feeling (Friends, Collaboration, etc.)
- Serious training record and analysis

The project is realized in collaboration with Gritsch (2013). He researched geographical information systems and web services, and is responsible for the implementation

of the computation and representation of geographical informations within the application. The design process includes an evaluation and selection of frameworks and tools which can be used as a basement to build a social network. The application is responsible to handle a web portal's basic tasks. Therefore its usage should bring several benefits compared an implementing from scratch. Main requirements on such a framework are changeability, extendability and flexibility because it has to interact with different external, self developed components.

1.2 Structure of the Thesis

This thesis is basically structured into two parts, the theoretical research of the background and the application domain and the practical implementation of the game based community website. The theoretical part is outlined in chapter 2 and 3 and the practical one starts at chapter 4, beginning with the definition of the requirements and ends with the evaluation of the finished application. However, regarded intently, each chapter build on the preceding one and derives information more in detail. This procedure leads to findings and requirements in chapter 4 and further to the practical implementation of them. The main contents and goals of each chapter are explained in the following.

Chapter 2 explains basic knowledge and concepts of social media. Different classifications and categorizations of external studies are explained to give an overview of the domain. These concepts are not something new or innovative but they are still valid and useful to understand how does a social community work. Further social game concepts are described which bring new potential to different types of applications.

In chapter 3 an explanation of theoretical psychological knowledge is given. This is necessary to understand what drives people to do sport activities and how can these needs be increased. Further a research and evaluation of sport and activity communities is done. The evaluation of them in relation to the motivational approaches and the theoretical knowledge of chapter 1 reveal different findings to define requirements for the proposed application.

In chapter 4 the requirements are discussed in detail. According to the findings of the evaluation, requirements are split into the sections sport, social and gamification. The conceptual architecture describes the logical components of the application and how they are interacting. The selection of framework and tools is followed, which is explained in this chapter. Different content management systems are researched with focus on building web communities, and one is selected to be the basement for the implementation.

Chapter 5 describes the selected content management framework Drupal. Concepts and terminology which are necessary to understand the implementation process are explained in detail. The most important, contributed, external modules which are used for the project are described further. Functionality and features of the modules are outlined.

Chapter 6 explains the implementation process in detail. First an overview of the architecture, the database schema and the Drupal configuration is given. Developed custom modules are described, what they provide and how they work. Other implementation steps and components are discussed next, including important templates, "privacy handling" or how "content creation" works.

Chapter 7 briefly illustrates a use case of the sport portal and discusses the evaluation process of different stakeholders and the related results. The application is evaluated according to usability, integrity and motivational usage. Furthermore the participants a classified in relation to their motives of using social sport applications.

Chapter 8 explains the learned aspects and findings according to the finished project. Chapter 9 describes how the application can be extended and improved as future work. It is also mentioned what could be the next necessary steps to publish the application and run a successful web community. A finishing summary as well as an outlook is given.

2 Social Media

Nowadays terms like social media, social networking and Web 2.0 are omnipresent. Various definitions of these terms are used which indicates that they are closely connected but not identical. When the publisher Tim O'Reilly coined the term Web 2.0 at the beginning of 2000s, he simply classified concepts which successful Internet organizations had in common. He defined these core capabilities as follows (Alby, 2008):

- Using the Web as a platform
- Embracing the users collective intelligence
- Access the data, which are difficult or expensive to achieve, and which become more useful if they are shared
- Including users into the software development process
- Software is runnable on different devices
- Simply and well defined Software Interfaces for: user, developer and processes
- Software life-circle, software is not a product, it's a service

Social Media describes the concept of distributing and sharing user generated content using Web applications which are built around the Web 2.0 technology. The major difference to classic or traditional mass media is that the information does not come from professional, payed journalists, broadcasters or other distributors, it is created and published by everyone. (Safran, 2010, p. 13) Mayfield (2008) defined social media applications including the following properties:

- **Participation:** Contribution from everyone, no difference between publisher and audience.
- **Openness:** Services are open for feedback, participation and voting. Hardly any barriers to access the content.
- **Conversation:** Contrary to traditional media the information is flowing between media and audience.
- **Community:** Social media is often built around communities with common interests.
- **Connectedness:** The services are growing by connectedness, links and interfaces are stimulation communities.

2.1 Basic Concepts and Classifications

There are a couple of fundamental theories which underlie the term social media. Safran (2010, p. 13) identifies three main concepts which social media applications have to implement. Because of these concepts a classification of web applications is

		Social presence/ Media richness		
		Low	Medium	High
Self-presentation/ Self-disclosure	High	Blogs	Social networking sites (e.g., Facebook)	Virtual social worlds (e.g., Second Life)
	Low	Collaborative projects (e.g., Wikipedia)	Content communities (e.g., YouTube)	Virtual game worlds (e.g., World of Warcraft)

Table 2.1: Classification of social media applications. (Kaplan & Haenlein, 2010)

possible and for each of it a representative example can be found. The connection and interaction between these Web applications leads to the social web. He define these concept as follows:

- **Communication:** Is the interaction of people within groups or communities by publishing content. Examples of applications which belong to this category are microblogs, discussion forums and social networks.
- **Collaboration:** Different individuals are intellectual working together, so called computer supported collaborative work. Wikis are probably the best known examples for collaborative projects.
- **Sharing:** Content communities, blogs and podcasts are applications where users can share their information and resources to people or groups with common interests.

Kaplan and Haenlein (2010) mentioned a classification of social web applications scaled by two dimensions: media research (social presence, media richness) and social processes (self-presentation, self disclosure). The outcome of this categorization is a six field matrix, illustrated in table 2.1, and consists of: collaborative projects, blogs, content communities, social networking sites, virtual game worlds and virtual social worlds.

According to Kietzmann, Hermakens, Carthy, and Silvestre (2011) a classification of social media activities (applications) can be made by 7 blocks, illustrated as honeycombs, to measure their extent. This illustration should help to identify the needs, requirements and the audience of the media. Each of these blocks describes a social media user experience and allows a specific research for those aspects. Applications can belong to one or more of those blocks, that allows to define virtually every social media configuration. Kietzmann et al. (2011) described these extents as follows:

- **Identity:** How the site's member is presented to other users, defines the user's identity within the system. That happens over personal pages or profiles which display name, personal information, pictures and a blog mostly. Privacy and data mining are very critical issues with reference to this point. Social media applications have to find a balance between sharing informations and data privacy.

- **Presence:** Describes the virtual presence of users at the system including who they are and how they are accessible. Current states like ”active”,”busy” or ”hidden” are a common way to implement this. Presence could be also coupled with geoinformation of the real world, showing where one’s friends are. Foursquare[1] is an example for such an implementation.
- **Relationships:** Describes the extent how the users are connected within the community. Social applications may have different terms for this, but nearly everyone is offering this concept.
- **Conversations:** Defines the scope how the communication of users within the network is happening. Solutions like blog entries, comments, instant messaging or private messages are only some concepts of social media conversation. Nowadays web sites often provide more of them.
- **Groups:** Is the extent how users can create sub-communities within the network. This feature primary helps users to manage their relationships, friends and contacts. Two systems of groups are common: First, the user can pool his or her friends together into self-created lists. The second concept is that users with common interests come together and build a group or sub-community, like clubs in the real world. This concept could be very extensive in practice, because of features like group member management, content access permission system and different group roles.
- **Reputations:** The extent of reputation indicates the standing or ranking of users within the application. Reputation can have different meanings in social networks but it is mostly coupled with an assessment of trust. This value rates the trustability of a user and its content and could be for example measured in visits (*YouTube*[2]), followers (*Twitter*[3]), likes (*Facebook*[4]) or a rating system (*ebay*[5]).
- **Sharing:** This is a major concept in many social media platforms. It describes how users publish, distribute, exchange and receive content. Kietzmann et al. (2011) suggested that there are two fundamental needs for every organization which wants to implement “sharing”. The first is to find an object of sociality which the users have in common, or to create a new need which is within their interests. The sharing platform would only be a network of connected users without commonalities, if this factor is not considered. Secondly, the questions how to manage the shared content according to copyright laws and terms of use. It would be impossible to observe the whole data pool to detect violations, so the application depends on its users who flag or report bad content.

2.2 Types of Social Media

The number of social applications in the World Wide Web seems to be virtually infinite today. Section 2.1 explains different classifications for them, the following sections describe the different types of social media applications, how they work and

[1] http://www.foursquare.com, visited 13th March 2012
[2] http://www.youtube.com, visited 14th March 2013
[3] http://www.twitter.com, visited 15th March 2013
[4] http://www.facebook.com, visited 12th March, 2013
[5] http://www.ebay.com, visited 14th March 2012

which opportunities they provide to their users. Everyone of them is overlapping the mentioned concepts and not exactly assignable.

2.2.1 Social Networks

Boyed and Ellison (2007) defined social networks as *"[...] sites as web-based services that allow individuals to construct a public or semi-public profile within a bounded system, articulate a list of other users with whom they share a connection, and view and traverse their list of connections and those made by others within the system."*

These profile-pages can be mostly personalized and display different kind of data like texts, photos, videos or maps nowadays. Social networks like Facebook, *Xing*[6], *MySpace*[7] or *StudiVz*[8] were enormously successful in the last years (Kaplan & Haenlein, 2010). Also companies discovered the phenomena social networking and terms like "Social Business" or "Social Media Marketing" arised. Organizations are now able to easily communicate with thousands of people. Tasks like information sharing, content mining, customer relationship management and other marketing exercises can incorporate into the social marketing department. However, nowadays social networks are not totally free from criticism. Especially data privacy is an often discussed issue, because personal information can easily reach people which should not have access to it if the contributor is not attentive enough or does not know how to use the privacy tools of the system. (Yüksel, Yuksel, & Zaim, 2010, p. 154)

2.2.2 Blogs

Blogs were one of the first appearances of the social web. Blogs are simple websites with chronological ordered articles, often written by a single author. Today every thinkable topic of the peoples life can be found as a online blog. The content is created by one entity, but everyone is able to comment on the article, this is how the communication works within a blog. Negative feedback can be written as well and in the case a business organization runs a blog this could have bad consequences for them. The second dangerous situation arises if the firm motivates their employees to run a blog, because wrong information could be contributed or they write something negative about the company. (Kaplan & Haenlein, 2010)

2.2.3 Wikis

Wikis are applications providing websites which can be contributed and edited by every user without much technological knowledge or a file transfer with the web server. By removing the technological barriers they allow everyone to collaborate as

[6]http://www.xing.com, visited 12th March, 2013
[7]http://www.myspace.com, visited 12th March, 2013
[8]http://www.studivz.net, visited 12th March, 2013

a writer for different tasks. Each modification is recorded and archived by the system to display the contents detailed history everyone. (Welser, Underwood, Cosley, Hansen, & Black, 2011)

Wikipedia[9] is probably the worlds most popular wiki and realized by a software called *Mediawiki*[10]. Wikipedia is an free to use online encyclopedia totally filled and maintained by its users with content. However, in the last years criticism arised in reference to the quality and the traceability of the articles. Safran (2010, p. 31) mentioned the main problems of Wikipedia as follows:

- Contributions can be erroneous
- Contributions can be incomplete
- Contributions can be slanderous
- Material on a person is outside the person's control
- Contributions can be unstable
- Material can be strongly biased
- Material can be contradictory

2.2.4 Podcasts

Podcasts are typical file or information streams which refer to collection of data and can be subscribed by users. If a users subscribe to a podcast they will receive these files (normally of the type audio or video) from the server. The distribution is achieved by *RSS* feeds (Really Simple Syndication). The download starts automatically and stores the data on the users device. Podcasting has become a mainstream Internet service in the last years and studies prophesy that they will grow enormously in the following years. Many traditional media publishing organizations are nowadays using this type of social media for distributing content. (Gunawardena, Karagiannis, Proutiere, & Vojnovic, 2009)

2.2.5 Forums

Forums are one of the first well known social media concept. These applications allow users to discuss common interests. Each debated topic runs as an own thread. (Kaplan & Haenlein, 2010, p. 63) Light and Rogers (1999) mentioned "bottom-up" generated ones, which where founded by private individuals or groups with no commercial background. Secondly, "top-down" forums which were run by commercial organizations to provide a communication field to their audience. Especially media firms like newspapers often combine a forum with their online articles. nowadays. This trend led to a single information exchange, which means that the audience can answer on the hosts predefined topics only.

[9] http://www.wikipedia.org, visited 14th March 2013
[10] http://www.mediawiki.org/wiki/MediaWiki, visited 14th March 2013

2.2.6 Content Communities

Content communities are platforms which provide their users the possibility to share data of all thinkable media types, e.g. images (*Flickr*[11]), videos (YouTube), books (*Bookcrossing*[12]), gps-data (*GPS-Tour.info*[13]) or slide presentations (*SlidesShare*[14]). The users presentation and communication are not main goals of these communities, so they often do not have extensive profile pages or communication features. Their main focus is lying on the distribution of content. However, they were also often exposed to criticism related to the violation of copy rights. They defined rules and were trying to remove those data with huge effort. Also firms and organizations discovered content communities as a new way for selling, recruiting, informing or just communicating. (Kaplan & Haenlein, 2010, p. 63)

2.2.7 Microblogs

Microblogs brought a totally new way of communication to an audience. By distributing small contents over those applications the fastest spread can be achieved, which would not be possible by traditional blogging or other media. (Wang, Ogihara, & Li, 2012)

A smooth transition between the features of social networks and Microblogs like Twitter is the normal case today. Twitter is today's best known micro blogging tool. It allows users to tweet ("share") short text messages (up to 140 characters) or pictures. Only 10% of the twitter users are doing this over the website, other approaches are mobile devices, instant messengers or desktop applications like *TweetDeck*[15]. A subscription via RSS feed is possible and a popular way to receive tweets. (Mayfield, 2008)

2.3 Game Aspects in Social Media

Since social networks experienced such an enormous growth in the last years, social games become more and more popular, a revolution in the game industry started and nowadays hundred millions of dollars run into social game development. Most of them run within a browser or on a mobile device and are distributed over the users network relations. (D.-H. Shin & Y.-J. Shin, 2011)

That led to the situation that borders between social media and gaming became blurred. Games are included and coupled with social networks or contain own features for social communication. Many games do not only aim at entertainment, they have the further goal to provide other advantages to their players, which are often useful in real life. These games are serious or educational games and gamification

[11] http://www.flickr.com, visited 18th March 2013
[12] http://www.bookcrossing.com/, visited 18th March 2013
[13] http://www.gps-tour.info, visited 18th March 2013
[14] http://www.slideshare.net, visited 18th March 2013
[15] http://www.tweetdeck.com, visited 15th March 2013

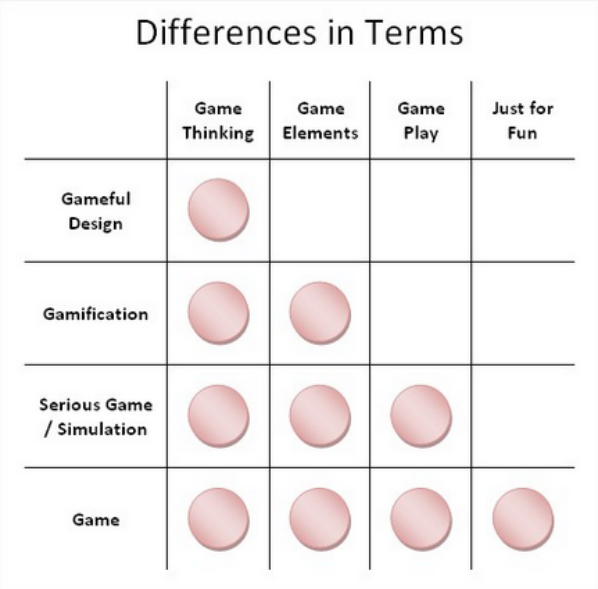


Figure 2.1: Differences of game concepts, from the designs point of view. (Marczewski, 2013)

applications. Marczewski (2013) describes the the differences of the them in figure 2.1. The figure illustrates the different game concepts according to their main property. It describes the transition from a simple gameful design to a full fledged game by increasing the game play as well as game elements. The following chapter explains these differences in detail, and gives an introduction into the different kinds of social game play and serious game concepts.

2.3.1 Motivation

Lazzaro (2004) researched why people play computer games. He found the following intensions by testing different types of gamers:

- Receive emotions and thoughts they can not get at work or at school
- Enjoy the competition by testing personal skills
- Do things they cannot do in real life
- Escape social norms and enjoy a foreign social environment
- Enjoy the challenge and total addiction (applies to nearly every gamer)
- The combination of relaxing and exciting emotions is sometimes used as therapeutic benefit

According to the results of the study he defined 4 keys which are able to unlock the gamer's emotions, and should be considered in every game design:

1. **Hard Fun:** Generated by challenges and problem solving, can sometimes lead to frustration.
2. **Easy Fun:** When players turn into foreign worlds and adventures, should lead to experiences of wonder and awe.
3. **Altered States:** The game should be within the players internal emotions, so the players can totally escape from normal feelings.

4. **People Factor:** Includes all thinkable social emotions arising by playing with others.

2.3.2 Gamification

Gamification is a term or concept, which describes how game elements are introduced to improve user experience for non gaming activities and applications. The concept does not use full developed video games, it just extracts objects and elements of them. Such elements could be reputation systems (points, awards, progress bars) or views of rankings. (Deterding, Dixon, Nacke, O'Hara, & Sicart, 2011) Deterding, Khaled, Nacke, and Dixon (2011) defined gamification as follows: *"Gamification is the use of game design elements in non-game contexts."* They illustrated their definition in Figure 2.2 and explained it by the following classification:

Figure 2.2: Gamification in context with serious games and playful interaction. (Deterding, Khaled, et al., 2011)

Game: It is focusing on game elements rather than "playing". Games are played, but playing includes a copious definition. Games are defined by concepts like rules, competitions and strives against outcomes or goals. From human computer interaction's (HCI) point of view gamification is differenced from playful interactions or playful design.

Elements: Gamified applications does not lead to entire a full fledged game. However, these distinction often blurs in praxis, because it is depending on personal usage and the social environment. For example: receiving badges for special activities may lead to gaming interactions between a group of friends.

Non Game Context: Gamification appendages does not aim on pure entertainment primary, there are other purposes beside of joy. Deterding, Khaled, et al. (2011) do not limit the usage of gamification applications in reference to contexts, purposes,

Level	Description	Example
Game interface design patterns	Common, successful interaction design components and design solutions for a known problem in a context, including prototypical implementations	Badge, leaderboard, level
Game design patterns and mechanics	Commonly reoccurring parts of the design of a game that concern gameplay	Time constraint, limited resources, turns
Game design principles and heuristics	Evaluative guidelines to approach a design problem or analyze a given design solution	Enduring play, clear goals, variety of game styles
Game models	Conceptual models of the components of games or game experience	MDA; challenge, fantasy, curiosity; game design atoms; CEGE
Game design methods	Game design-specific practices and processes	Playtesting, playcentric design, value conscious game design

Table 2.2: Abstraction of game design layers. (Deterding, Dixon, Khaled, et al., 2011)

or scenarios. Applications in domains such as sport, health, news and education are thinkable.

According to the research of current literature made by Deterding, Dixon, Khaled, et al. (2011), game design elements can be assigned into different levels of abstraction. These levels reach from concrete levels to abstract. They classified the layers as follows: Interface design patterns, game design patterns, design principles, heuristics or 'lenses', conceptual models, game design methods and processes. Description and examples of the layers can be seen in table 2.2.

Aparicio, Vela, Sánchez, and Montes (2012) explain a method to analyze gamification as a tool to force participation and motivation of human beings to do tasks. According to them, gamification approaches should always aim on of the intrinsic motivational needs of people. They are autonomy, competence and relatedness, a further explanation of these needs can be found in chapter 3.1. They founded a method to implement effective gamification including the following steps:

- **Identify the main objective:** To identify a main task which should be supported by the gamification.
- **Identify the transversal objective:** To find objectives which may be interesting for users, these should flow into the game mechanics to create further motivation of people.
- **Selection of game mechanics:** To find the right game mechanics which meet the people needs in relation to their intrinsic motivation.
- **Analysis of the effectiveness:** The implementation of gamification should be analyzed in relation to fun, quality indicators of the objective and satisfaction.

Bista, Nepal, Colineau, and Paris (2012) developed a gamification model to improve user experience within a social community. Based on the problem that 90% of the users never contribute and 9% contribute just a little bit, their concept improves

the following three aspects by gamification. Bootstrapping (how to get members during the initial phase and keep them), monitoring (observe users behavior) and sustainability (how to sustain members over the community's life cycle). It was their approach to award actions of users with points which are converted into badges later. These badges represent a reputation concept to motivate others. They founded the analysis of the award winnings, improves the community's observer's overview, analysis according to bootstrapping and sustainability were not executed.

Criticisms

Gartner (2012) published an article that 80% of gamification applications will not reach their objectives until 2014. They affiliate their prediction primary on poor design. Brian Burke, research vice president at Gartner said: "*As a result, in many cases, organizations are simply counting points, slapping meaningless badges on activities and creating gamified applications that are simply not engaging for the target audience. Some organizations are already beginning to cast off poorly designed gamified applications.*" They describe gamification as the usage of game mechanics and game design to change the target group's behaviors or learn them new skills. To receive benefits from gamification three objectives have to be achieved:

- **Changing Behaviors:** The prime usage of gamification is to bring the target audience to change a set of defined behaviors. If the peoples desired behavior is turned into the game, then they will change their traditional habits.
- **Developing Skills:** Gamification can be perfectly inserted to improve learning or training experiences. Two approaches for a more extensive learning effects are mentioned:
  - Competition and collarboration between learners should be rewarded by badges and ranking lists.
  - While training and learning is changed into a game, students have to be in a safe virtual environment to practice and develop new skills and should get immediate feedback.
- **Enabling Innovation:** Games which support innovations distinguishes typically from those which change behaviors. Innovation games have structures which bring users to explore, experiment, collaborate and solve problems. This happens ideally collaboratively by lots of users.

2.3.3 Serious Games

Serious games or educational games are mostly digital games with further goals than simple entertainment. They are primary deployed in education because the "game feeling" can be a high motivation factor for students. Other business fields for serious games could be physical treatment or health care and military. However, different definitions of serious games can be found of course. According to education.com[16] educational games are: "*Individual or group games that have cognitive, social, behavioral,*

[16]http://www.education.com/definition/educational-games, visited 27th March 2013/

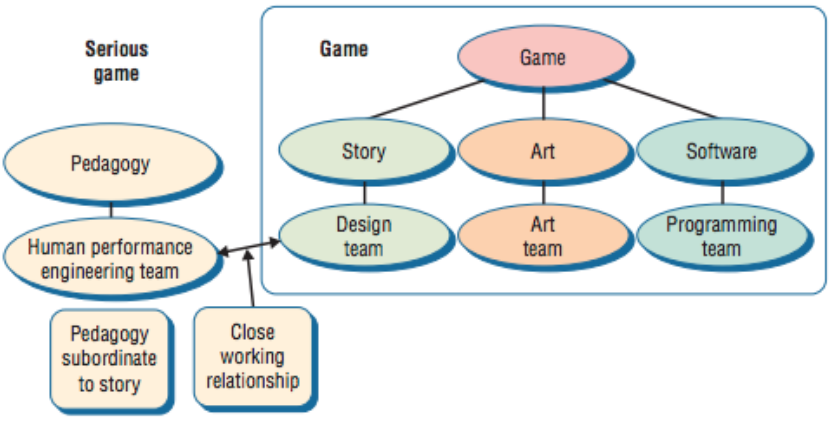


Figure 2.3: Components of a serious game. (Zyda, 2005)

and/or emotional, etc., dimensions which are related to educational objectives." Zyda (2005) describes in figure 2.3 necessary components to create computer games as well as the extensions to make them serious. He defined serious games as *"[...] a mental contest, played with a computer in accordance with specific rules, that uses entertainment to further government or corporate training, education, health, public policy, and strategic communication objectives."*

Michael and Chen (2006) summarized and simplified different definitions by saying that serious games are, *"[...] games that do not have entertainment, enjoyment, or fun as their primary purpose. That isn't to say that the games under the serious umbrella aren't entertaining, enjoyable, or fun."*

However, these games are able to implement different learning steps such as teaching, training and informing on an interactive way. They are making use of different computer game concepts, therefore they have become very popular in the last years. For example students could be motivated by challenging others or simply by increasing the own level and team playing could be moved to collaborative learning.(Hakulinen, 2011)
A combination, or deep integration of social games and educational ones is usual nowadays. According to Gui and S. Zhang (2010, p. 51) these educational-based social games have three characteristics:

1. **Educational value:** Facilitates the capacity of students.
2. **Social characteristic:** Game is based on intrinsic motivation ("share to friends").
3. **Usable for classroom teaching:** Should be combinable with curriculum concepts and rules.

Coupled Concepts

Closely coupled concepts of serious games are e-learning, edutainment and game-based learning. E-Learning is more or less the main concept for technology aided learning or distance learning which will not be discussed more detailed in this thesis. Edutainment is a term raised during the 90s which stands for all kinds of multimedia

learning. At that time the small children were primary target users, but the software mostly failed the positive effects. Game based learning is sometimes defined as a branch of serious games and sometimes as the same concept. (Susi, Johannesson, & Backlund, 2007)
In the application domain of sport and health exergames are closely linked with serious games. They are computer games which allow users to interact with the game through their body movement. Beside fun, they bring a couple of different advantages like the improvement of physical, psychological and cognitive skills. Today well known platforms for these games are the gaming consoles *Playstation 3*, *Xbox 360* and *Nintendo Wii*. They have to be extended by cameras and controllers to play these games. Decreasing prices of those devices leaded to the situation that these games are not only in use at home, they can be found also at school classes, fitness centers and hospitals nowadays. (Lai, Wang, & Yang, 2012)

Application Fields

The following application domains are outlined by literature discussing serious games, but they are target domains for gamification applications as well.

Education: As already mentioned, games are used to educate and teach students since the 1990s - more or less with bad quality and therefore unsuccessful. Charles and McAlister (2004) mentioned that the potential of current educational games increased and different researches demonstrated that the success of educational tools became measurable. Issues like the rate of learning, knowledge retention and stagnation of learning were improved explicitly by the motivational power of games. Kebritchi and Hirumi (2008) explain educational games as *"[...] games that are thought to be effective tools for teaching hard and complex procedures because they use action instead of explanation, create personal motivation and satisfaction, accommodate multiple learning styles and skills, reinforce mastery skills, and provide interactive and decisions making context."* However, educational games make use of the often cited phrase "learning by stealth", a situation where the learner does not realize that he is within the learning process, it is more an unconscious learning. This is probably most significant approach of education games, because it makes learning to fun. (Kirriemuir & McFarlane, 2004, p. 21)

Health Care and Sport: Serious games have become very popular in this application domain and they are still rising, because they could be an ideal solution for different issues within this application domain. First, physical games have positive physiological and psychological effects anyway. (Hakulinen, 2011) Health and sport games can be used by individuals for prevention and by health organizations for rehabilitation. Especially prevention could be improved enormously by offering various fitted motivation factors to individuals. (Göbel, 2012, p. 1) Muller-Lietzkow (2012) mentions four categories of serious sport games as follows:

- **Wellness Games:** Are games which should relax the user and make him or her feel better.
- **Self Improvement Games:** Target on improving the users individual performance, mostly by a virtual rewarding system.

- **Skill Based Games:** These games aim to improve reaction and cognitive skills.
- **Exergames:** Are computer games combining physical experience with challenges.

A detailed discussion of them can be found in chapter 2.3. Furthermore an explanation and listing of practical examples of sports and health care application is given.

Military: Was probably the first application field for education realized by games. Soldiers have always been trained and educated by games and scenarios simulating the real world. From time to time simple training games for individual officers moved to high complex battle simulators for planes, helicopters and tanks. Enormous sums ($ 4 billion by the US, 2004) are spent for training, simulating and recruiting especially by the United States and NATO members.
In 2002 the United States published a 3D computer game called *America's Army*, which became the most successful recruiting instrument of all time. It was not simply a recruiting tool, it also prepared the players on the army's base training. Later on active soldiers used the game for a specific mission preparation too. (Michael & Chen, 2006)

Government: Governmental or political games try to simulate situations which happen rarely and are difficult to manage for political leaders. Such tasks could be traffic control, finance balancing, environmental disasters or city planning. (Michael & Chen, 2006)

Benefits and Criticism according to Related Works

A great number of researches and studies tried to analyze serious games to confirm or confute their often explained benefits. The following sub section mentions some quintessences of them, provides an insight into the main positive aspects, but also into some critical approaches.

Bartolome, Zorrilla, and Zapirain (2011) conducted a review on serious games of the last 10 years to display benefits and find new trends with focus on health care and therapy games. They evaluated a couple of medical applications for different user groups by satisfaction surveys and personal interviews. The researches found that the games are a *"good support compared with traditional methods"*, offering technology advantages, which could rapidly engage the user into the therapy. They explicitly mentioned the following two benefits for health games:

1. **Social Benefits:** The game improves the users motivation.
2. **Medical Benefits:** The application could collect data, which can be used for an objective assessment of the therapy, "the time to pass a level" could be such a parameter

In focus on online educational games A. Zhang and Ge (2011) explained the following four advantages:

1. **Interestingness:** A game could let the player dive deeply into a virtual world. If the knowledge is closely coupled with the game's act, the enthusiasm of students would increase enormously.
2. **Competition and Cooperation:** Games stimulate the learner's interaction by groups and competitions. This promotes the motivation of students as well as the communication between them and their teaches. These concepts also reduce the learners isolation and its mental pressure.
3. **Controllability and Flexibility:** Games can offer excellent flexibility and controllability in reference to checking the players skills. They have total control over their behavior and can try different roles or different degrees of difficulty. If a players fails, he or she can always try it again by learning from mistakes.
4. **Improved Evaluation System on Processes and Effective Feedback:** Educational games often provide perfect evaluation and feedback of the learning process. The application saves the gaming process and the player is able to monitor the learning flow over a long time. The software could also give real time - feedback which would influence the following steps of a player during the learning process in a positive way.

Papastergiou (2009) reviewed actual studies, researches for computer games in physical education and health education, to identify potentials benefits, to present a synthesis of the empirical evidence and to find future research topics according to an educational use of computer games. He concluded that electronic games may offer huge benefits for physical and health education. He summarizes that the studies had positive effects for peoples knowledge, skills, attitudes and behaviors in relation to health and physical exercise.

Najdi and Sheikh (2012) executed a study to analyze the success of educational games on chemistry students in reference to their learning attitude. Three classes from Jerusalem used different educational games for 3 weeks. The teaching content and tools were prepared by special educators and the questionnaire, which the students had to answer after the period, was created by educational researches. The results of the research confirmed the highly positive impact of educational games to the student's attitude. The games decreased the dread of natural scientific education and mediated the feeling of fun and comfort to the learners. The study facilitated the students leadership skills, their respect among themselves and their learning cooperation in a very positive way. However, the experiment could not remove the students total fear of science and was not able to create a new need to solve further scientific problems.

Tashiro and Dunlap (2007, p. 118) researched educational games of higher order thinking like understanding clinical judgment, language learning and understanding scientific work flows. They mentioned 4 major problems for serious game development:

1. Instructional designers often do not arrange the research themselves, what would be necessary, to actually improve learning.
2. Too many commercial educational games are not able to force the learner's critical thinking (metacognitive, procedural and declarative knowledge) enough.
3. Only some commercial games are able to cooperate perfectly with themselves or other education and training programs.

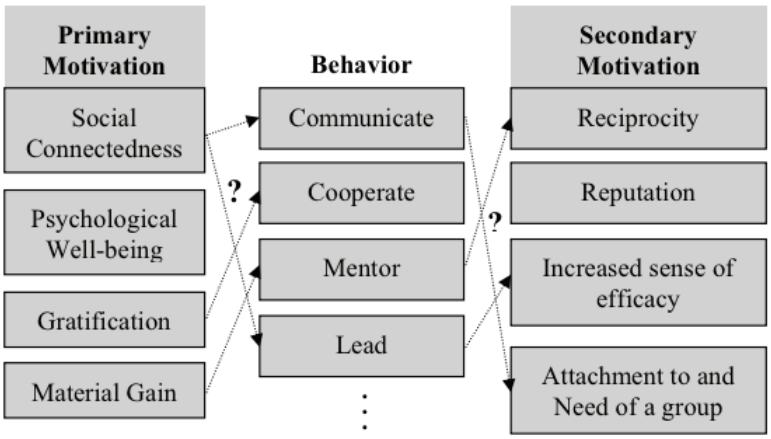


Figure 2.4: Motivation theory and players behavior(M. Kim, 2011)

4. There are no commercial products available, which can ensure an improvement of learning results and competences that are part of an evidence-based education framework as well as an evidence-based practice framework. A traditional learning evaluation over correctness and scores can never give such detailed information over the learners standing, like an educational game. It displays different statuses like: the current progress, where is the learning target, personal improvements or aggravations.

2.3.4 Social Network Games

Social network games normally run in web browsers are coupled with social networks and offer an asynchronous multiplayer gameplay to their users. *Farmville*[17], *Dawn of the Dragons*[18] and *Mafiawars*[19] are probably the best known today. These games are using social media relationships for their distribution exclusive. (D.-H. Shin & Y.-J. Shin, 2011, p. 852)

M. Kim (2011) tried to analyze which factors motivate people to play social network games. The study was based on Lazzaro (2004). The research used primary and secondary psychological motivation patterns from two different foreign social network studies. The primary ones represent why people are using social networks, the secondary ones should be more or less the outcome from playing a social game shown in Figure 2.4. The behavior represents the social interaction done by a gamer. The study evidenced all three theories and their motivational patterns according to social network games.

[17]http://www.farmville.com, visited on 2th April, 2013
[18]http://www.dawnofthedragons.com, visited 2th April, 2013
[19]https://www.mafiawars.zynga.com, visited 2th April, 2013

2.3.5 Alternate Reality Games

Alternate reality games are games which mix activities from real world with contents and stories from virtual worlds together. They are part of the concept mixed-realty, *"[...] the merging of real and virtual worlds to produce new environments and visualizations where physical and digital objects co-exist and interact in real time."* (Petridis et al., 2011, p. 76)

The success of these games is totally based on the wide distribution of smart phones and other mobile devices, because the applications are transferred on different sensors and features of them like: GPS (Global Positioning System), photo camera, video camera or NFC (Near Field Communication). (Petridis et al., 2011)
The so-called storymaster or puppetmaster works as game designer and distributes hints and tasks over the gamers communication space, including all social media platforms, instant messaging tools, e-mail or real places. The combination of these hints create a storyline with the goal to break into real life. Each member can become part of the story or change it by following the clues and completing the tasks. Players can or have to work in a collective to solve problems, because game designers distribute problems all over the world. The community has to build teams to pass these tasks. (J. Kim, Lee, Thomasand, & Dombrowski, 2009)

Examples for popular alternate reality games are:

Gbanga Familia: *Gbanga*[20] is a game development studio based in Zurich, which focuses on alternate reality games. They published a couple of successful games like gbanga famiglia. Players join a Mafia Family and have to take over different stores and other facilities of their real city by physical movement. A positive take-over depends on the strength of the player's family.

Xi: Was published in 2009 and ran on the console Playstation 3. It was distributed over the internal Playstation social gaming network. The goal was to find Jess by watching video clips, collecting puzzle objects and searching for hints in the virtual and in real world.

Ingress[21]: Launched by Google in 2012, players belong to one of two teams fighting for energy: "Enlightened" or "Resistance". They have to generate "energy" by following real world paths, than they can start *missions* by visiting *portals* which are based on public accessible places. The game is only available for Android mobile phones at the moment.

2.4 Aspects for a Successful Community

Since social web applications have become enormous popular researches and studies tried to detect conditions which made them successful. Some communities experienced a gigantic growth and different scientific disciplines tried to illustrate respon-

[20] http://www.gbanaga.com, visited 5th April, 2013
[21] http://www.ingress.com, visited 8th April, 2012

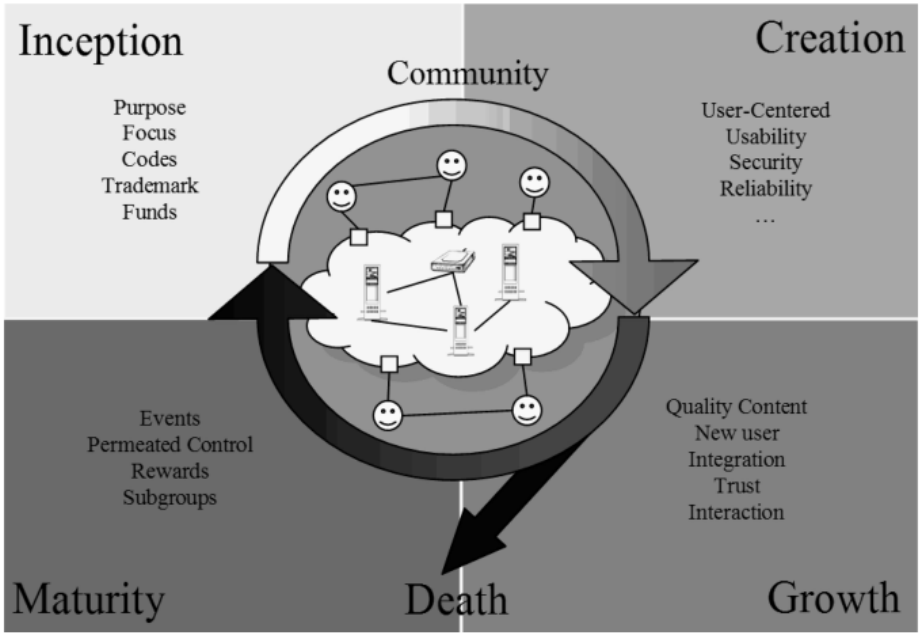


Figure 2.5: Comunity success factors of different scientific disciplines in reference to the comunities life-cycle. (Iriberri & Leroy, 2009, p. 18)

sible factors for this effect from their own perspective. However, the combination of disciplines like: sociology, management, psychology, economy and technique could probably answer the question of reasons for the success. (Iriberri & Leroy, 2009)

According to A. J. Kim (2006) there are 9 important strategies for building a successful community: purpose, places (bringing people together), profiles (getting to know your members), roles, leadership, etiquette, events, rituals and subgroups which correspond to the above mentioned social media definition.

Iriberri and Leroy (2009) explained the recommendation for success in reference to the life cycle of a community, strategies should be adapted to the developing stage in which a certain community stays. Developers have to recognize a community's phase and identify the stakeholders needs. They mentioned 5 stages (Figure 2.5) as follows:

- **Inception:** The vision of a community accrues out of a need. First community rules and technology components are defined.
- **Creation:** Starts when the first components are realized and initial users start to communicate and interact.
- **Growth:** Members choose roles (e.g. leader, follower), run discussions, provide information, read information or support others. This stage is also identifiable in physical communities.
- **Maturity:** Emerge of new rules, relations and sub groups. If new members join the cycle of interaction could start again.
- **Death:** Lack of quality content, unorganized content distribution, less communication are indicators that the community is going to die.

Based on success factors found by researches of different scientific disciplines, Iriberri and Leroy (2009) assigned them to the different stages of the community's life cycle.

In reference to the honeycomb model explained in Section 2.1, Kietzmann et al. (2011, p. 249) defined the four C - Model, which should help organizations to define their social media platforms and find a good partition within the honeycomb framework. The four Cs are:

- **Cognize:** Organizations need to realize their social media environment, it is important to know where interaction and communication about the organization is already happening. It is necessary to identify the critical and negative aspects of the social media project. Monitoring the competitors strategy and the effects of it should be considered.
- **Congruity:** Finding strategies which are aimed at the enterprise's goals and which are realized by social media represents the second step. Focusing on the core honeycomb for business needs and defining the success evaluation metrics will help to define the application further. Social media strategies should be connected closely to other marketing strategies so that they can complement each other.
- **Curate:** The operating company has to work as a curator. It hast to be planned when and how often the firm accesses to the conversation and which employee does it. It could be positive if the communicating person got enough authority to build up communication with customers by solving problems.
- **Chase:** The chase for new information at the social media landscape should always be considered, because the enormous speed of this business area could always influence on the market. Different platforms should be observed to recognize future trends.

2.5 Summary

The social web is more in use then ever before and accessed by divers devices around the clock. Different literature found classifications to structure applications according to their functionality and main features. However, latest applications are combining services and mix features and functionality from different social media concepts. This leaded to various interpretations of social media for now. Nevertheless, concepts like communication, relationships, identity, collaboration and sharing can be found in every social media application .
Social gameplay, gamification and other game appendages are newer approaches which are closely coupled with social media today. Especially gamification and serious games can offer crucial benefits to their players. They are already successful in use for education, health care and military, because these games hide the learning process behind fun what increases the user's motivation like no other learning concept. Game elements are used to improve user experience and increase the motivation for participation on non gaming activities. However, they also have been facing criticism. Critics claim that too many applications use the conceptions improvident in hopes of solving every kind of issue by gaming. They do not deny the

opportunities of gamification, but predict failing if its usage is not well designed. A further game concept, which can provide interesting input for this thesis are alternate reality games. They are depended and distributed mainly on social media applications. These games insert a virtual story into the players real life, so they are mixing the virtual with the real realty. Their success bases mainly on the powerful technical possibilities of smart phones, because these devices allow users to interact with their environment over sensors permanently.

The next chapter discusses social sport and fitness applications and evaluates their features. First an introduction into motivation theory is given, to understand the peoples intention to do sports.

3 Information Systems for Sport Activities

In recent years different kinds of technology, hard- and software based applications, support the people's sport activities. All these technologies have the further goal to drive the user to be more active, keep him motivated and healthy over long time. The topic motivation in the context is these days more interesting than ever, because the number of overweighted people increases every year and raised to 1.4 billion worldwide in 2013 (WHO, 2013)[1]. The WHO affiliates this problem mainly on physical inactivity coupled with increasingly sedentary nature of many forms of work. However, there are different scenarios how technology, especially social software, can act positive on lazy people. Especially the rapid distribution of smartphones may be an approach to fight the problems. Mobile fitness trainings application have become enormous popular these days, because they can be used as personal trainers or motivators. (Sims, 2012; Chi-Wai et al., 2011) For example Consolvo, Everitt, Smith, and Landay (2006) describe an "ever day fitness application" which should integrate fitness activities into the daily life, by measuring steps for example. These applications aim not at forcing an advanced sports training, they should change everybody's basic behaviors.

Different studies researched game, persuasive and social based software appendages, and founded consistent very positive effects. This chapter tries to give a view into the business field of social sport applications and evaluates well known examples. In reference to the thesis project, the focus of this chapter is on web portals and mobile apps.

3.1 Motivation Aspects

By building a social application which supports personal training and provides motivational factors, it is necessary to look for some basic psychological concepts and sport theories to identify the right requirements. "What drives people to do sports?", "What is motivation?", "How can the social feelings be used to motivate?", are questions which are answered in the following chapter and should help to find the right features. The OxfordDictionary[2] simply defines motivation as *"[...] a reason or reasons for acting or behaving in a particular way"*. Alfermann and Stoll (2010, p. 107) distinguish between motives and motivation. A motive is a relatively stable personality

[1] http://www.who.int/mediacentre/factsheets/fs311/en, visited 8th April 2013
[2] http://oxforddictionaries.com/definition/english/motivation, visited 9th April, 2013

trait which can not be directly observed. It explains why people do or leave something. Motivation is more a temporary process or state, were a special acting is forced to achieve a goal or state. This process can be clearly observed by determination, endurance (despite of failurs), personal effort and emotions like joy, happiness and enthusiasms.

According to Sprenger (2010, p. 24) motivation can be pushed by an intervention, and furthermore fall back into a latency phase. He defines "motivating" around the following range of meaning:

1. To issue somebody with motives, which he or she had not before.
2. To meet somebody's motives, and allow him to realize them.
3. To "charge" behaviors with subjective meaning/importance.
4. To spark enthusiasms.
5. To incite.

Rheinberg (2008, p. 16) explains motivation as an *"[...] activating alignment of the current conduct of life, into on an positive rated target state."*, he furhermore mentions that highly motivated people have a goal, they struggle for it and avoid any deviation.

Motivation can be caused by external or internal factors. Intrinsic motivation or self-motivation comes from inside of an individual and is mostly coupled with its personality, it's will to perform. (Meta, 2008, p. 3) Myers (2010, p. 312) found the following definition, *"The desire to perform a behavior effectively and for its own sake"*. Extrinsic motivation comes from external factors and influences an individual to show a certain behavior (Meta, 2008, p. 3). Myers (2010, p. 312) defines extrinsic motivation as *"[...] a desire to per- form a behavior to receive promised rewards or avoid threatened punishment."* However, Alfermann and Stoll (2010, p. 138) recommended concepts which affect positive on motivation and may be a very relevant input for finding requirements for the game based sport portal:

1. **Difficulty level:** The level of difficulty should be differenced for every member. Every one should find a suitable, accomplishable challenge according to his performance level.

2. **Goal orientation:** Personal performance goals should have priority over competitions goals. The exercise alignment should be more in focus than the competition alignment, this will retain the fun in activities. Advanced athletes with a higher sports competence can be motivated by competitions anyway.

3. **Mediation of attribution patterns:** Success and failures should have understandable reasons. If the athlete does not bring enough effort, he or she should recognize the problem.

4. **Forcing positive affects:** The attention should always lie on the success, failures can be uncared from time to time.

5. **Encourage independent intrinsic motivation:** People are more motivated if they can define their own targets. An extrinsic motivation can easily be con-

verted into an intrinsic, if the former reasons are satisfied.

6. **Support for finding competition goals:** If the athlete's goals are competitions, should they be suitable selected. It makes no sense to compete people with an unsuitable performance capability.

The actual reason for doing sports represents the motivation of an athlete relating to this special activity. These reasons can be very different: to improve skills, to join a challenge, to experience social contacts, to seek sensations and to have simply fun. These goals can be reduced on three base psychological needs which represent reasons for human action. The needs for autonomy, competence and relatedness. Autonomy describes the wish of being self - initiating to do tasks, choosing between options, self controlling and positive feedback, will improve peoples autonomy. Competence is the need of effective interaction with the environment, to participate on challenges and competitions. Relatedness expresses the desire to be connected to significant others, what convey security to individuals. (Vallerand & Losier, 1999; Aparicio et al., 2012)

As explained in section 2.3.3, serious games may be an ideal motivator for athletes. Solutions for the worlds health problems like cardiac diseases, obesity and diabetes caused by overweight are easy explained: adequate nutrition and more exercising. But exactly these seem to be an insurmountable obstacle for so many people. Those people are within the ideal application area of serious games, because they catch them from a total different approach. (Hardy et al., 2011)

3.2 Social Media and Sport

"Don't Just Map your Run, Earn Points for It"[3] is an article by Sims (2012) for the New York Times, which emphasis the current popularity and success of mobile sport applications coupled with content web communities. He describes how the social factor, especially "sharing" can drive people to be active and how these applications are able to replace personal trainers partly. Three successful applications are mentioned: *Runtastic*[4], *Endomondo*[5] and *FITOCRACY*[6], these are also discussed in this chapter.
Many "training-content-communities" provide a mobile app beside their web community and backwards, because the mobile device can be an optimal data recorder and the web application seems the perfect place to represent results and share it with a crowed.

Because the "fitness app boom" is pretty new, not so much researches had been done for this business field up today. Chi-Wai et al. (2011) evaluation proposes a system workflow for an app design for exercising professionals based on the American College of Sports Medicine (ACSM) guidelines. In reference to this workflow they use social and technological theories to create a benchmark - measurement for

[3]http://www.nytimes.com/2012/08/11/sports/11iht-athlete11.html visited 11th April, 2013
[4]http://www.runtastic.om, visited 12th April 2013
[5]http://www.endomondo.om, visited 14th April 2013
[6]https://www.fitocracy.com, visited 14th April 2013

evaluating mobile fitness apps. Their evaluation of apps displayed that the results according to social support and persuasive technologies were relativity low what may be a potential for future applications. They also mentioned that mobile apps can not replace fitness coaches totally today, that can be another interesting approach for future work.

3.2.1 Content Communities for Sport Activities

The following section describes and evaluates well known content communities and networks. Of course, countless applications of this kind exist today, which can not be researched all, the chosen examples are popular, successful and in different medias spotlight these days. All these websites provide mobile applications, which are no researched explicit. They do not all aim on the same target group and their provided benefits are not exactly congruent. Their key objectives is quiet the same, but each application is following an own path to realize it, special features and addons that make them comparable and interesting for this evaluation.

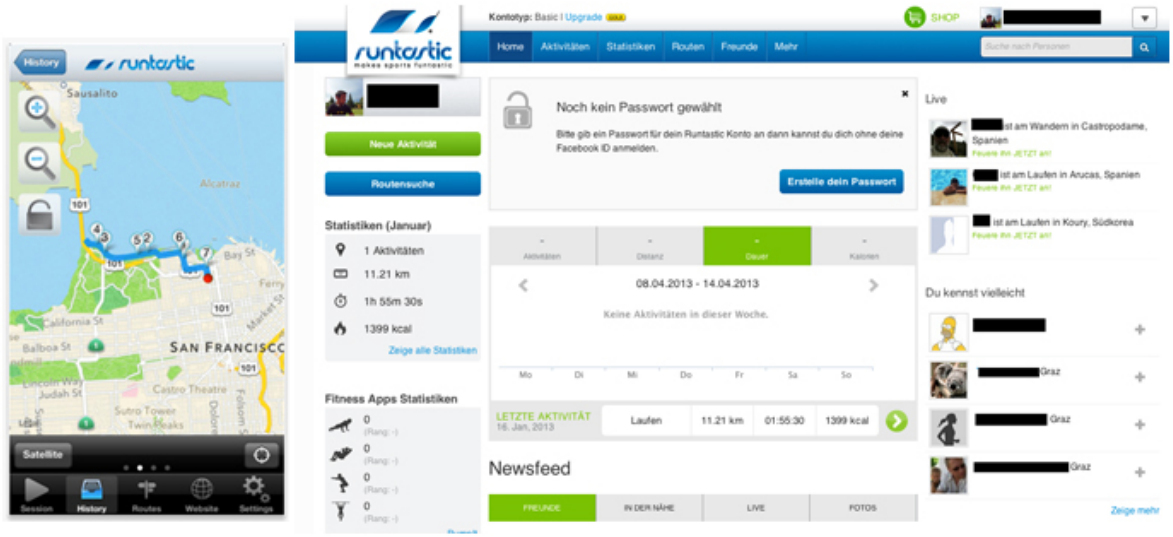


Figure 3.1: Runtastic mobile app (itunes) and the webinterface. (Runtastic, 2013)

Runtastic

Runtastic's success and awareness is obvious based on the mobile application, but also the web portal offers powerful functionality and features. The web application as well as the mobile app are shown in figure 3.1. User can track their sports movement with the mobile app and share it over the website to the community. The website allows also to create GPS tracks by an Google Maps route planner. Past activities can be managed, activities can be planed for the future and detailed statistics of the personal performance can be viewed. The detailed trainings results make Runtastic also interesting for advanced sportsmen. Interesting features are the view of "trainings

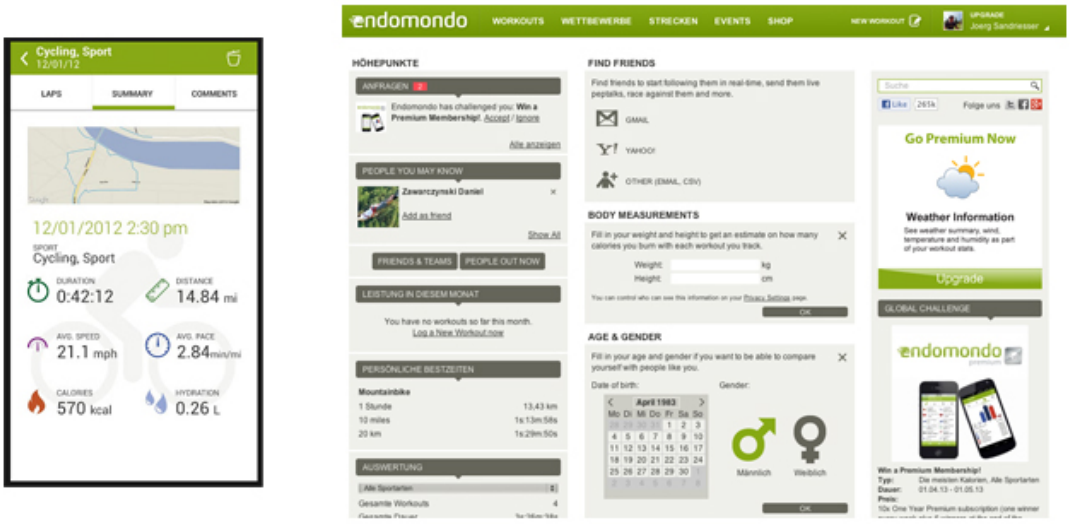


Figure 3.2: Endomondo mobile app(itunes) and the webinterface. (Endomondo, 2013)

progress" and "trainings habits". The social support is quiet good, users see behaviors and performances of their friends and what happens at their local environment. Runtastic does not follow any game - based approaches. The advanced pro-version of the platform is not for free. People can connect to friends, but they can not create groups or organize events and competitions. A special feature is the live tracking possibility, where everybody can follow the movement of the user in real time on the map. Runtastic offers different apps for different sports, therefore users have to download the cycling app and the running app if they want to track both activities. (Runtastic, 2013)

Endomondo

Endomondo is basically of the same application typ as Runtastic, a mobile phone app which offers the possibilities to track the users movement coupled with a web portal to share the activities to the public community and to manage the past activities (Firgure 3.2). A special focus of Endomondo is lying on competitions, many are published by Endomondo user created and can be configuration detailed. "Who runs the most kilometers in the next week", would be an example for such a competition, which can be public or limited for friends. Also here was a permanent improvement of the "social feeling" recognizable over the last year. Anyway, the social support of this application ranks among the best in this application area. Endomondo's business model is also based on a free and a charged premium account. On the free app features like time-interval, personal goals, graphs and "beat yourself" are locked. Live tracking of people who are on the move is a special feature and also available on the free version.

Endomondo is motivating their users by social aspects, competitions and detailed personal results what targets on serious sportsmen as target group. There are no

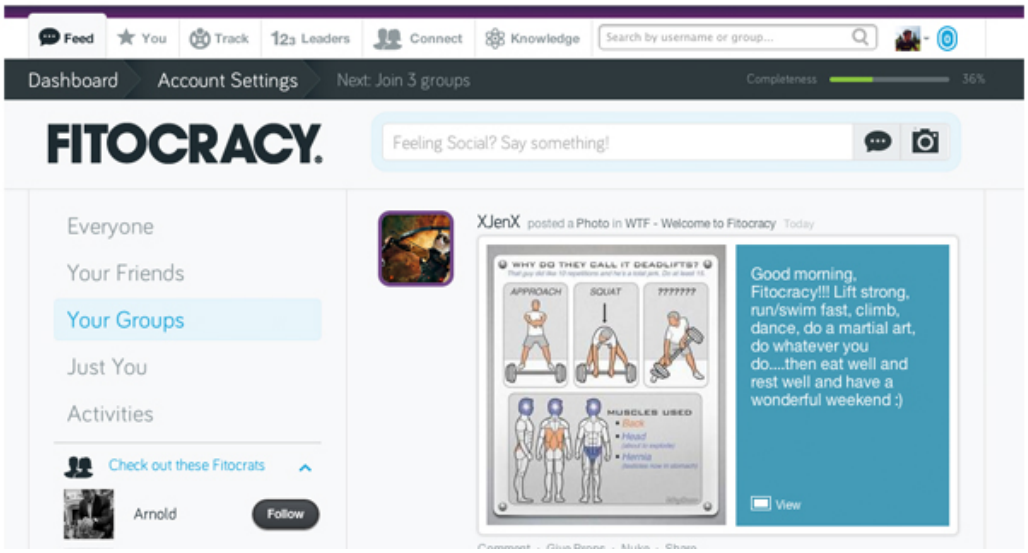


Figure 3.3: FITOCRACY's web interface. (FITOCRACY, 2013)

fun or game elements for people who may be not interested in sports performance. (Endomondo, 2013)

FITOCRACY

It was founded in 2010 by Richard Talens and Brian Wang, two students who found who combined fitness training with game approaches. Fitocracy is a mobile and web application which process the users training game based. A clipping of their web application is shown in figure 3.3. Users have to accomplish quests and challenges, they receive points for it and increase their level. Duels are a quite interesting feature, where users can compete themselves. The whole concept is packed into an extensive social environment, news streams, groups, friends and different rankings are available. Fitocrazy explains: "One of the best ways to keep motivated is to talk about your fitness with others"(Sims, 2012)

Quests consist of every kind of workout like walking, running, push-ups, knee raises and are available for different fitness levels. The trainings type can be chosen, beginners can select from "Everyday's Training", "Cardio Training" or "Strengh". The applications does not support any GPS data to display movement like their most competitors, activities are only represented by simple data. (FITOCRACY, 2013)

fitbit[7]

fitbit is a classical persuasive web and mobile application. It helps users to life healthier by tracking and measuring different daily life activities such as the intake of food and the movement. fitbit applies different wireless wearable devices to measure the

[7]http://www.fitbit.com, visited 15th April 2013

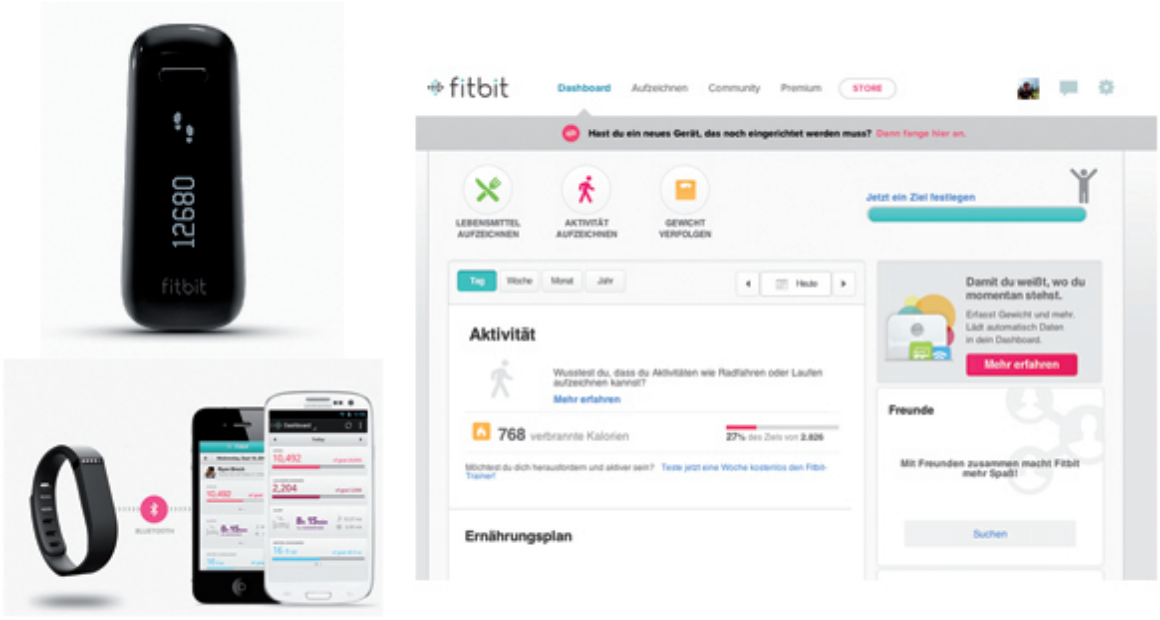


Figure 3.4: fitbids tracking devices and the web interface. (Fitbit, 2013)

users daily behavior, like the "Flex" band and "the One" tracker are two activity and sleep logging devices illustrated in Figure 3.4. This equipment is able to measure data like the number of steps, the quality of sleep or the number of burned calories. A coupled mobile phone app is also provided.

The web application allows to observe personal physical information like the movement, the weight, the diet, the blood pressure and the blood glucose. A pretty nice feature are user-defined tracking variables which could be cups of "coffee per day", or "bars of chocolate per week". By holding this facts against the people they should be motivated to improve them. They should be forced to change daily habits and their lifestyle. This concept does not support any kind of advanced or detailed training analysis, but it may be ideal for people who are not interested in traditional sport or do not have the time. (Fitbit, 2013)

Further Interesting Portals and Concepts

As mentioned above, not all sport, fitness or activity communities can be researched in detail. The selected ones should only constitute some approaches for social activity applications. But there are other web portals not directly focusing on sports, but providing functionality and concepts which may be interesting for the realization of this project.
For example GPS-Tour.info[8] is a web community where users share personal recorded

[8]http://www.gps-tour.info, visited 15th April 2013

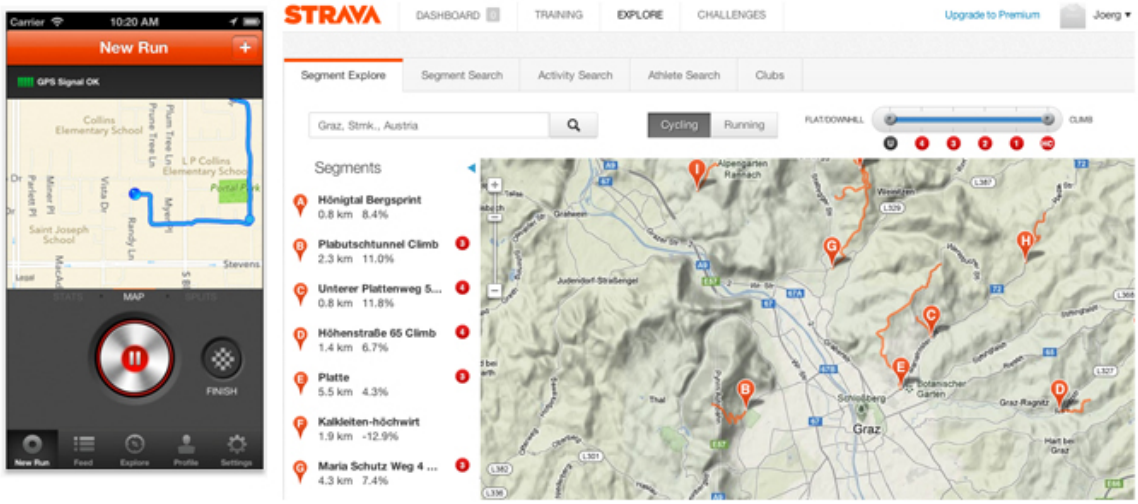


Figure 3.5: Stravas mobile app and the according web portal. (Strava, 2013)

GPS Tracks for any kind of movement. With 231498 Users and 72782 Tracks (GPS-Tour.info[8]) is it probably one of the most popular GPS portals in the European region. The application provides useful search filters and very well GPS data preparation. Strava[9] is a GPS supported trainings network very similiar to Runtastic and Endomondo, which come into media recently, because Strava allows its users to define virtual race tracks. Many competitors broke the road traffic code to win these competitions and it came to a some legal proceedings in the United States. Users complained the high dangerousness of races within a city and also easy cheating possibilities. (Bukovec, 2013)

woosp.me[10] is another social sport network, with a special focus on events. It does not only support fitness activities, it allows any kind of outdoor sport like snowboarding and windsurfing. The portal enables a very well presentation of activities, by large pictures and a social timeline. The famous energy drink producer Red Bull released a very similar application in 2013 which recorded a quick success. redbullplaygrounds[11] is a mobile and web app where everyone can publish its favorite personal sport location. The service supports Red Bull - typical actionsports like: snowboarding, mountainbiking or skateboarding. The upload of tracks or routes is not possible. However a detailed presentation of the personal "playground" is possible by pictures, videos and weather forecasts. User can also follow proffesional sportsmen to see their preferred spots.

3.2.2 Evaluation

The following section presents a more detailed evaluation of the above mentioned online portals. The evaluation is split into three parts. The first one describes the

[9]http://www.strava.com, visited 15th April 2013
[10]http://woosp.me/, visited 12th April 2013
[11]https://www.redbullplaygrounds.com, visited 16th April 2013

general features and base functionality of the applications, the second focuses on social support and the third distinguishes motivation factors.

Generally the evaluation tries to review if a features is implemented in a certain portal or not. But the way how the functions are implemented are too different, so a scale was found to rate the software. The portal earns "0" points if the feature is not implemented, it receives "1" point if the feature exists partly or if it is not as well implemented as by other competitors and it earns "2" points if the feature exits and it is very well implemented.

General Evaluation

	Runtastic	Endomondo	FITOCRACY	fitbit	STRAVA
Android App	2	2	2	2	2
iOS App	2	2	2	2	2
Oth. App	2	2	0	0	0
Oth. Device compatible	0	2	0	2	2
Free to use	1	1	2	2	1
GPS Support	2	2	0	0	2
GPX upload	2	2	0	0	2
Diff. Sport Types	2	2	2	0	2
Route planer	1	2	0	0	0
Calendar View	2	2	2	2	2
Trainings Progress View	2	2	2	2	1
Privacy of Data	1	1	1	2	1
	19	22	12	14	16

Table 3.1: Researched fitness web applications in relation to general functionality.

Social Support

	Runtastic	Endomondo	FITOCRACY	fitbit	STRAVA
Relationships	2	2	2	2	2
Private Messages	0	0	0	2	0
Content Comments	2	2	2	2	2
Users News Stream	2	2	2	2	2
Public News Stream	2	2	2	1	1
Groups	0	0	0	2	0
Users Ranking	0	2	2	0	2
Content reputation	2	1	0	1	2
Activity Suggestions	1	0	1	0	1
	11	11	11	12	12

Table 3.2: Researched fitness web applications in relation to their social features.

Motivation Factors

	Runtastic	Endomondo	FITOCRACY	fitbit	STRAVA
Public Competitions	0	2	2	0	2
Private Competitions	0	2	2	0	2
Live Tracking	2	2	0	0	0
Personal commitments	0	0	2	2	0
Predefined quests	0	0	2	0	0
Performance Ranking	0	1	1	2	2
Game appendages	0	0	2	2	2
Levels/Points	0	0	2	2	0
Adjusted challenges	0	2	2	1	0
Goal orientation	0	1	2	2	1
Collaborative exercise	0	0	0	0	1
	2	10	19	13	10

Table 3.3: Researched fitness web applications in relation to their motivational concepts.

Conclusion

The evaluation of the sport portals and communities in the last part of the paper demonstrates that there are lots of different providers and there fore the market is highly competitive. The comparison contrasts features of the applications, altough they are not 100% comparable. The evaluation is more or less to recognize emphases, trends, weaknesses and shortcomings.

It can be seen that the social support of all products is quite the same and mobile apps for the high distributed operating systems iOS and Android are standard. Further, serious game play approaches are recognizable but sometimes not realized comprehensive enough. The in Section 3.1 explained motivational factors are not visible in many portals, especially the adjusted challenges according to the users capability are sometimes missing. FITOCRACY does the combination of game play according to the users fitness level in the best way. GPS - Training networks like Endomondo and Runtastic are waive game appendages mostly, except their race - competitions, which bring a game feeling to the users. It seems that their enormous success is mainly based on the sharing and comparing of personal sport performance, what may be problematic for beginners and opens some possibilities for the requirement finding process of the described project.

3.3 Summary

The success story of sport applications like Runtastic and Endomondo confirmed the user's social need to publish personal training data to a community. To understand in detail why the people are using these application, it is necessary to explain a couple of theoretical, psychological concepts of motivation. Of course, these concepts exist for a long time and look sometimes very general, but a closer look on the applications features shows that they are mostly considered. Different kinds of sport applications demonstrated different kinds of strengths, what confirmed their popularity. They all have a couple of things in common, they use extensively social media features and they all provide mobile apps beside their web portals. According to this thesis a separation could be made by game and gamification applications and those who are still providing sport and social features. It is interesting to see that all the GPS supported communities mainly do not use game elements. The executed evaluation and the following comparison should compare functionallity, because the researched applications provide intentionally different features. But the results show on which functionality they are focusing. That aspect enables to make a classification and reveals issues and other findings. An extended research for websites which work with GPS data showed that not only sport and trainings oriented approaches can give input for this project. Other interesting examples are Geo Caching appendages, GPS sharing communities or organizational - event based sites.

The next chapter outlines findings and derives requirements for the sport portal. Furthermore an evaluation of content management frameworks is discussed, to find a software basement for the implementation.

4 Requirements and Conceptual Model

The research described in chapter 3 discussed different concepts of social sport applications, illumined their key success factors as well as their unique selling propositions. The theoretical analysis and practical test also revealed potential of improvements. The second part of this chapter explains requirements derived from the findings mentioned following:

1. **Route planning**
   The research bases on the usage of the application without their mobile versions, therefore alternative opportunities like route planers or file uploads were evaluated. Nearly all route planers presented different short comings. No one at all was able to use biking, hiking or forest paths, but exactly that would be enormously useful for every kind of outdoor sport. Also the quality of navigating between points often was deficient or failed totally. These issues may not be taken seriously by providers, because they are offering smart phone apps. In the course of the practical research it was found out that many athletes cannot or do not want to take the device with them. This aspects speaks for the implementation of a tool which allows the generation of every GPS path, which can be passed by outdoor activities.

2. **GPS sport app including game elements**
   Successful training application with GPS tracking like Endomondo or Runtastic allow an advanced training analysis. But none of them is providing game elements in order to increase the motivation of their users. Such features must not go on the trainings analyze charge, FITOCRACY shows how these concepts can be combined perfectly.

3. **Motivational approaches**
   The study of sport motivation theory (section 3.1) revealed some possibilities which may be applicable for sport applications. The "goal orientation" is already well implemented by different providers, but the adaption of the "difficulty level" as well as "forcing positive effects" are often not directly recognizable.

4. **Social comparison**
   Nearly all existing sport communities are facilitating a high social feeling, but a comparison with friends from the sport performance view is often not possible. "How is my current physical shape in comparison to my friends?", is a question which normally can be answered at second view. If an user joins a social game some time before an other and they are doing the same training,

the second user will never catch up the first in reference to points or level.

5. **Collaborative Training and Competition**
   Nowadays sport portals do not sufficiently support collaborative training events. Features like "planned future events", "team training" and "team competitions" are often not available.

According to the analysis of the findings, the goal of the thesis practical part is to implement a social web application which allows users to manage and share sport activities. These activities are represented as GPS tracks and additional information to analyze the performance. The social environment is supported by game elements, to increase the user's experience and make the training more "fun". Competition and collaboration are concepts which are forced by the web application.

4.1 Functional Requirements

In reference to the above mentioned findings this section should give a short view into project requirements. Of course many of them, especially the social ones, are just must haves and do not represent a new feature. However, within the game elements some new concepts can be found which are not in common practice. The sports features are not basically new, but allow some improvements against existing solutions. Generally the right combination of this three concepts should make a difference to all well known applications. They are described following.

4.1.1 Sport Features

These set of requirements do exclude gamification or other social media concepts. They just present, summarize and analyze serious results of the user's sport activities. They are necessary features for every sport application which provides a serious training analysis.

- **Activities:** User should be able to create activities representing personal training. Activities must be realized by the following functionality:
  - **Different Sports:** The system must provide different popular outdoor sport types like: running, mountainbiking, walking and cycling.
  - **Route Planer:** The user must be able to design his track on a rout planer, including hiking and biking paths.
  - **Reuse past tracks:** It should be able to reuse designed tracks for new activities, upload recorded GPX files or add others as favorites.
  - **Joining Friends:** Users can add friends to the activity who also retrieve the training to their personal profile.
- **Analyze Performance:** Users should get detailed results of his or her training: map-view, distance, calories, time, average speed, altitude and altitude chart.

- **Summarized Performance:** Users should get a detailed summarized analysis of all their activities, graduated by sports type, to see the performance over a long time period.
- **Future Events:** It must be able to create future events with a suggested track and to invite people to join or discuss the event. If the event is past, it should be converted into an activity for all attendants.

4.1.2 Social Feeling

These concepts are social media standard concepts apportioned on a sport application. They are theoretically explained in chapter 2. They are must haves, because they represent a main motivation factor as already mentioned. The following points are responsible to represent the "social elements" of the website:

- **Friends:** Users must be able to create relationships to others.
- **Messages:** Users should be allowed to send private messages, because a "private" way of asynchronous communication can be useful, especially to organize trainings.
- **Comments:** Each content (activities, events, teams) should provide a "comment" feature.
- **Teams:** A group functionality is absolutely necessary for social sport platform. Teams should create sub communities, represented by the following features:
  - **Private community:** All the site's features must be available within a group, so that their members can run a "private" community.
  - **Group results:** The group member's results must be summarized, to make them comparable with other groups and further create group competitions.
  - **Group content:** Each content can be attached to a group.
- **Privacy:** Personal information must be highly editable in reference to privacy. The settings must be easy understandable and insertable. The privacy settings can be separated by the following points:
  - **User content:** Each created content should retrieve its own privacy settings. It can be visible for everyone, only for the user self, for friends, for a team or for a combination of that.
  - **Group privacy:** It should be possible to add public content to a private group and private content to a public group.
- **Present Friends' Behaviors:** It is absolutely necessary that users perceive the friends' behaviors, activities, performances, points or wins to get motivated. This could happen by a news stream or other block - views for example.

4.1.3 Gamification Appendage

The following sections describes concepts which made use of gamification benefits explained in chapter 2.3.2. Particular they are standard, known elements of gamifica-

tion. But the adaption for the sport application as well as the combination with other features make them special. The requirements in reference to gamification are:

- **Levels and Points:** Users' sport results should be converted into a level scale to create a game effect. This makes different sport activities comparable and should represent the users' current standing. The level will be calculated out of the average of the users last 10 activities. This brings two advantages: first, everyone can enter the competition, whenever he or she joined the system, and second the level should always represent the user's current sports capability. Points can be earned differently, they can be earned directly by performance (distance, altitude in meters). Second, they are earned by badges. That means that users who are not able to increase their performance can although increase their level by focusing on winning badges.
- **Badges:** Badges are awards for special exercises a user has accomplished. They represent the main game feature, are sports type adapted and are deployed in various features of the website. Different badge types are available for users, they are:
  - **Performance:** Are achieved by finishing special performances like: 5 km running, 1000 m altitude biking. They can be ones only won.
  - **Point:** Point Badges should be scattered by users all over the map. These badges represent special places like bridges, favorite user points or mountain tops. Point badges can be collected by everyone passing special places.
  - **Track:** Track badges represent a total path. Users will achieve them if they pass exactly the given route or include them into their own. These route tracks should be further implemented to racing competitions.
  - **Collections:** Badge collections consist of a set of badges, every single has to be won to get the whole collection. Two types of collections are planned: Fun collections and training plans. Training plans should be seriously adapted training plans for a special goal like a half - marathon training plan. Fun collections consist of badges which can be won at every sport activity and at every user level. That means they are adjusted to the users needs, for example to win the "Around the Central Park" badge, a level 1 - runner has to pass it once, against a level 5 - cyclist who has to drive "15 times around the Central Park."
- **Competitions:** Are another competitive appendage. Users can define own race tracks, currently only for running (because of legal troubles, see section 3.2.1). Other competitions types could be the collecting of distance, time or calories over a defined time period.

4.2 Non Functional Requirements

The following explained non functional requirements look more or less like standard concepts of software development which should be considered and guaranteed in every project. However, they are absolutely necessary, especially for a community application. Because they keep the system flexible, generate possibilities for future

work to increase the users experience permanently. Main important non functional requirements are:

- **Look and Feel:** Although the thesis describes technical facts, it is about a web community. The success is definitively also depending on the design which should facilitate the right "feeling" in reference to the application domain.
- **Usability:** The defined functional requirements describe many different features, which may confute non advanced computer users. Relating to their usage, they have to be wrapped well into the portal. A challenge is to provide user interfaces, presenting functionality to users, which they currently may need and later on no more.
- **Configurability:** The project is realized by the means of a content management framework providing an admin-backend-view to configure the website. It is a goal to pack as much configurablity as possible into this area. It will not be possible to manage all features there, especially GPS services and game settings might be sometimes only changeable within the source code.
- **Extendability/Modularity:** Extendability is an important aspect for web applications, because extends are necessary to keep users entertained over a longer time. The portal must provide new features and change or remove existing ones from time to time. A high modularity should simplify these processes and ensure a good mutability of the application.
- **Security:** It is absolutely necessary, that the application is able to implements and the latest security standards of web development. The problem of cyber crime is omnipresent nowadays. Users have to insert personal information like their e-mail address, therefore the security of those data has to be guaranteed by the software. It will be a permanently task in the future to keep the standard, because malicious attacks develop and change from time to time.

4.3 Conceptual Architecture

According to the significant requirements found in the section before, this part gives an overview of the project's conceptual architecture. The following explained objects are derived from requirements and it is not defined what they are or how they look in practice. A classification of them could look like the requirements structure **sport elements**, **social elements** and **game elements**, they will overlap in practice of course. Figure 4.1 gives a trivial overview of the logical system components.

1. **Users** should be able to create contents of events, activities and badges.
2. **Events** are distinguished from activities by timestamp. They are sport activities which are planned collaboratively by users for the future.
3. **Activities** are training units in the past having performance results and points. Users should be able to create GPS tracks on a map, for activities as well as for events. Users can invite friends to join the event or mark friends who attended the activity.
4. **Competitions** are user defined tracks, if a section of an activity overlaps the competition's track and the user confirmed his participation to the competition

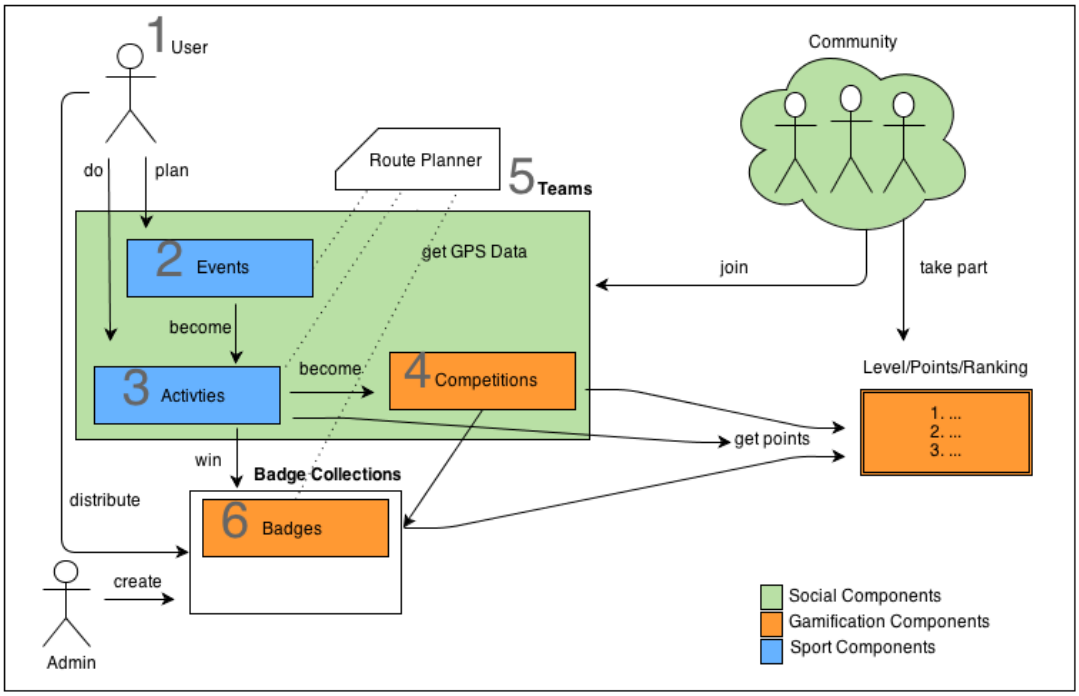


Figure 4.1: Conceptual Model of the activity portal.

than he or she would be added to the ranking.

5. **Teams** are an internal construct of an own social community. These groups should have all the possibilities of the whole system within their private range. That means the members should see an internal ranking based on performance plan events or do activities jointly.
6. **Badges** represent mainly the game concept, they are distributed all over the map by users for users. It is more or less a "geocaching" concept, what means that users have to pass different places during their training to receive points. These awards are not only geographically based, they will be also winnable for special sport performances. The summarization of the users behavior within the system, should result in the current score and level to make users comparable.

4.4 Evaluation of Community Frameworks

The selection of the proper environment or framework is the first very important technical decision which has to be made by web developers for the realization of a complex web project. This is the basement for all other following technical steps and will influence them significantly. An implementation from scratch is always more effort than using a framework or another software solution which offers ready-made functionality like frameworks and Content Management Systems (CMS). Especially on the web based open source software market the user has a wide choice of different tools.

4.4.1 Introduction

There are very different software products in relation to their operating range and supporting usage. Some software products just offer an independent source code and other portals are finished social platforms. Developers are lucky if a finished product meets mainly their requirements, but in practice they will have to adapt the application to get the best result and normally this comes along with huge effort. To use pre-existing software, to implement from scratch or to find a compromise just depends on the certain project. Of course it is necessary that the requirements and the goal of the project are well defined as soon as the decision and evaluating process starts, because the involved people have to know what they are searching for. In practice the crossover between Portals, Content Management Systems, Content Management Frameworks and simple web frameworks is floating, but the following chapters give an overview over the possibilities to realize a social Web 2.0 community portal and a short research for possible solutions to implement a specified web based project.

Content Management Systems

A Content Management System (CMS) is a software to create, publish and administrate content of websites or similar digital formats. Modern CMS can handle more than just simple content like text or picture information. For example they can manage the website behavior, the layout, the navigation or the user management. Those systems could be categorized by the main functionality, but in practice many products belongs to more than just one category. A categorization could look as follows (Spörrer, 2009, pp. 9-19):

- **(Web) Content Management Systems:** Simplify the handling the multimedia content of websites, are simply extendable to more functionality (Joomla, Drupal, Mambo)
- **Enterprise Management Systems:** Can handle different exercises of a company, like a Portal (Liferay)
- **Document Management Systems:** Serve primary to share documents to community (Microsoft Sharepoint Server)
- **Knowledge Management Systems:** Is the software basement to run a knowledge Management in an organization (Wikis)

The big advantage of a CMS is that the administrator or the user who is running the system does not need any programming skills, knowledge about databases or any other knowledge about computer science. Of course this knowledge might be useful to modify or extend a CMS. Nearly every CMS which is in use today, offers the possibility to modify the existing source code or to create new components or modules. They allow any thinkable customization, this starts with the user design/interface and goes to highly complex back-end functionality. (Baumgartner, Häfele, & Maier-Häfele, 2010, pp. 1-4)

The power of actual systems consists of thousands of add–ons, modules or other external services which are easily integrated on a website. Such add–ons could be:

Google Maps integration, forums, calender function, e-commerce shop system, picture galleries or a Facebook connection. So a CMS is a very good basement for developing complex web applications, because it can serve an extensive standard functionality consisting of front- and back-end which can be easily extended by developers.

Frameworks

A Framework is a collection of source code mostly for object oriented languages. It is not a runnable or compilable program. The usage of frameworks is very flexible, they could be used for programming from scratch and of course they can be combined and imported in other software applications. Developers can use the whole framework functionality or just one function. Frameworks are very helpful because normally they offer the functionality which is often needed by the programmer during a web implementation process. So re-usability and "saving time" are the main reasons to use frameworks. Developers often have to implement simple standard routines and processes, this task is assumed by the framework. That is a further cause why frameworks are so popular. In case of a web service these routines could be database connections, database queries, print functions, form checking functions or the authentication process. So modern frameworks should offer following positive properties (Lipautz, 2010, pp. 1-6):

- Quality, balance and security
- Performance
- Actuality and further development
- Useful functionality
- Independence and flexibility
- A detailed documentation

However, an exact defined programming interface (API) is a condition to use the foreign source code. Frameworks often implement software design patterns, in case of web based frameworks they are mostly the MVC (Model-View-Controller) Pattern or CRUD (Create-Read-Update-Delete). (Lipautz, 2010, pp. 1-6) The web based framework market is huge. A first separation can be made by the programming language which implements the framework. This project should build on a CMS, that means frameworks have just a supporting role and does not represent a fundamental layer.

Portals

In computer science a portal is a software solution which allows the user to create and manage websites and web applications by integrating and handling components, other integrated applications, services or processes. The definition of a portal reaches from a simple micro – presentation website, to high multiple back-end management software which is able to control services and activities of organizations. Portals can be deployed as web solutions for the Web, as application for the Intranet or

as a combination of both to handle the total data representation of an institution. (Kirchhof, Gurzki, Hinderer, & Vlachakis, 2010, p. 4)

The main exercise of a portal is the specified preparation of contents to a couple of defined user groups. This includes personalization, the preparation and selection of information and contents for these users. A user could be an internal person of the organization, for example an employee or a manager or an external, a customer or supplier. Normally these two user groups have to sign in if they want to use the portal. But portal applications can also be prepared for users who are not in contact with the organization, then the system works as a Content Management System for a simple website. The high data and information exchange between these different portal users and a homogenous user design for all operators defines also a portal. All these features, options and possibilities make portals insertable for many different web based applications. But in practice portals are mostly used by business companies because the software exposes exactly their demand, and they have the resources to handle the complexity of those mighty applications. Enterprise portals allow companies to separate their processes and services, to decouple information. Company divisions or branches can work with their own portlet (area within a portal) which is exactly configurated on their needs. Such portlets can be employee – oriented, supplier – oriented, knowledge – oriented, development – oriented, production – oriented, marketing – oriented or prepared for other use cases. (Kirchhof et al., 2010) Nowadays many different trends are influencing the portal market. Primary those trends consist of the social web, mobile phone usage and cloud computing. All these web trends brought many alternatives for portal users.

Portal providers started to learn from users and their experience. This learning process brought many innovations including features for the social web and the mobile usage. Nearly every actual portlet provider is offering components to build a social community. Other possibilities like knowledge management systems or e-learning platforms have become a standard today. Some providers started swapping out their components development to third parties and introduced something like a Portlet–App-Store. In practice the number of web portals which are using these components is rapidly growing nowadays. (Valdes, Murphy, Phifer, Tay, & MacComascaigh, 2013)

4.4.2 Requirements on a Content Management System

A large number of different content management systems (CMS[1]) are available. Every kind of a website can be realized or supported by a CMS from simple blogging sites to high complex enterprise class content management solutions. (Tomlinson, 2010, p. 2) There are some standard requirements that should be fulfilled by each software solution in this area regardless of the special needs of the project (Mercer, 2010, p. 11):

- Reliable and robust (Are there a lot of bugs?)
- Efficient (Does the software use my servers' resources wisely?)

[1] http://www.cmsmatrix.org

- Flexible (How will I be able to change and extended my site?)

The project requirements are outlined before and describe a classical social web application with focus on sport activities of the users closely coupled combined with GPS functionality. Furthermore the platform will allow users to plan and organize their activities in groups or alone. The following enumerated concepts are minimal requirements on the CMS:

- Under open source license
- User Management
- User roles coupled with a permission management
- Asynchronous communication features
- Multi languages possible
- Group functionality
- Up to date security standards
- Modular based
- High extendablity
- Changeability of existing functionality
- Active, supporting community in the background

4.4.3 Evaluation

The implementation of the sport portal does not start from scratch, but builds on a software basement with maximal development freedom, with focus on expandability and adaptability. All the above mentioned requirements are fulfilled by the tested solutions, the research tries to find out which product does this in the best way and might be the ideal environment for implementing the sport community.

Joomla[2]

Joomla is probably the best known open source CMS worldwide. Properly speaking it is a web content management system to handle a dynamic website's content, but is able to realize community portals, e-commerce sites, e-learning platforms, government platforms or organization's web pages nowadays. The development of Joomla is directed by the so called "core team", which is responsible for the basic functionality. It is written in *PHP 5*, uses a *MySQL* database and runs typically on an *Apache* webserver. Joomla's architecture consist of the *Core System*, which is basically responsible for the control of the webpage and powerful extensions. Joomla comes with useful core features like a user management, media management, language management, contact management, polls, search, content management and a menu manager by default. The extensions are splitted into components, add-ons, modules, languages and templates. (Kempkens, 2009) (Joomla, 2013)

The *Comunity Builder* is a very powerful and comprehensive component which includes a full social network into a Joomla website. It allows everyone without any programming skills to build a personal social network quickly including all standard

[2]http:joomla.org, visited 17th April 2013

functionality like news stream, private messages and profile pages. (Joomlapolis, 2013)

Drupal[3]

Drupal is primary a content management system, but also a content management framework (CMF) based on the programming language PHP. It is an open source software running under the GNU General Public License. Famous websites which are implemented with Drupal are: whitehouse.gov, economist.com, ubuntu.com and amnesty.com. (Byron et al., 2012, pp. 1-2) Drupal community websites exist nearly in every language and country. Of course there are lots of papers, references and literature to the topic Drupal. The main advantage of these software is, that Drupal is not only ready to implement a social community, it has a focus on it. That is also the big difference to other content management systems. It is possible to integrate personal sites, web blogs, forums, chats and all components are referenced to an extensive role and permission system. (Byron et al., 2012)

Drupal has a very big and active community, where support and documentation can be easily found. What is confirmed by drupalfacts.mogdesign.eu[4] by following numbers: 761,244 people are working in 228 countries with Drupal and developed 14,462 modules and 1400 themes. The main component of Drupal is the core. All other components and modules are based on the core. The next layer of the core consists of so called "core - modules" and "distributed - modules", these are providing Drupal's real functionality. Also the security level of Drupal is very high. The huge and growing community tried always to push and improve the standard. Authorization, login and other security features are up to date and offer a good protection against attacks. The community always describes all these features as well documented. The Software works with popular web technologies and programming languages: PHP 5.2, mySQL (or SQLite), Javascript (also jQuery), css and HTML 5. (Byron et al., 2012) (Kordewiner, 2012)

PHP Nuke[5]

PHP Nuke is another very popular open source content management system which is community driven by default. That means the PHP Nuke is ideal for people with common interests to build a community platform for sharing their information. The software uses HTML 5, PHP 5 and Javascript and is like competitors modular built. The standard installation or core comes with following features: article management, user management and registration system, discussions, polls, surveys, encyclopedia, link management ,RSS and a multilingual interface. The theme management allows a quick change of the website's look and feel. PHP nuke modules are distributed by its community and provide functionalities similar to other CMS. (Paterson, 2005, pp. 2-5) However, modules are built on the core but are not deeply rooted with the core.

[3]http://www.drupal.org, visited 15th April 2013
[4]http://drupalfacts.mogdesign.eu/, visited 17th April 2013
[5]http://www.phpnuke.org, visted 19th April 2013

The number of existing contributed extensions is obviously smaller than Drupal and Joomla ones.

Elgg[6]

Elgg is an open source social community framework written in the programming language PHP and u. The software's main components are: a powerful data model, activity streams, a plugin API, a user management system, access controls and a web service API including functionality like an administration management system (backend), social networking sites, cross – site tagging, control lists, internationalization and a multiple view support (computers, tablets, mobile phones). Elgg is implemented with the following popular web technologies: HTML 5, PHP, Javascript (jQuery), AJAX, xml, json, OpenID - Ldap and offers a graph functionality. Examples for built in components are: micro blogs, dashboards, file repository, groups and friends, calenders, private messaging, widgets and many more. Of course everyone can develop and integrate own functionality as add-ons or widgets. (Elgg, 2013)

Very often Elgg is mentioned as a (personal) learning environment, because the ground features of the software work like an e-learning platform and offer some knowledge management and e-learning tools. The auto-tagging and cross-site tagging function makes it easy to connect groups, users and resources. The concept of Elgg attaches importance to a good search engine and social tag clouds, resources must be available to users easily. The community around Elgg is often described as an active and growing fast one. (Baumgartner et al., 2010, pp. 34-38)

4.5 Why Drupal?

Basically all of the CMS are suitable to implement a community site. Choosing a framework is more or less a "war of opinions" between web developers, everybody got an own favorite. An objective, exact and detailed comparison in reference to their functionality is of course possible, but does not regard the subjective factor of sympathies. During the implementation phase web developers have to work with the CMS source code and architecture, a bad software design, an uncomfortable extendability or changeability might be a horror. Thats why developer's "feel good factor" according to the CMS is so important. CmsMatrix (2013) provides a detailed comparison of all popular content management systems (table 4.1 and 4.2).

To find the right solution a detailed definition of the requirements and an evaluation was necessary. This evaluation displayed that Drupal is currently the most effective framework for building a web community or social network with the given requirements, because Drupal's modularity offers a high scalability and extendability and nearly every feature which is known in Web 2.0 is available as an add on which only has to be adapted. Drupal is able to keep up with every competitor in reference to security, usage and applied technologies. Joomla including the *community builder* extension may be a better "ready built in solution" to create a social network. But

[6]http://elgg.org/, visited 17th April 2013

Security	PHP Nuke 6	Joomla! 2.5.4	Elgg 0.673	Drupal 7.12
Audit Trail	No	No	No	Yes
Captcha	No	Free Add On	No	Free Add On
Content Approval	No	Yes	No	Yes
Email Verification	No	Yes	Yes	Yes
Granular Privileges	Limited	Yes	Yes	Yes
Kerberos Authentication	No	No	No	No
LDAP Authentication	No	Yes	Yes	Free Add On
Login History	No	Yes	No	Yes
NIS Authentication	No	No	No	No
NTLM Authentication	No	No	No	Free Add On
Pluggable Authentication	No	Yes	Yes	Yes
Problem Notification	No	No	No	No
Sandbox	No	No	No	No
Session Management	No	Yes	Yes	Yes
SMB Authentication	No	No	No	No
SSL Compatible	No	Yes	No	Yes
SSL Logins	No	Yes	No	Free Add On
SSL Pages	No	Yes	No	Free Add On
Versioning	No	Free Add On	No	Yes
Support	PHP Nuke 6	Joomla! 2.5.4	Elgg 0.673	Drupal 7.12
Certification Program	No	No	No	Limited
Code Skeletons	No	Free Add On	No	Yes
Commercial Manuals	No	Yes	No	Yes
Commercial Support	No	Yes	Yes	Yes
Commercial Training	No	Yes	Yes	Yes
Developer Community	Yes	Yes	Yes	Yes
Online Help	No	Yes	No	Yes
Pluggable API	Yes	Yes	Yes	Yes
Professional Hosting	Yes	Yes	Yes	Yes
Professional Services	No	Yes	Yes	Yes
Public Forum	Yes	Yes	Yes	Yes
Public Mailing List	No	Yes	Yes	Yes
Test Framework	No	Yes	No	Yes
Third-Party Developers	Yes	Yes	Yes	Yes
Users Conference	No	Yes	No	Yes

Table 4.1: CMS Comparison part 1. (CmsMatrix, 2013)

Ease of Use	PHP Nuke 6	Joomla! 2.5.4	Elgg 0.673	Drupal 7.12
Drag-N-Drop Content	No	No	No	Free Add On
Email To Discussion	No	Free Add On	No	Free Add On
Friendly URLs	No	Yes	Yes	Yes
Image Resizing	No	Yes	No	Free Add On
Macro Language	No	Yes	Yes	Free Add On
Mass Upload	No	Yes	No	Free Add On
Prototyping	No	Yes	No	Limited
Server Page Language	Yes	Yes	No	Yes
Spell Checker	No	Free Add On	Yes	Free Add On
Style Wizard	No	No	No	Limited
Subscriptions	No	Yes	Yes	Free Add On
Template Language	No	Yes	No	Yes
UI Levels	No	Yes	No	Yes
Undo	No	No	No	Limited
WYSIWYG Editor	No	Yes	Yes	Free Add On
Zip Archives	No	No	No	No
Performance	PHP Nuke 6	Joomla! 2.5.4	Elgg 0.673	Drupal 7.12
Advanced Caching	No	Yes	No	Yes
Database Replication	No	No	No	Yes
Load Balancing	No	Yes	No	Yes
Page Caching	No	Yes	No	Yes
Static Content Export	No	No	No	No
Management	PHP Nuke 6	Joomla! 2.5.4	Elgg 0.673	Drupal 7.12
Advertising Management	Yes	Yes	No	Free Add On
Asset Management	No	Yes	No	Yes
Clipboard	No	No	No	No
Content Scheduling	No	Yes	No	Free Add On
Content Staging	No	No	No	Free Add On
Inline Administration	No	Yes	No	Yes
Online Administration	Yes	Yes	No	Yes
Package Deployment	No	No	No	Free Add On
Sub-sites / Roots	No	Yes	No	Yes
Themes / Skins	Yes	Yes	No	Yes
Trash	No	Yes	No	No
Web Statistics	Yes	Yes	No	Yes
Web-based Style/Template Management	Limited	Yes	No	Yes
Web-based Translation Management	No	Free Add On	No	Yes
Workflow Engine	No	No	No	Free Add On

Table 4.2: CMS Comparison Part 2. (CmsMatrix, 2013)

Drupal brings advantages for further developing processes and editing community extensions. The interaction between self developed modules, distributed modules and the core is simple to realize. Drupal's *hook system* (explained in section 5.1.2) is probably the most effective way to do this. The large and active developing community behind the system is also an important reason for choosing this solution. These points are crucial and represent the advantage of Drupal over other solutions for implementing a web community.

4.6 Summary

After the research of the application domain and before the implementation process starts, different requirements for the social training community are defined. They resulted from issues and other findings recognized by the research. The application's functional requirements are split into three sections: sport features, social feeling and game appendage. Sport features are more or less must haves which are not basically new, except the route planner which should be improved and extended towards existing ones. Sport performance analysis should be calculated exactly as possible and include data like: distance, average speed, altitude chart and burned calories. The second concept, the "social feeling" assumes standard social media concepts like relationships, groups and comments. A focus should lie on "collaborative training", where users should be forced to plan and do activities together with friends or teams, to perform collaboratively. The third concept, the game approaches should let serious game concepts flow into the sport community to motivate the athletes. A special level and point concept, geo-caching features, a rewarding system and competitions try to increase the fun of a training. The found non functional requirements describe well known and important concepts of software engineering, whereby extendability, changeability based on modularity are the most important ones. The conceptual component architecture describes the system components and how they interact.

The second aspect of this chapter describes the evaluation process of the web framework, on which the community will be built on. Terms like "portals", "frameworks" and "content management systems" are explained in theory. However, the evaluated solutions combine these concepts because everyone provides content management, community portal elements as programming interfaces. The evaluation showed that there are a couple of different software products which can support the implementation of a web community. Available social features, how "to hook into the code" and an active community were defined as the most important requirements on the framework. Joomla and Drupal established that they are perfect environments to realize such a project. Finally Drupal was the choice, because the supply of contributed social modules is a perfect basement for building a web community. The programming interface and hook system provide maximal freedom and support for developers to adapt or extend components. The developing and supporting community behind the software should be a supporting factor, especially at the beginning of the implementation.

The next chapter describes Drupal's terminology and technologies in detail. All the

used external Drupal modules are outlined and explained. This introduction is necessary to understand the further implementation process.

5 Framework and Tools

After the evaluation process of the last chapter it was founded that Drupal provides a proper environment for the implementation. This chapter outlines basic concepts and the architecture of the content management framework. Details of the software are necessary to explain, because the implementation part should be totally integrated in it. The external modules which extend the Drupal's functionality are also explained within this chapter.

5.1 Introduction into Drupal

Drupal[1] is a Content Management System (CMS) and Framework, it is free to use because it is under the GNU General Public License. The software enables its user to generate and manage content rich websites, web portals and web communities. Drupal provides web administrators a great variety of tools and components to build websites and manage the sites content. But it is not just a Content Management System, it is also a Framework for web developers and programmers. It offers the possibility to hook into every event and action which happens within Drupal by using plug-in modules. Every module can be modified and extended. Examples for modules are picture galleries, shopping systems, forums or user management components. Most of these modules are contributed by the community itself and this large crowd of web programmer's makes Drupal so powerful. They do not just release the software, they maintain and update their modules permanent and of course every developer will find quick support by the community. Nowadays Drupal is used by big companies, universities, institutions and organizations like the *New York Observer*, *The Onion*, *Popular Science* magazine and *the Whitehouse*. So the application field of Drupal reaches from a simple website which displays content, to large web portals, social communities or E-Learning platforms. (Byron et al., 2012, pp. 1-2)

5.1.1 Drupals Technology

Drupal's design and architecture was built to be flexible and scalable. It runs on every operating system that supports the script language *PHP*. The most used webserver for Drupal is Apache (because Drupal comes with .htaccess files and clean URLs) but also the usage of Microsofts IIS is possible. The mostly wide used database systems are MySQL, MySQLi and PostgreSQL but also other systems are thinkable with

[1] http://www.drupal.org

limitations. The popular Javascript bibliography *jQuery*[2] is included into the core by default since Version 7. (VanDyk & Westgate, 2007, p. 2)

5.1.2 Base Terminology

Drupal uses special terms which will often be used in this thesis and which have a special meaning for the system. Before the detailed explanation of the architecture, functionality and implementation starts, this part describes the base terminology of Drupal. The following concepts are standard in every Drupal Website and represent the base functionality of the CMF.

Admin Interface - Backend

As every CMS also Drupal offers its administrator a special interface for managing and generating the sites content. This interface is nearly totally included in the normal users page. That allows the administrator to see changes and effects of his tasks every time. The first user who is created will be a "superuser" and administrator forever. A different interface depending on the permission level of the user is possible. (Graf, 2008, p. 32)

Node

Nodes are a main concept, very important and multifarious usable. Nodes represent content, that means that every content is a node. Examples nodes could be Articles, Blog Entries, Basic Pages or Group Pages. A node has a title and a body by default. The site administrator is able to define own content types as nodes. Settings like permissions, publishing options, menu entries, comments or other meta data about the content can be defined and edited for every single node type by the administrator. (VanDyk & Westgate, 2007, p. 5) (Butcher et al., 2010, p. 32)

Block

Blocks could consist of every type of content. They are primary used to place information or navigation elements into the structure of a Drupal site. This could be all over the page, but normally they are in a sidebar, header or bottom of Drupal website. The administrator is able to configure each block separately in reference to the design and the access permission. They can be totally customized by templates. How customized source code is added over templates will be described later. (VanDyk & Westgate, 2007, p. 6) (Graf, 2008, p. 32)

[2] http://jquery.com

Menu

The menu system, the so called menu subsystem of Drupal is not only responsible to navigate visitor through the website, it also defines the relationship and links of the whole website. So the menu decides which information is displayed to the requester. Menus are hierarchical built and each item can hold children, so it is a tree structure. This structure is totally editable by the admin or developer. Each menu can be displayed within a block to let the user navigate on his own, or can work at the background to direct the visitor to his target. (Butcher et al., 2010, p. 17)

Field

Fields are inseparably coupled with Nodes and every other data concepts in Drupal, for example nodes, comments and users. The simple standard text fields for nodes were not powerful enough so Drupal introduced Content Construction Kit (CCK) which allows the admin to define own fields which are very powerful. So fields primary represent the type of data which have to be saved in the database by users. Now it is possible to create own complex node types. Examples for such fields from the node type "event" could be "attending people", "place" and "event time". The data which are represented by the field are defined by the field type. Standard field types are numbers, text, files, long text, date or references to other nodes, but contributed modules can extend these options and the permission access for each field. So fields primary define the type of data which is saved in the database by the user. CCK Fields have a own programming interface (Field API), what is very important and powerful for developers. (Butcher et al., 2010, p. 17)
The sites admistrator can also define how the input possiblity should look like to the websites user for this field. This is realized by so called Widgets which could be dropdown lists, checkboxes, radio buttons or text fields. Those are also expandable over modules. (Byron et al., 2012, p. 96)

Taxonomy and Tagging

Taxonomy is a very useful concept of Drupal to organize, manage and classify content. That means that information in Drupal can be organized by its description the so called vocabularies. Each vocabulary consist of terms or tags, for example: car, train and bike. If a user creates a new content he can relate it to these terms. He is also able to create new tags. That introduces a free-tagging system which is quite similar to those from Twitter or Instagram. The opposite would be a controlled vocabulary, where the tags are defined by the admin. This concept makes it very easy to search for content and categorize it. (Byron et al., 2012; VanDyk & Westgate, 2007, pp. 221-222)

Roles and Permissions

Drupal is not only powerful in managing content, it also allows everyone to create a social media platform. Therefor a extensive user management system is integrated right from the start. Users can be summarized by roles an there are three by default: visitors (not logged in), members (logged in) and administrator (have full management access of the site). These roles are user classes and each class is coupled with a collection of permission rules. Drupal's right-system is handled over permissions, that means that the administrator can define rights per role for every page, block, view or function of the whole system. Most of the contributed modules extend the collection for their special needs, so they are as configurable as core components. There are extern modules such as the Content Access Module[3] which extend the right system and enable more settings and options. The practice showed that this could be very dangerous in some cases because different right and permission modules or layers can crossover themselves what may lead to undefined behavior. (Butcher et al., 2010, p. 211)

Hooks

Hooks are internal events which offer the opportunity to customize, expand or edit the request life cycle of Drupal. Before and after nearly every step of the life cycle developers get the possibility to influence the defined behavior. For example: whether a user writes a comment about anything at the website, the hook function "comment_insert" is called. Drupal checks if any module implements this function and executes it. Within these hooks the developer has the possibility to edit the whole behaviour of the comment creating process. (VanDyk & Westgate, 2007, pp. 4-5) (Butcher et al., 2010, p. 14)

5.2 Architecture

To understand how Drupal works and how developers can use all the advantages which are offered by the system it is necessary to know something about the architecture, the core and the base functionality. The following part gives a short introduction into those concepts.

5.2.1 A Drupal Request

Firgure 5.1 shows how Drupal drives a request and it also displays the base structure and software layers of the system. A request to a Drupal webpage normally run as follows (Butcher et al., 2010, p. 12):

[3] http://drupal.org/project/content_access

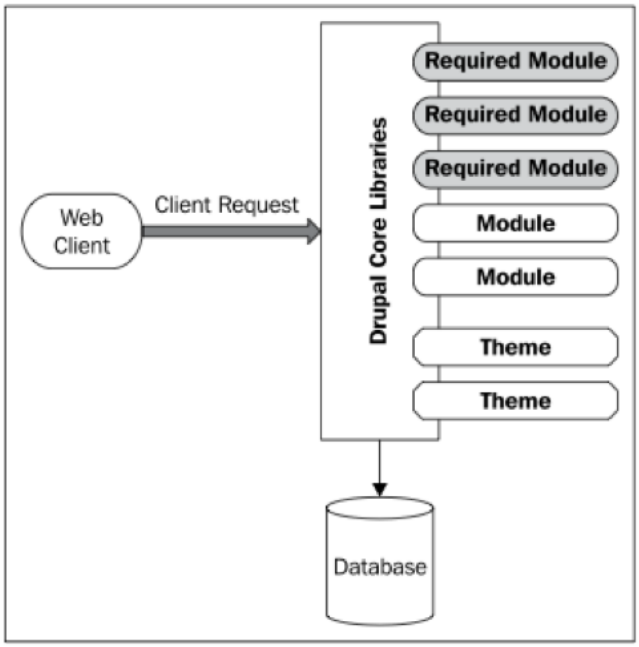


Figure 5.1: The different layers of a Drupal Request. (Butcher et al., 2010, p. 11)

1. The webserver receives a request for an url. Drupal works with clean urls, for example "http://example.com/node/1". The .htaccess file translates it into "http://example.com/index.php?q=node/1", the url parameter *q* describes always the internal Drupal path. (VanDyk & Westgate, 2007, p. 8)
2. Each request runs into the *index.php* file, the Boostrap process starts.
3. The menu system decides how to handle the internal path "node/1"
4. The node system responds by loading the content with the id 1, typically from the database or the chaching system.
5. Finally the theme and templating system converts the data into readable information by using html and css.

5.2.2 The Core

The Drupal Core represents the base layer of the software on which each other component builds on. It consists of core libraries and a couple of core modules. The index.php file always starts the bootstrapping process that means it loads the core libraries and initializes the whole system at each request. (Butcher et al., 2010, p. 12) The core libraries are responsible for functions and services which are needed by Drupal permanent. For example: The sanitization of user input, the module management, generation of forms and the communication with the Database. (Butcher et al., 2010, p. 12)

By default Drupal comes with a few core modules. These modules cannot be uninstalled because they include functionality which is needed by the whole system. Core

modules work like contributed modules, they influence the behavior over hooks. Examples for such modules are: User Management, Login System, Forum, Comment, Node, Number, List or Blog. (Butcher et al., 2010, p. 13) All modules, the contributed ones included, are based on the same API functions. This API allows a high source code consistence and security. (Graf, 2008; VanDyk & Westgate, 2007, pp. 2-3)

5.2.3 Theme and Template

Like most of the web frameworks Drupal totally splits the application from the presentation logic. That brings several advantages whereof the most important are: to structure the code and make it maintainable and expandable. One layer could be edited or exchanged and the other one can remain constant. After the data is processed by the module (business logic) are theme functions (*themename_hookname()*) responsible for the presentation.

Another concept that makes Drupal so flexible is its data granularity. Each piece of information which should be displayed is processed separable. This mechanism brings several advantages. First each module can use its own theming, so the components will not intersect themselves. But if they want the same presentation of a layer beneath them, they can access it. An example for this scenario could be that comments of articles look as the comments of pictures. (Butcher et al., 2010, p. 62)

5.3 Contributed Modules

Contributed modules are developed and distributed by the community[4] and represent the real strength of Drupal, because they implement nearly every thinkable web feature. They are easy to install, provide often an own programming interface and are mainly well documented. They are building on dependences among themselves. That means, to install *Organic Groups* a couple of other modules have to be installed before. In the course of the implementation phase lots of different modules are included, the most important ones, which represent main functionality are explained in this sub chapter. Many features are available at different alternative modules, what makes it sometimes hard to choose the best one, but the following are almost unraveled and essential for every Drupal community site.

5.3.1 Views

Views is Drupal's most downloaded module and comes with Drupal 8 by default. It allows the sites administrator to retrieve data from the database and display it in most diverse types like lists, posts, galleries, tables, maps, graphs, menu items, blocks or reports. This happens over a user interface (Figure 5.2) which allows admins without any programming skills to create SQL-database queries and to define the results display. That is not only interesting for users without any programming

[4] http://drupal.org/download, visited 22th April 2013

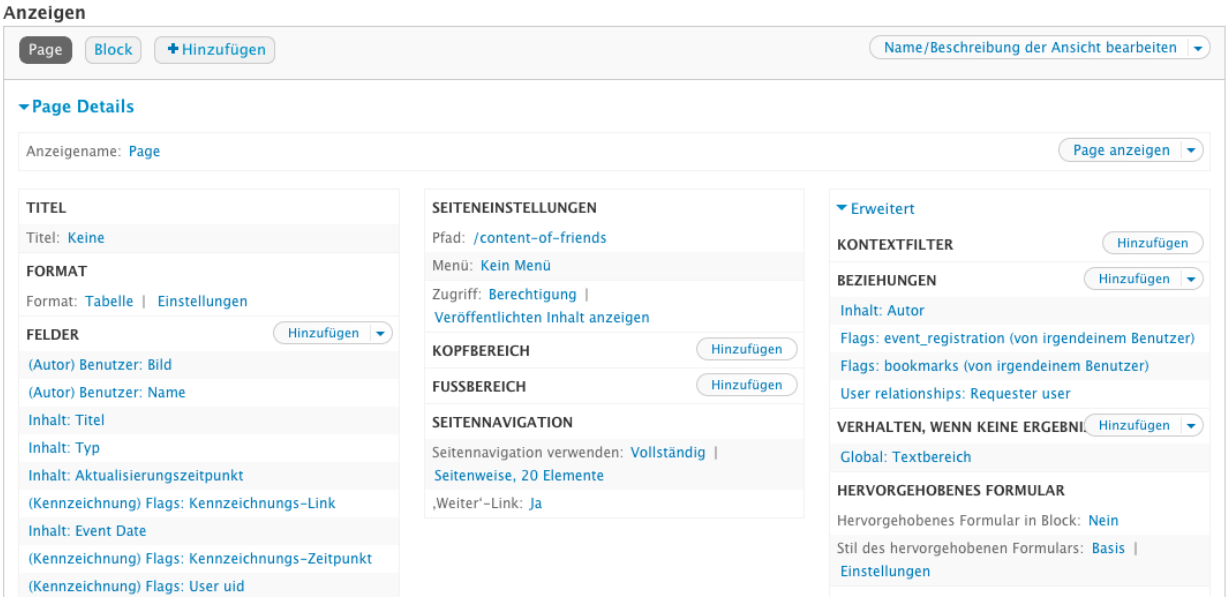


Figure 5.2: Views module, administrators interface to create database queries.

knowledge, also advanced developers may create complex queries quickly and easily. There are only a few disadvantages of views against the usage of normal source code. One of them is that views are not able to replicate all SQL queries, especially complex table dependencies may sometimes be hard to implement. Secondly, views cardinality runs at performance costs, it will never be as efficient as self written and optimized code. A further problem is that Views simplifies the fetch of data if its user is in practice with the tool, it takes a couple of hours to read in and understand the possibilities. (Miles, 2013)

5.3.2 Organic Groups

Allows users to create and manage their own groups. Each group has subscribers and one administrator by default, further group roles can be defined. Every node type can be defined as group type, this means that users can join to it, or as group content, that is content which can be posted or published within groups. The groups administrator is responsible for the user management, he can invite users, or remove users, if a group is set selective, he has to confirm membership requests. Groups can be private (only visible by members) or public (visible for everyone) and can have private or public content, for example if a private article is posted to a public group, non subscribers could look into the group but they would not see the article. Anyway organic groups come with very powerful permission settings (Figure 5.3), the access of every group field can be defined according to the user role. (Burstein, 2013)

PERMISSION	NON-MEMBER	MEMBER	ADMINISTRATOR MEMBER
Organic groups			
Edit group Edit the group. Note: This permission controls only node entity type groups.	☐	☐	☑
Administer group Manage group members and content in the group. *Warning: Give to trusted roles only; this permission has security implications in the group context.*	☐	☐	☑
Create *Activity* content	☐	☐	☐
Edit own *Activity* content	☐	☑	☑
Edit any *Activity* content	☐	☐	☐
Delete own *Activity* content	☐	☑	☑
Delete any *Activity* content	☐	☐	☐
Create *Badge* content	☐	☐	☐
Edit own *Badge* content	☐	☐	☐
Edit any *Badge* content	☐	☐	☐
Delete own *Badge* content	☐	☐	☐

Figure 5.3: Organic Groups, group permission settings.

5.3.3 User Relationship

This module allows administrators to define relationships types, for example: “friend” or “follower”. They can be defined as one-way or mutual relationships. At one-way relationships the requester is in a relation with the requestee but not reverse. They can be set as “needing approval” by the requestee or not. The base functionality of this module is not something spectacular, but related modules can extend it a lot. *User Relationship Privatemsg* allows related users to communicate over private messages, *User Relationship Node Access* provides permission control settings or *User Relationship Implications* enables automatic generated user relations like manager to assistant. (Karshakevich, 2013)

5.3.4 OpenLayers

It is the module which support the GPS map component for the web portal. Open layers is generally a Javascript framework allowing to integrate any kind of mapping service (Figure 5.4) such as Google Maps, Open Street Map and Microsoft Bing Maps in the same way, developers must not care about the specific programming interfaces. Each mapping service can be included with the same interface on the client side. (Palazzolo, 2013)

According to Jansen and Adams (2010, p. 17), there is no other mapping framework which is comparable with Open Layers in reference to freedom and possibilities of usage. The well documented source code as well as the huge community of developer simplifies the implementation process enormously. The library provides base functionality to display geographical information on a map with controls, which allow users to navigate and zoom on the map. (Jansen & Adams, 2010, p. 58)

Figure 5.4: Openstreetmap integrated by Open Layers module.

5.3.5 Flag

The contributed *Flag* module is providing a full "flagging" system, and allows site administrators to define and customize it. Flags can be used for any content type like nodes, comments or users. To flag a content, is more or less like bookmarking a content. The first click event, on the specified link, creates a relation between the current user and the content, the second one removes it. Because the module is versatile it may be used for features like: favorite content, bookmarked content, friendships, "attending or joining" or something else. The module also extends the Views functionality to generate flag related content views. (Drupal, 2013)

5.3.6 Memcache

This module enables the PHP memcache feature for drupal. The standard caching system is quite useful, but for the handling of content rich and community sites this is sometimes not enough. Memcached (2013) defines it as *"[...] a high-performance, distributed memory object caching system, generic in nature, but originally intended for use in speeding up dynamic web applications by alleviating database load."*

That means that information, which typically come from databases are also written into the memory temporary. The piece of information is identified by a key value pair which enables a quick access. Memcache improves the memory management as well as the memory usage of the webserver. Because it allocates memory from parts which are not working to capacity at the moment and offers it to parts which have less memory as needed. Figure 5.6 describes how the server does the memory management without memcache, each node is separated, after the install of memcache the server is able to allocate memory out of a big virtual pool. Practical tests showed enormous improvements of performance by using this technology. (Memcached, 2013)

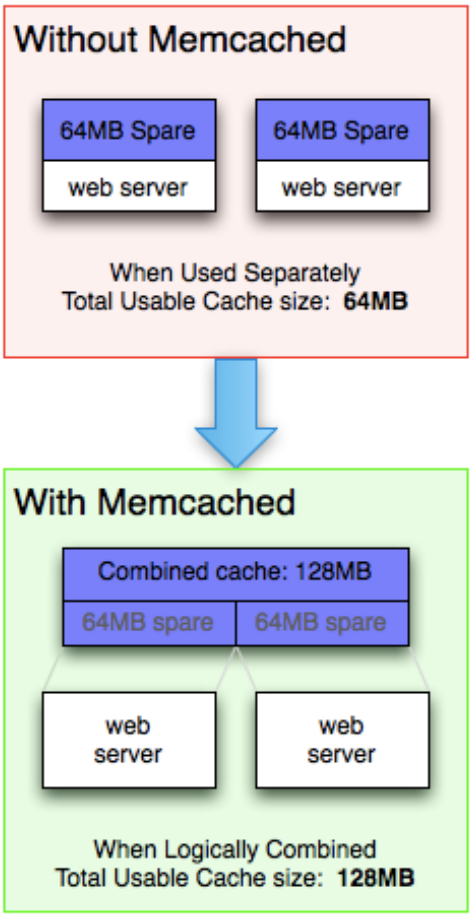


Figure 5.5: Memcache memory management. (Memcached, 2013)

5.3.7 Content Access

The *Content Access* module is another extension to manage permission settings more detailed. The developing community offers lots of permission modules like this one so it may be dangerous to combine different ones, because they will come in amiss. The result is probably that the administrator cannot reproduce access conditions of content. This project will just combine Drupal's normal permission functions, the content access module and Organic Groups access permission, because they are all providing necessary functionality. (Ziegler, 2013)

This module allows to define special conditions for each content type per user role and it should integrate itself very sensible. That means that all existing permission rules should stay the same after the installation. If it is enabled, this extension allows users to define the content access per each node separately.

5.3.8 Further Modules

The following modules take work out of developers hands and expanded the web-portal by further usefull features.

PERMISSION	ANONYMOUS USER	AUTHENTICATED USER	ADMINISTRATOR
'me' Aliases			
use PHP for me alias paths use PHP for me alias paths	☐	☐	☑
Block			
Administer blocks	☐	☐	☑
Comment			
Administer comments and comment settings	☐	☐	☑
View comments	☐	☑	☑
Post comments	☐	☑	☑
Skip comment approval	☐	☑	☑
Edit own comments	☐	☑	☑
Content Access			
Grant content access View and modify content access for any nodes	☐	☐	☑
Grant own content access View and modify content access for own nodes	☐	☐	☑
Content translation			

Figure 5.6: Content access module, settings interface.

Devel
Is the Drupals best known debugging tool. Because of the system's complexity a successful development without such a module would not be thinkable. It allows to observe all database queries, to print all current available variables, to run a backtrace of all function calls and many more. (Weitzmann, 2013)

Facebook Connect
Enables the Facebook login feature. So users have the possibility to join the website without a registration process, their authentication is totally handled over Facebook. (Nam, 2013)

Calendar
Is a very useful addon to display a calendar. It provides nearly every common calendar feature. Year, month or day view "time period" events and different styles of calendar entries (Figure 5.7). The module is closely coupled with the contributed *Date* module which enables a comfortable way to manage dates in Drupal. The *Views* module is used to fill the calender with entries, what opens a lot of possibilities the select content, because of *Views* filter and condition criteria. (Stevenson, 2013)

Invite
Allows authenticated users and administrators to send invitations from Drupal site. That is important to get the community growing and retrieve positive network effects. Every sent invitation can be tracked and observed in reference to success. (Kud-

Figure 5.7: Calendar Module.

wien, 2013)

Boost
This module increases the performance of sites which are available for non-authenticated users. This happens by a static page caching, boost is able to cache and compress HTML, XML, AJAX, CSS and Javascript. (Carper, 2013)

5.4 Summary

Why Drupal is the selected framework for the implementation was explained in the last chapter, this one gives a short introduction into the architecture, terms and concepts of the content management framework. These concepts are responsible for the behavior of the system so it is necessary to understand them for the implementations process. To work efficient with Drupal, developers have to work with the system and not against it, that means it is positive to use default concepts and integrate own components where Drupal's engineers dedicated it. Of course, that would be possible to uncouple "self-developed code" from the rest, but that would restrict the power of Drupal. That means the the base architecture of Drupal never changes, although it is extended or adapted by different components.

Contributed modules can provide sheer infinite functionality to content management systems. The above explained ones are very well known in Drupal circles and are mostly leading the download charts of their category, because they are providing well realized base features which are needed by thousands of websites. Basically they can be installed and will run. Just a few settings have to be done to change behavior or the look of them. However, for the project's needs it is necessary to modify their source code or to use their programming interfaces to get their functionality in other contexts.

The following chapter discusses the implementation details. It outlines how the above mentioned software components are integrated and used. The software architecture as well as the database schema is explained first. The functionality of created and edited modules is described further.

6 Implementation Details

This chapter discusses the implementation process based on the acquired requirements (see section 4.1). Because of the usage of Drupal, a lot of base functionality already exists, but has to be adjusted. This process seems to be trivial for a content management system, but basic steps like selection of node types, usage of fields or choice of modules have to be well wrought, because they are building the basement for further development. Therefore the implementation process can be divided into three different tasks:

1. **Configuration of existing components**
2. **Adaption of existing components and usage of their API**
3. **Implementation of new components**

6.1 Architecture

Like many other web information systems also this application can be structured into a three tier layer (see Figure 6.1). To use of the content management system's benefits, the whole application is built in Drupal's architecture, structures and concepts, which is outlined in section 5.2. However, Drupal stretches over all three layers because the core as well as modules include and interact with Javascript technology. But there are also other external components, which are especially necessary to provide GPS services. These Geo Information Services (GIS) are free to use web services and databases, which allow to query geographical information like altitude information or navigation algorithms to navigate over maps. The communication with these external services is described by Gritsch (2013) in detail.

1. **Presentation Layer**
   The first or presentation layer is responsible to print the website into the users' browser. As mentioned in chapter 5.1.1, Drupal's design can be seen as a Model-View-Controller (MVC). The view layer is represented by templates and theme functions building all sites. The whole source code which is executed on the client belongs to this layer. This code consists of the Javascript code and corresponding libraries. User input attains from this layer into the application over normal HTTP requests and Ajax. Especially during a track creation process this layer permanently interacts with the application layer over Ajax requests.

2. **Application Layer**
   This layer mainly consists of Drupal's source code, split into core and modules. It is responsible for all the application logic. Main tasks of this layer are to receive user input from the first layer and to store it into the third, and to query

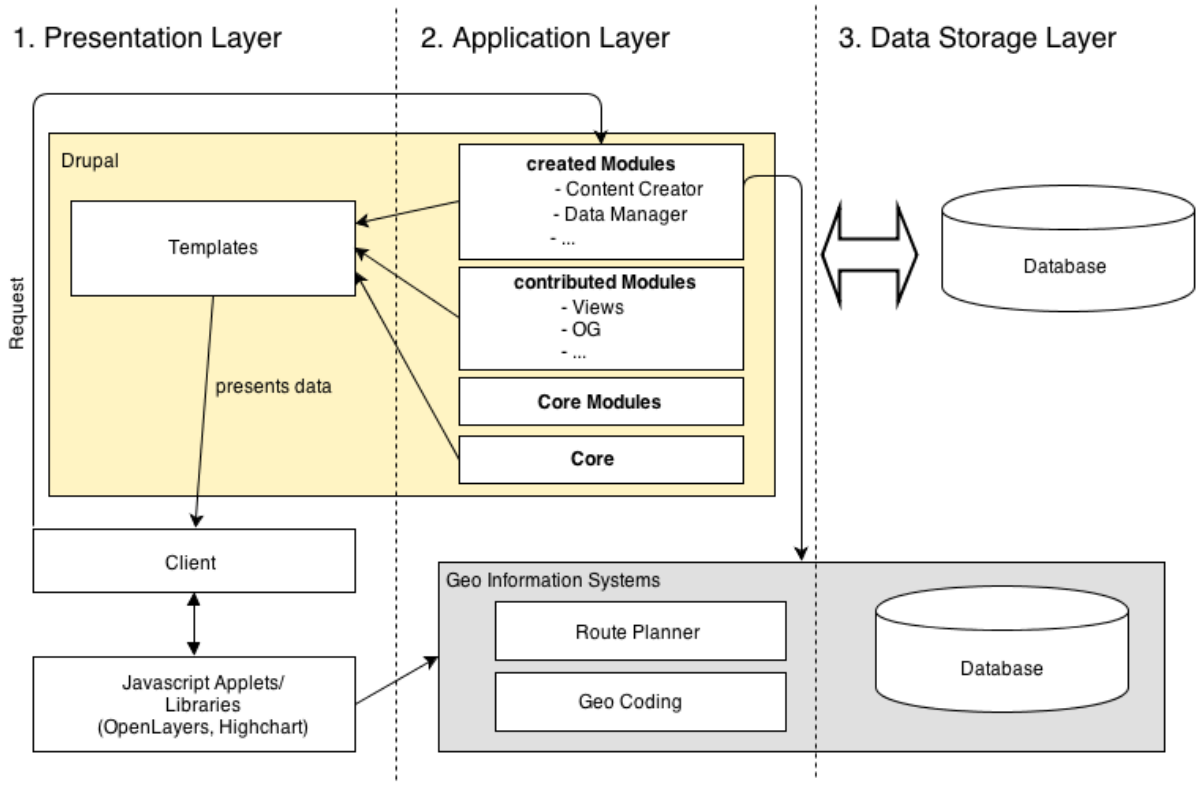


Figure 6.1: Architecture of the sport portal, including Drupal and external components.

data from the third and to provide it to the first layer. This layer also does the whole communication with third party geo-information services. The huge quotation of external GIS services providing the same functionality make them replaceable. All the selected ones are free to use. They have little differences according to accessibility and quality of results. The following were chosen for the moment:

- Elevation API
- Route Planner API
- Geo Location Services

3. **Data Storage Layer**
   The third storage Layer includes the database which is responsible to store the information. A more detailed explanation of the database schema can be found in section 6.2.2 within this chapter. The external GIS databases illustrated in 6.1 hold data like the altitude of coordinates and points of interest. Points of interest are for example bus stations, bars, hospitals, police stations and restaurants.

6.2 Configuration of Drupal

Defining the configuration and the settings of the CMS is process which has to be done permanently and not only at the start phase. These tasks enable or ban possi-

bilities of extends and changes. Many steps of the implementation process have to be combined with settings and tasks in the Drupal backend. These exercises often generate the basement like data structures for further development. Although they are sometimes realized by a couple of mouse clicks, they can have huge affects on the system.

6.2.1 Node Types

As already mentioned nodes are representing content in Drupal. The following node types are created for the sport portal to keep it scalable and maintainable. Some of them can be created also by users who have not administrative permissions such as activities, events, badges, teams and competitions, others are just existing in background to structure the content like badge collections and friendship groups. Each of them consists of many fields which can not be listed all, but the mentioned ones are important and should give a small view into the structure of the node type.

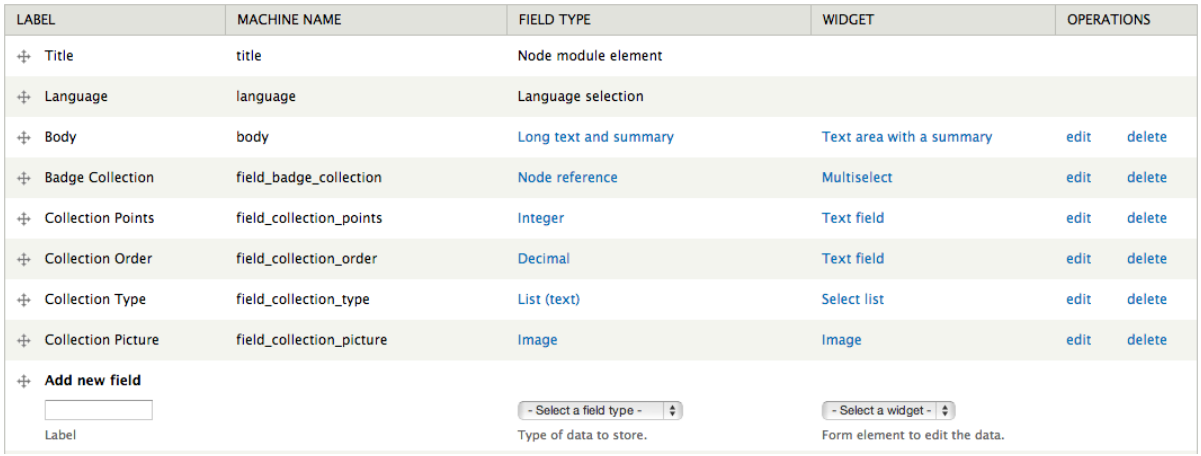
Activities
This node type represents a sport activity and is probably the most important content type of the application. "Activities" contains fields like title, type of sport, duration, GPS waypoint information, distance, altitude, top point, attenders, group reference and description. A detailed explanation of the creation procedure is given in section 6.3.1.

Events
Events, represent activities which are planned in the future. They are converted into activities automatically if they are in the past. The structure of this node type consists of very similar fields as activities, because events can hold tracks including all the according meta data. "Invited Friends" is an important field, because it references users who receive an invitation as a private message for the event. If the event is private, only the invited user are allowed to access it.

Teams
Is a node type which is set to group type, to get group functionality realized by the Organic Groups module(see section 5.3.2). Nodes of this kind get only descriptive fields like title, team picture and team description. Teams can be public, seen by everyone and private, only seen by invited users. The access permission options according to team content are quite extensive and explained later.

Competitions
Represents all kind of challenges within the system. This node type is also set to group type, to provide its creator to an extensive user management. Because competitions can be also a race over defined GPS paths, this node type has all the fields the handle GPS data like edges, GPS waypoint informations and start- and endpoints.

Friendship Groups
This node type was introduced to handle the privacy of users content. Each user runs an own "friendship group" at the background, that means nodes of this kind cannot be accessed directly. If users share content to friends only, it is automatically posted to this group, so friends are the only ones who are allowed to access it. The



LABEL	MACHINE NAME	FIELD TYPE	WIDGET	OPERATIONS
Title	title	Node module element		
Language	language	Language selection		
Body	body	Long text and summary	Text area with a summary	edit delete
Badge Collection	field_badge_collection	Node reference	Multiselect	edit delete
Collection Points	field_collection_points	Integer	Text field	edit delete
Collection Order	field_collection_order	Decimal	Text field	edit delete
Collection Type	field_collection_type	List (text)	Select list	edit delete
Collection Picture	field_collection_picture	Image	Image	edit delete
Add new field				
Label		- Select a field type - Type of data to store.	- Select a widget - Form element to edit the data.	

Figure 6.2: The field management of the node type "badge collection"

content would not be visible for anyone else. This concept was chosen because of the comprehensive setting possibilities according to permission access of groups.

Badges
Represent a very scalable way of an awarding system. It allows administrators as well as normal users to easily create own badges. The different kinds of badges are mentioned at the requirements chapter and the *badge_type* field defines it. The *compare_value* and *compare_field* are fields, describing which kind and amount of performance has to be done to win the badge, and are used for querying them from the database. Because badges may also represent geographical points or tracks all the GPS fields are also included. The *badge_type_detail* field is another classification for geographical badges.

Badge Collections
This node type is responsible for pooling badges, and it is used for different scenarios. The node's main field is the *badge_collection_field* which holds all the referenced badges of the pool. The "points" fields hold the number of points a user receives after winning all the badges of the collection. This node type is multiple usable, "training plans", "geo chaching collections" or "fun badge collections" are implemented for now. Figure 6.2 shows the field management of badge collections.

Badge Awards
This node type was introduced to manage data about the users' awards. Just a simple reference from the activity to the badge would be possible, but would not avert the storing of meta data about the winning. These data could be for example: how often was the badge won? This node type has a referencing field to the user who did the activity, to the badge and to the activity which won the badge. That simplifies queries to analyze or display winnings or summarize points.

Sports
Constitutes all the available sport types which can be done by users. To handle them by an own node type and save their details into fields, ensures a high scalability and changeability. The *points_multiplicator_distance* and *points_multiplicator_altitude* fields hold factors which define the difficulty of the sport against others. For example,

running has a higher distance factor than cycling. Because it is harder to pass a distance by running than cycling. This factoring system builds a basement of the realization of gamification, because it allows a comparison of different sport types to generate rankings.

Action Stream
This node type is responsible to observe special social events within the application, to display it to users news stream. For example if related people of a user, join a team or create a further relationship an "action_stream" node is created and the affected users (and friends) can be informed of the happening via timeline. Without these nodes such events would not be comprehensible. The field "user" represents the user which does the action, the field "node" describes the entity to which the user references and the "type" field is responsible to track which kind of behavior was done by the user.

6.2.2 Database Schema

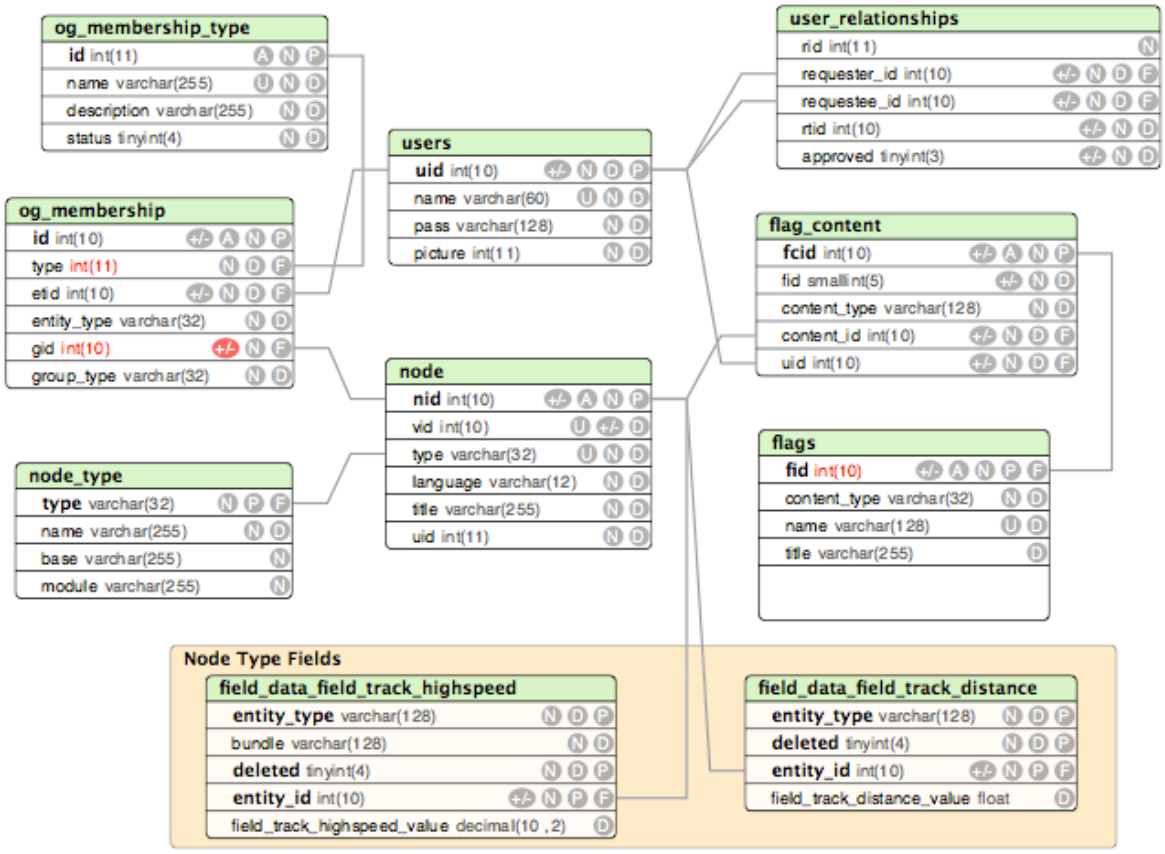


Figure 6.3: A very small clipping out of the database schema.

Drupal's standard installation comes with a lot of tables, it would not be possible to describe them all or to illustrate a schema of the whole database. According to the above discussed configuration of Drupal, this section gives an overview of the schema of the most queried tables that should be representative for the whole

database. Thus, figure 6.3 gives a small clip out of the database schema. An important role has the *node* table and the field *nid*, which stores and increments the unique identification number for every node of the website. Many tables are referencing this field by the field *entity_id*, for example all the above mentioned fields of node types got its own table. That brings several advantages, especially changeability, extendibility and modularity. This concept allows to use fields for different node types as well as a multiple selection of input per field.

Every installed module creates its own tables, to manage content. Organic Groups for example, is directly using the node id as the group id, what simplifies database queries. However, entities are not only nodes, comments, users or taxonomy terms may be also referenced by *entity_id* fields.

6.3 Custom Created Components

This section discusses "self" developed modules. They implement new features as well as they influence and change existing functionality. As mentioned in section 5.1.1 the ideal way to attach source code to Drupal is to use *hooks* and *theme functions*. They are written into module files. Custom created modules for the sport portal are placed in folder *sites/all/modules/custom*. These software components run on the server's side of course, but are closely coupled with client side actions. Because they are mainly triggered by user input, which further transfer data to the server. Compared with downloadable, contributed modules which integrate full fledged features into the site, these modules are more or less a pool of different hooks providing functionality needed for the sport community. These modules do not work in any other Drupal site, because they need the right structures and background.

6.3.1 Content Creator

This module got its name because it is primary used to handle content creation processes for any content types. The content creation runs through different stages, represented by different hooks. This is necessary because Drupal allows to access the uploaded data in every stage differently. This component is also responsible for all additional tasks which belong to the creation of content.

Activity Creation

Activities are the main content type of the system. During its creation process different things have to be done, like "calculating track details", "looking for badge awards" or "copying content for attenders" or increasing points and level. The following points describe an activity creation process which is simplified illustrated in Figure 6.4. Figure 6.5 outlines a more detailed view of the activity creation process, including client side events, communication with external servers, internal server side events as well as database communication.

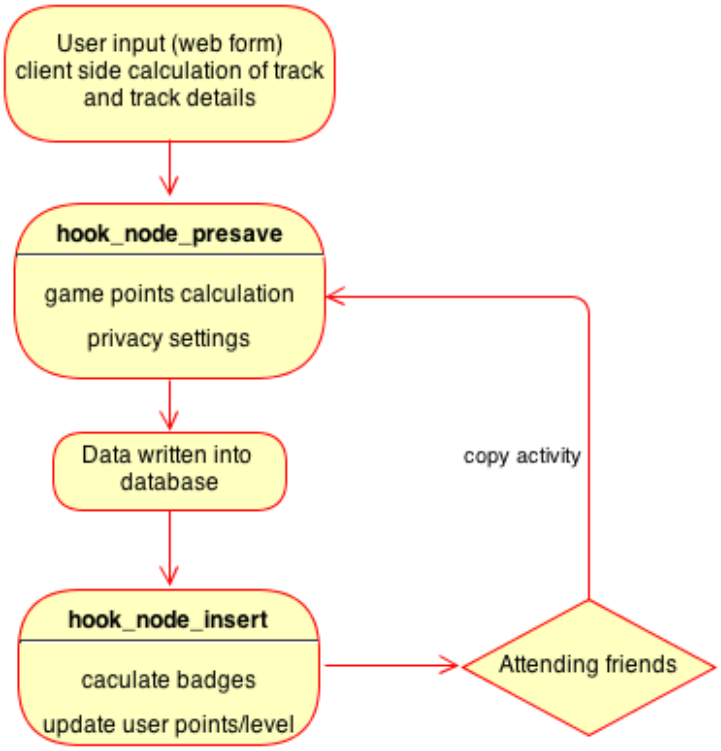


Figure 6.4: A simplified chart of the activity creation process.

1. **Client Side**
   After the user has designed his or her route on the route planner, or uploaded a GPX file, data like distance, altitude and speed are calculated client side supported by the Javascript library Open Layers. All summarized information like total distance and total altitude in meters is also written into hidden fields, so they will be directly written into the right database table by default. Gritsch (2013) explains the client side process, especially the creation of the path, as well as the communication with GIS services in detail.
2. **Hook Presave**
   After the user has pressed the submit button to upload the activity, the hook-function *hook_node_presave* is called before the information is stored. This function sets the right access permission according to the users' selections and convenient points are calculated in reference to users' performance (distance, altitude and upload). Figure 6.6 shows users' possibilities to define access permission for content. Details about the access permissions and the privacy handling are explained in section 6.3.4. After this hook Drupal writes the node data directly into the database and a further function *hook_node_insert* is called.
3. **Hook Node Insert**
   This function runs more or less parallel to the database transaction, because the database query may not be finished until this function gets invoked. Because of that developers have to take care which data are accessed within this function. In relation to this project the hook is responsible for copying the node for all users who are referenced by the creator as attendants. This is realized by Drupal's node API and starts the node creation process for every attend of the

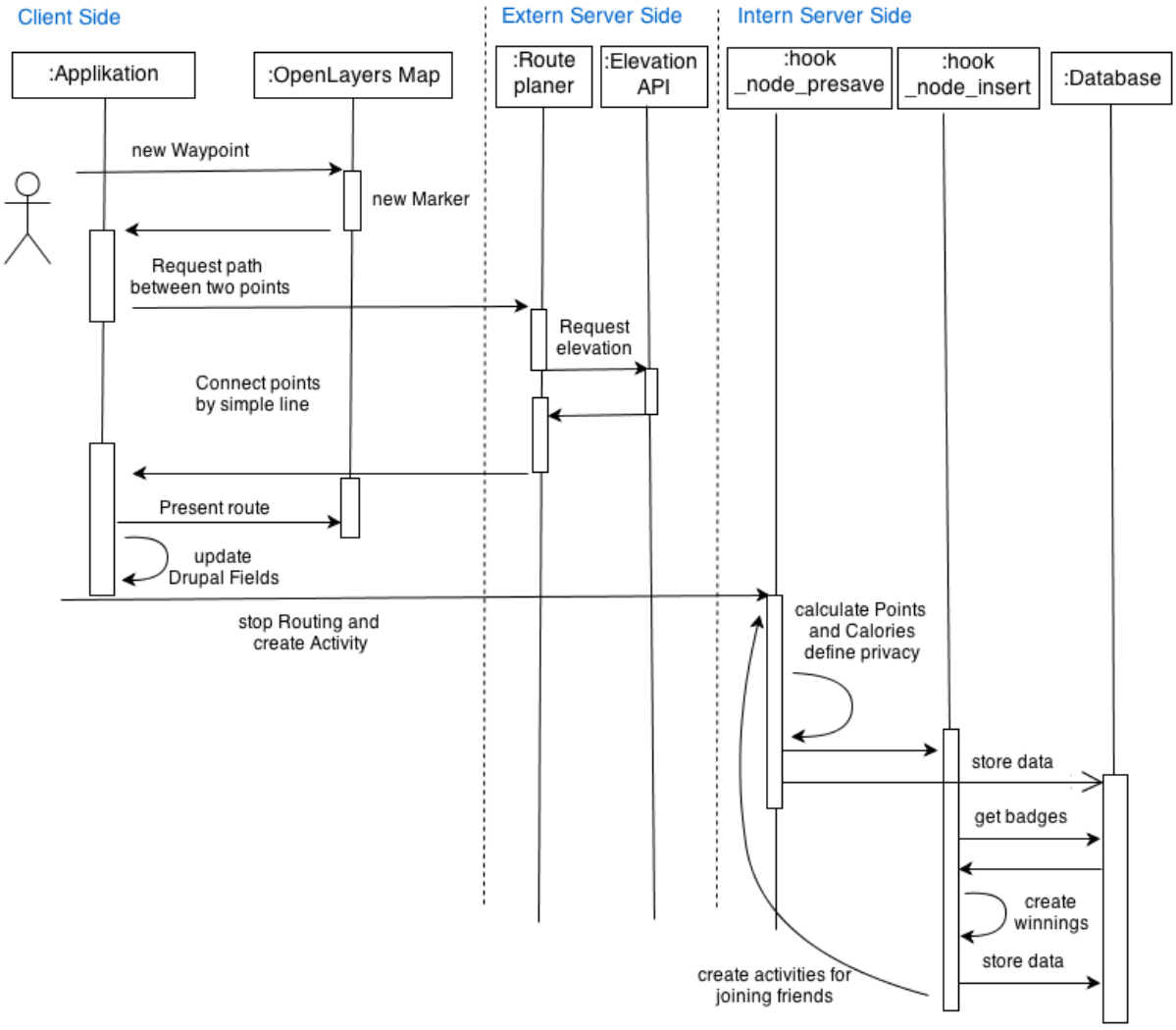


Figure 6.5: A detailed sequence diagram of the activity creation.

activity. The first activity is defined as parent node and all the copied ones are defined as children, therewith this process does not lead to an endless loop. The activity is copied to the friendship group, if the user selected "friends" as visibility permission, the concept of friendship groups is described in section 6.3.4. The next step is to query the different badges which are won by the activity. "Performance badges" are queried by looking for nodes of the type badge, having a smaller compare value than the activities' performance (distance, altitude) which was not already won by the user. To retrieve "Sum Badges" all the performance data of the users' past activities are summarized and compared with badges of this type from the database. The calculation of geographical badges (point and track badges) is done by queering badges which are within the activities' geographical boundaries. These borders are calculated in the first steps client side. Further an algorithm verifies every point of the track if it matches with one of the queried badges. For all the calculated badges, *badge_win* nodes are created. The procedure of selecting geographical objects like geo-badges, track-badges and competitions is chronological listed and summarized as follows:

a) A new GPS track is generated (client side).
b) According to route details, track extreme points are calculated and stored.
c) Geographical objects (f.e. badges, competitions) within these borders are queried from the database.
d) All these objects have to be proven, if they lie within a defined tolerance range to the currently generated track.
e) If the tolerance is not exceeded the object is won by the user.
f) The time of a track segment has to be extra calculated, if the track segment overlaps a virtual race track.

User's level and points are updated finally. This process is supported by the data manager module which is responsible to calculate level and points. The user's currently retrieved points are included in the level computation.

Event Creation

Users are allowed to design routes for future events, therefore the creation process of events runs through the same, but simplified stages as activities. The calculation of badges, points and calories are missing of course, other steps like permission management and calculation of track details are also done. An additional step is to send invitation messages to invited users. This happens over an API provided by the Private Message Module. That means users will receive private messages, including the confirmation link for the event. The "attending list" is implemented by the flag module, every user who wants to join the event, flags/marks the content. This is probably not the planned usage of module by its creators, but it is simple and effective, because it allows to create lists and views of related users. The module also provides an API to print the hyperlinks *flag content* and *unflag content*. These are renamed to *Join Event* and *Leave Event*. A special feature of events is, that they automatically become activities if they are in the past for all users which are on the events attendant list. The transformation from event to activity happens during the user's login process, by the hook *hook_user_login*. This action is triggered by the first user who logs in after the event elapsed. The attending people are queried from the *flag* table and the activity is created overtaking all the events available data.

The editing process of content is very similar to its creation, it runs through the same stages (Figure 6.4), because each value of the GPS track may be changed into the edit form, so all the information has to be recalculated. The only exception is that the hook *hook_node_insert* is replaced by the hook *hook_node_edit*, where all the according badge node wins are deleted, and totally new retrieved.

6.3.2 Data Manager

The module called data manager does not have an exact defined or limited functionality, it is more or less responsible for all the other hook - functions and other functions which are needed. Some of them are used to configure and edit foreign external modules. These features are explained below:

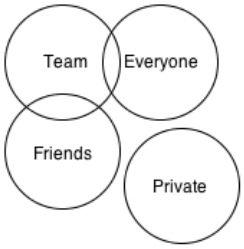


Figure 6.6: Overview of the permission settings possibilities of content.

Menu System

As already mentioned in chapter sec:drupal the menu system is not only responsible for the user's navigation through the website, it also manages URL paths, to build the websites' structure and to call and load the right template file. All changes, extensions and other settings according to the websites structure are done by the function *data_manager_menu()* in this module. This is important, especially to open a self defined template site by a defined link. For example, the path */game* is called this way, the path is defined by this function and within the "theming" function is decided which template file should be called according to the URL path. The theming function is also placed at this module file. All the template files which are called by this module are also in the modules folder.

Preprocessing of Content

Is a process which is called before Drupal prints theme elements. That means these hook functions allow to edit or extend the element's variables. Many Drupal elements like templates, blocks, nodes, pages and fields got its own preprocessing function. The element's variables and information are stored in associative arrays which come as a function parameter and are easy to extend or adapt. This array will be further accessible within the template file of the Drupal element. *badge_me_preprocess_node()* is the function which is responsible to preprocess the data for each node type. The distinction between the node types is made by "if" statements within the function. In the following it is mentioned how each node type gets adapted for the sport portal:

- **Activity:** It is necessary to query the badge's points which are related to the activity node on the fly. That makes the point system flexible and changeable, because the sites administrators can always alter the badge points definitions. Further all geographical badges, especially their longitude and latitude information are retrieved from the database, to display them on the map. The graphical illustration of the won badges is assumed by a view included in the activity node template. These data are not preprocessed by this function.
- **Team:** Team nodes got extended by summarized data of all activities which were added by team members. How much distance, time and altitude accomplished the team collaboratively by how many activities is shown to team subscribers for now. Further extensions like "How much was contributed by each member?" or "How is the teams performance in relation to others or to competitive teams?" are thinkable.

- **Badge:** For badge nodes information about the winnings of the node is important. Interesting database queries which are: How often was the badge won? Does the current user own this badge already? If not, what has he or she to do, to win it according to the current level? All these information will be printed later at the badges site.
- **User Profile:** To preprocess the user's profile page, Drupal provides a hook function *data_handler_preprocess_user_profile(variables)* which collects all the user information which is needed by the profile page including badge winnings and total performance results.

User and Gamification Related Functionality

The data_handler module contains a couple of further functions which supports the gamification approach. *activity_printer_get_user_information()* is responsible to get all the gamification relevant user information and provides them to different components. This function is also used to retrieve data for the user's profile page. Primarily all the activities created by the user are queried separated by the sport type to supply a detailed overview to the user. The following information is getting summarized sport type specific: distance, altitude uphill, altitude downhill, time, calories and related points. The next step is to calculate the user's level and points, what is realized by an own function which calculates the user's standing in detail. Points are split by their source (badge, distance, altitude, upload) so that users can comprehend how their level is compounded.

6.3.3 Stream Manager

Is a module created solely to observe and record special events, if users create friendships, join groups or write comments. This is necessary to display these social actions on the news stream on the front page. The contributed module called heartbeat[1] nearly provides the same functionality, but short practical tests showed that the implementation of such a feature brings advantages over the usage of the module. The news feed is basically a simple view, printing the last contents of the user and his or her friends. *Activities*, *Events*, *Teams* and *action_stream* entries which are created by this module, are nodes which creation is published in the stream. The observation of these happenings is realized by hooks, which are offered by the respective external module which is responsible for the event. For example the Organic Group module calls the function *hook_og_membership_insert* whenever a user subscribe to a team. The *action_stream* node has just to be created here and filled with the information of the action, which comes as parameters to the hook functions. Of course it is necessary to delete the entry if user leaves the group, this happens by the hook *hook_og_membership_delete*. A more detailed explanation of the "news feed" can be found at section 6.4.4.

[1] http://drupal.org/project/heartbeat, visited 6th May, 2013

6.3.4 Content Permission Handling

As already mentioned Drupal provides different possibilities regarding the management of content permission. The core, the content access module and OG Permissions are features which are used to let users define their own access permissions for published content. This part should describe how the different possibilities are realized. Users can choose between four permission possibilities at the content creation which is already illustrated in Figure 6.6. But these checkboxes in the form are more or less a customized veneer, the real actions are set during the upload process. This happens differently for each option as follows:

- **Public:** To publish a content to everyone no settings have to be changed. Content is accessible to the community by default.
- **Private:** This setting means that only the creator itself is able to see and access the content. This is achieved by *state* field, which every Drupal content has. This boolean field can be set to "1 - published" or "0 not published".
- **Team:** The OG API provides different function to add content to a team. Important parameters are the team id, node id and node type. The team's permissions settings are also assumed for the added content by default, but can be changed over the content field *og_content_access*. This field works like the node state field "published" or "not published" in relation to teams. That makes it possible to share public content in private teams, that means everybody can see the content, but only team members see the team's site. Or reversely private content in public teams, everybody can see the team, but only team members can see the attached content.
- **Friends:** the OG module is also used to make content just available for friends. A private group, called *friendship_group* is created during the users registration process. If users build relationships to others they are inserted automatically into these private groups. If a user wants to post nodes to friends only, it is attached to these private groups as private content.

6.4 Templates

Creating templates for the sport portal was a very important procedure and consumed much time. Templates are simple PHP files which overwrite the default output of elements like pages, views, nodes, blocks and fields. They are a powerful instrument to build totally customized websites. They are included by their filename, that means Drupal will use this template files automatically if they are right named and within the theme folder. All the data which would be displayed without the template are available within the template as normal array variables. More than 50 templates were created and are listed following, the most important are discussed afterwards:

Name	Description
block–bottom.tpl.php	Represents the whole "footer" area, including 3 columns of information.
block–highlighted.tpl.php	Displays the blue colored column on the left side, includes user's personal information and the sub menu.
block–tagclouds.tpl.php	Displays the block of activity tags at the front page.
comment.tpl.php	Defines the look of different comments.
node–activity.tpl.php	Constitutes how each activity node look like.
node–article.tpl.php	Defines how articles look like.
node–badge-collection.tpl.php	Defines the output of a single badge-collection.
node–badge.tpl.php	Defines the look of badge node.
node–competition.tpl.php	Defines the output of competition nodes.
node–event.tpl.php	Represents how events look like.
node–team.tpl.php	Defines how team nodes look like.
page.tpl.php	Represent the utmost template, the structure of the whole site, every single page is using it.
user–login.tpl.php	Displays the user's login screen.
user-edit-form.tpl.php	Constitutes the user's edit screen.
user-profile.tpl.php	Represents the profile page of users.
user-register.tpl.php	Displays the register screen of users.
views-view-table–badge_collection_training.tpl.php	Displays training plans.
views-view-table–badge_collections.tpl.php	Displays the overview of badge collections.
views-view-table–badges_of_collection.tpl.php	Constitutes the single badges of a collection.
views-view-table–badges_of_collection_training.tpl.php	Represents the single badges of training plans.
views-view-table–badges_of_sport.tpl.php	Constitutes badges in relation to sport types.

Table 6.1: Custom created templates for the sport portal (part 1).

6.4.1 Node Activity

The activity node template is probably one of the most visited sites. It displays the detail view of activities including a map with the highlighted track, the altitude high chart, meta information about the sport performance and the comment feature. Nodes can appear as a whole page or as a small clipping in lists. Both views are implemented by this template, it is simply distinguished by an if-statement. The map as well as the GPS path are printed by Javascript, supported by Open Layers. The waypoint coordinates which belong to the activity are provided by the corresponding

Name	Description
views-view-table–badge_sum_sports.tpl.php	Constitutes sum-badges in relation to sport types.
views-view-table–badges_to_activity.tpl.php	Displays badges in relation to the activity node, beneath the map.
views-view-table–competition_ranking.tpl.php	Represent the ranking of competitions.
views-view-table–competition_to_activity.tpl.php	Displays competition, on which the current activity takes part.
views-view-table–content_of_friends.tpl.php	Displays the timeline or news feed at the front page.
views-view-table–event_attend.tpl.php	Represent all the user's upcoming events.
views-view-table–events_created.tpl.php	Displays the user's self created events.
views-view-table–friends_points_ranking.tpl.php	Constitutes the points ranking of friends at the "game" page.
views-view-table–latest_activities.tpl.php	Displays activities at the users profile page.
views-view-table–latest_activties_front_page.tpl.php	Displays latest activities of all users, for unauthenticated users at the front page.
views-view-table–latest_badges_of_friends.tpl.php	Displays a clipping of the friends' latest badges at the front page.
views-view-table–og_all_users_content.tpl.php	Displays the content of team members, within a team.
views-view-table–og_members.tpl.php	A listing of all team members.
views-view-table–og_ranking.tpl.php	Constitutes an internal points ranking of team members.
views-view-table–og_users_groups.tpl.php	Displays all the teams of a specific user, at his or her profile page.
views-view-table–personal_geo_badges.tpl.php	Displays geo-badges of the current user.
views-view-table–personal_performance_badges.tpl.php	Displays performance badges of the current user.
views-view-table–personal_sum_badges.tpl.php	Displays sum badges of the current user.
views-view-table–teams_to_activity.tpl.php	Constitutes all teams to which the current activity belongs to.
views-view-table–user_event_past.tpl.php	Displays the current user's events which are in the past.
views-view-table–users_training_plans.tpl.php	Represent training plans which the current user subscribed.

Table 6.2: Custom created templates for the sport portal (part 2).

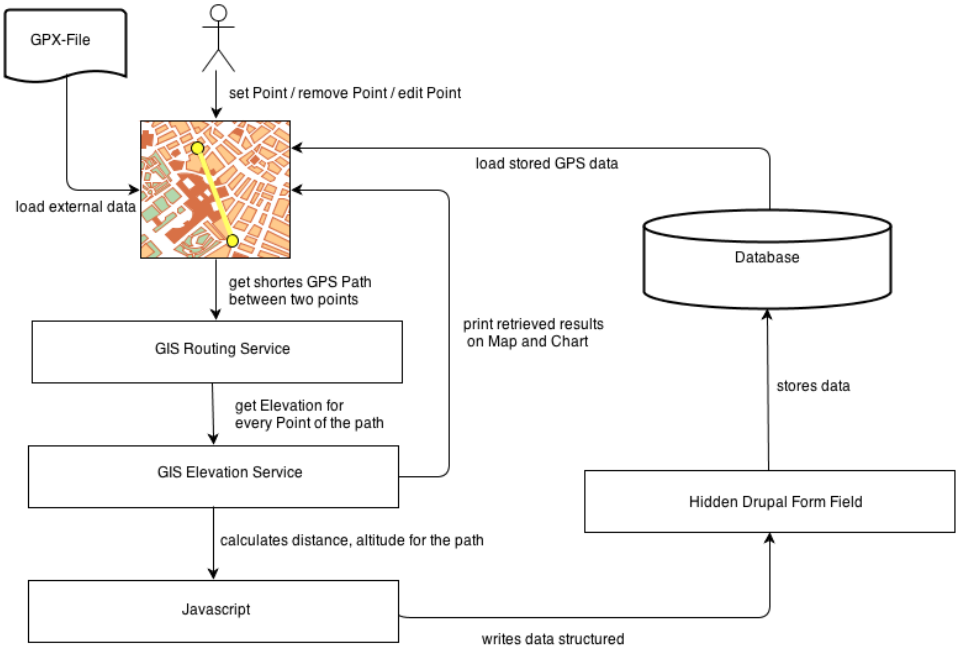


Figure 6.7: The life cylce of GPS data, from the creation to the storage.

field. The won geo-badges are provided by a preprocessing function to the template. The listing of the badge icons is included by a view, which is also customized by an own template. All the nodes information like date, distance and description are accessible over the "$node" object. Further views which are printed in this template are *teams_to_activity* and *competitions_to_activity* printing the referenced teams and competitions of the activity. The comment block is printed by Drupal's *render* function, it allows to print pooled elements in structured HTML code. For the elements transformation into html, it is necessary that they exist as a defined associative array. For example the order *print drupal_render(node['comments'])*, prints all comments in a structured table as well as the form to write new comments. How these comment elements look, could be defined in further sub templates.

6.4.2 Activity Node Form

Node forms are forms which are responsible to create content (nodes) in Drupal. They can be templated as well as normal nodes. Each node type which can be created by normal users, got a customized form for the content creation. This is partial necessary because they do not look well by default, and provide unimportant settings which could confuse users. But the main reason is that users have to design GPS tracks with these forms, so it is necessary to provide a map including features to create and edit a path. The activity form (*activity_node_form.tpl.php)* is taken as an example and explained in the following.

Figure 6.7 illustrates the life cycle of GPS data within the application. The base tasks are done by Javascript supported by the famous library jQuery and Open Layers.

According to the specified requirements it should be possible to include GPS information differently. The first possibility is to upload a GPX file, which was recorded by a GPS device. The second is to design a track supported by a route planner. The usage and the adaption of own past activities should also be possible in relation to the second possibility. The path between two points is calculated by external GIS services and requested over Ajax. The usage of different GIS services should improve the reliability and the accuracy of the data. The answer of the service consists of waypoints representing the shortest path between the two input points. The elevation has to be queried by another external GIS service for every retrieved waypoint. The path consists of a pool of GPS points having the following information: longitude, latitude and altitude. The distance between these points has to be summarized to get the total distance, although the altitude difference from point to point has to be summarized to get the total elevation gain. To equalize the connection of points the Douglas-Peucker algorithm is used. However, an extensive explanation of these client side processes are outlined by Gritsch (2013). The following steps describe a single step of the route creation procedure summarized:

1. Setting a startpoint on the map.
2. Setting an endpoint on the map.
3. Query the routing API, to receive all the points between start- and endpoint.
4. Query the elevation for the retrieved points.
5. Presenting the route on the map and the elevation by a chart.

A further task of the template is to handle the user input of privacy. Only some combinations are valid, as already mentioned. The form has to react on wrong input like the selection of private and public together.

6.4.3 Geo Object Forms

Geo object is a collective term for contents which represent geographical information like badges, track badges and competitions. The creation of them works as well as the creation of tracks for activities illustrated in Figure 6.7. These geographical points or virtual race courses are generated by the route planner. After the user has defined his or her geographical element some additional data have to be calculated. These information are boundaries build as a geographical rectangle around the object or track. They are calculated by the most northern, southern, eastern and western point of the object. These boundaries will help to query geographical objects from the database later, by limiting results. Badges which represent just a point do not need these borders of course. In the case of competitions creation the user is able to define a time window, where meanwhile the competition is accessible.

6.4.4 The Timeline

The news feed or timeline on the front page is the most extensive view - template and shows how powerful and variable the Views module is. It is realized by a normal view, the important settings are illustrated in Figure 6.8 to query information from

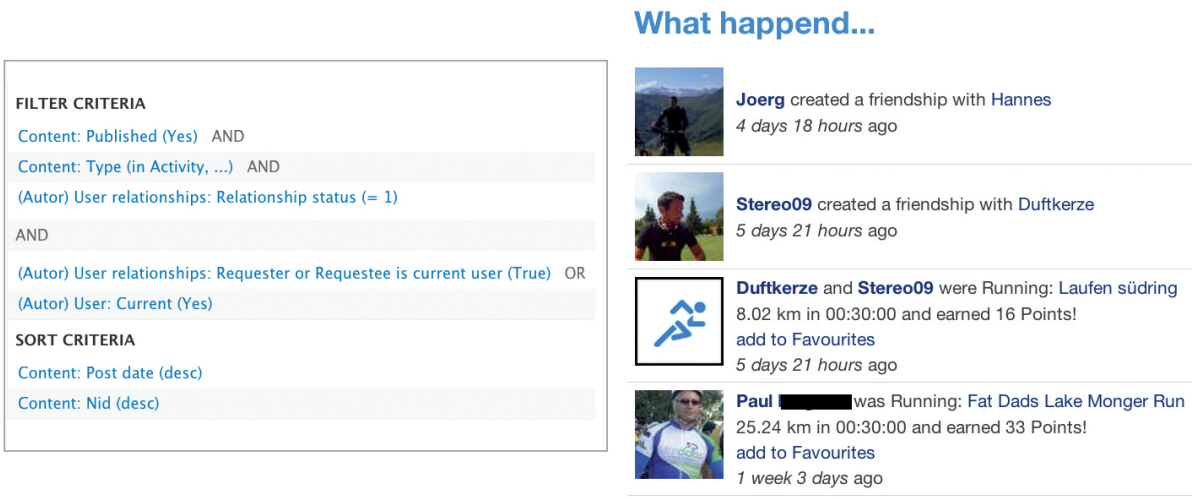


Figure 6.8: The filter criteria to query the data and the result displayed from a customized template.

the database. Each node type got its own section within the template, because each entry should look differently. However, the Views module is just able to supply full nodes, but the news stream should display also additional information of the node. For example comments of activities or attendants of events. This further information is loaded dynamically from the template. Because the template is totally customized some access permission has to be self controlled by the source code, which would normally be overtaken by Drupal's right system. For example private events should be visitable by invited users. Each node appears just one time within the timeline, to provide a better overview to users. That means, if two or more users join an activity or comment something at different times, all the information gets centralized by the latest happening.

6.5 Summary

To implement a social gamification community supporting GPS services in Drupal different components have to be developed, edited and extended. Drupal's core extended with different contributed social modules is building a good basement for the application. These contributed modules are mainly responsible to bring social standard features like user relationships, private messages or group functionality. These standard features were partly extended and adopted by hooks and templates. To meet non-functional requirements like extendability and changeability all the contents like activities, events, teams and badges are assembled as Drupal nodes. That means that Drupal's architecture as well as the database scheme is more or less untouched and administrators can influence the content types at the backend. All the additionally needed functionality is realized by custom modules which simply intervene and extend default procedures over hook functions. These hook functions

manipulate different kinds of happenings within the application. Important hooks which play main roles for this project and which are also explained in this chapter are invoked during the creation phase of nodes and during the preprocessing of single sites. The creation of a theming and templates was another necessary task related with huge effort. Because the sport community's requirements according to the user interface and the look of the website are something special and differ from Drupal's standard output. Lots of templates had to be written to realize a unique gamification style of the whole site. The content creation process, especially the procedure of creating tracks and other geographical objects would not be realizable with standard Drupal forms. All the implemented GPS features are supported by free GIS services. They are responsible for features like GPS routing and elevation queries.

The next chapter illustrates results of the implementation by screenshots. Most of the existing features are presented and different possibilities of use cases are discussed. Finally an evaluation of the sport portal is outlined. The evaluation should reveal possibilities to improve usability and functionality. The process is described in detail and results are analyzed.

7 User's Viewpoint

After the requirement analysis and the explanation of the implementation process this chapter presents results and discusses an evaluation of the implemented web community. The first part discusses the most important screens of the website and procedures which can be done by users. The evaluation analyzes usability as well as functionality.

7.1 Showcase

This part illustrates results as a collection of screen shots including explanations of the application. The depicted figures show the results. "Home Screen", "Game Screen" and "User Profile" are general views which do not provide much functionality. They are primary responsible for presenting overviews and summarized information to users. These sites often are an entrance point to further features and are very important for the users' understanding of the system.

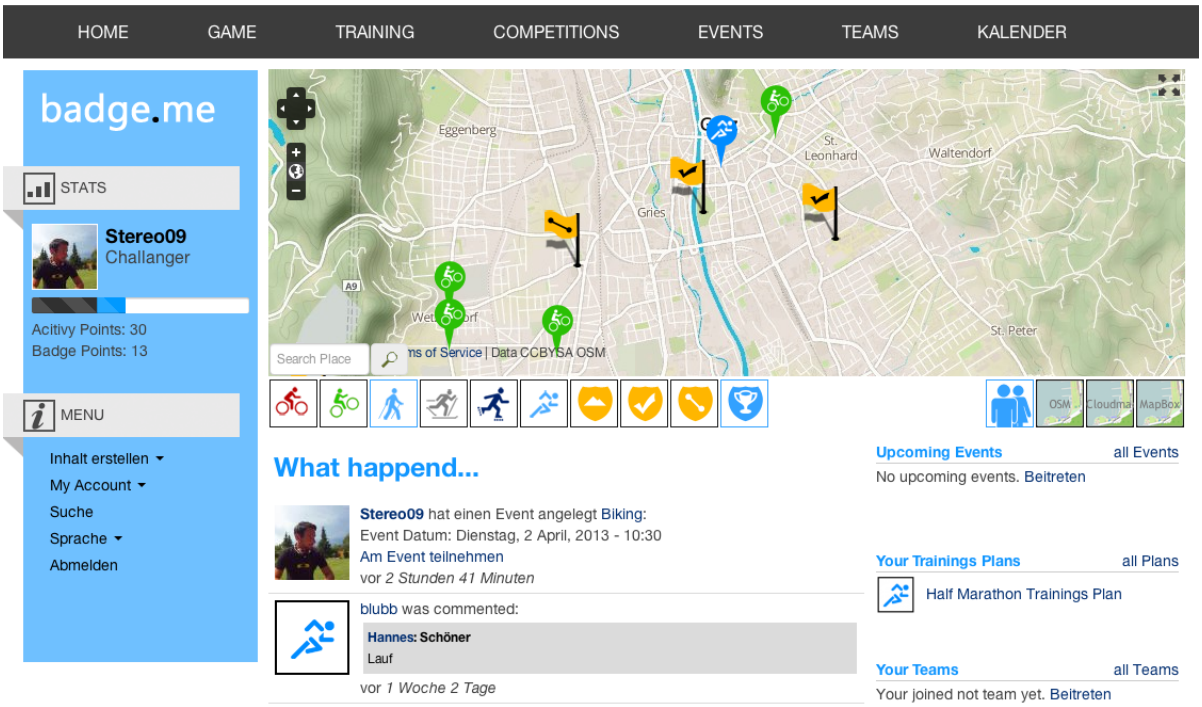


Figure 7.1: Home screen including overview map, timeline and additional blocks according to the user.

Home Screen

The home screen is more or less the entry point to the webportal. Users get an overview of what happened in their social environment and should be able to navigate quickly to every section of the website. Figure 7.1 illustrates the home screen and its possibilities. The map at the top of the page displays the locations of all sport activities, competitions and badges, which the user may see according to his or her access permissions. To ensure that the map is never overfilled, different filter criteria are provided to show and hide selected elements. Users can select each element type separately and choose between friend created elements and all elements. Beneath the map the news stream/timeline is placed, showing all social happenings and activities in relation to the user. Beside this big block, a couple of small blocks present to the user other relevant information and quick links. This information are listings of the user's teams, upcoming events, current training plans and current competitions. The "home screen" is available for authenticated users as well as for unauthenticated ones, who are called guests. Although they are not able to do something, they can look for GPS tracks on the map and see all the activity details. The blue colored sidebar displays the current user level and further important values to give a better overview to users. This area always looks the same and contains links which often are in use to provide a faster navigation over the website.

Admins View

As already mentioned in the description of Drupal (see section 5.1.1) users with administrative roles have nearly the same view as "normal - authenticated" ones. Only the *admin menu* (Figure 7.2), which provides access to all administrative features, makes a difference. The menu enables the following configurations:

- **Content:** Administrators can manage the websites content here. They can edit and remove nodes created by everyone.
- **Structure:** Includes the definition of node types, taxonomy and blocks as well as the settings for many installed modules like Views.
- **Appearance:** The websites theming can be defined here.
- **People:** The user management can be found here.
- **Modules:** Administrators can handle external modules here. Modules can be installed, removed, enabled and disabled.
- **Configuration:** Enables the configuration of the Drupal and external modules. User roles, cache settings, Organic Group settings and Drupal's Update management important features of this section.

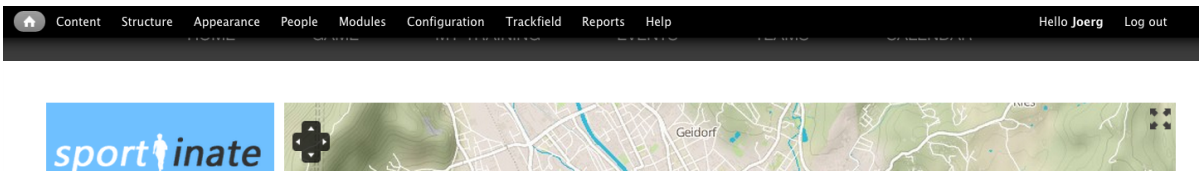


Figure 7.2: The menu only seen by administrators.

Game Screen

Figure 7.3 illustrates the "game screen", which presents gamification scores to users. To figure the users' current physical performance, the last 10 activities are taken as already mentioned. The points average of these activities calculates the current user level.

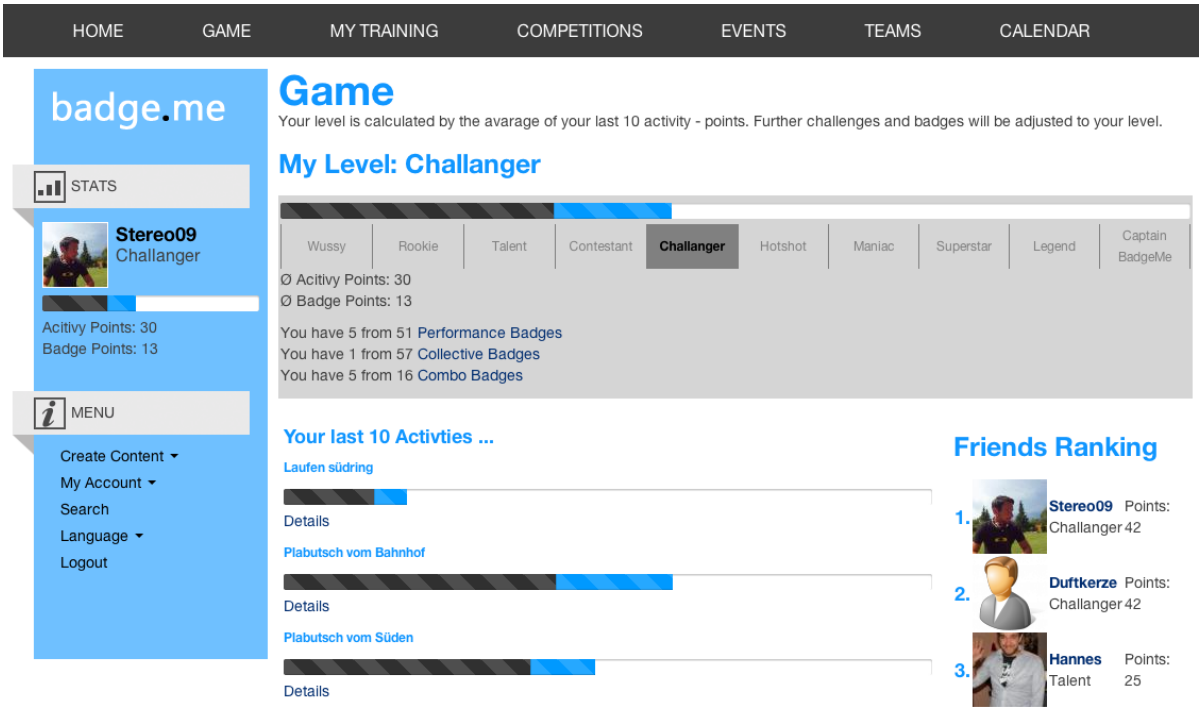


Figure 7.3: Gamification overview showing last activities and the friends ranking.

That allows a comparison of every user, indifferent how long he or she takes part in the community. Another advantage of this reputation system is that users have to be active to keep the level. This page explains the level and point system for users. They see their last 10 activities in detail and so they should be able to comprehend the calculation of their current level. The progress bars always show the current standing and so users can see how far it is to reach the next level. To see the points calculation for each particular activity, users can click on "Details" and they can see badges, distance points and altitude points.

User Profile

The user's profile page is an area which summarizes all information and contents of a user. Figure 7.4 illustrates the user profile and displays basic information of the user like nickname, level, points and country at the top. A "friendship request" link and a "private message" link can also be found there. Beneath this area the user's content is ordered by tabs. "Badges" display all badge winnings of the user, listed by the badge type. The "Training" tab displays all training's relevant information summarized and structured by the sport type to display sports type related results.

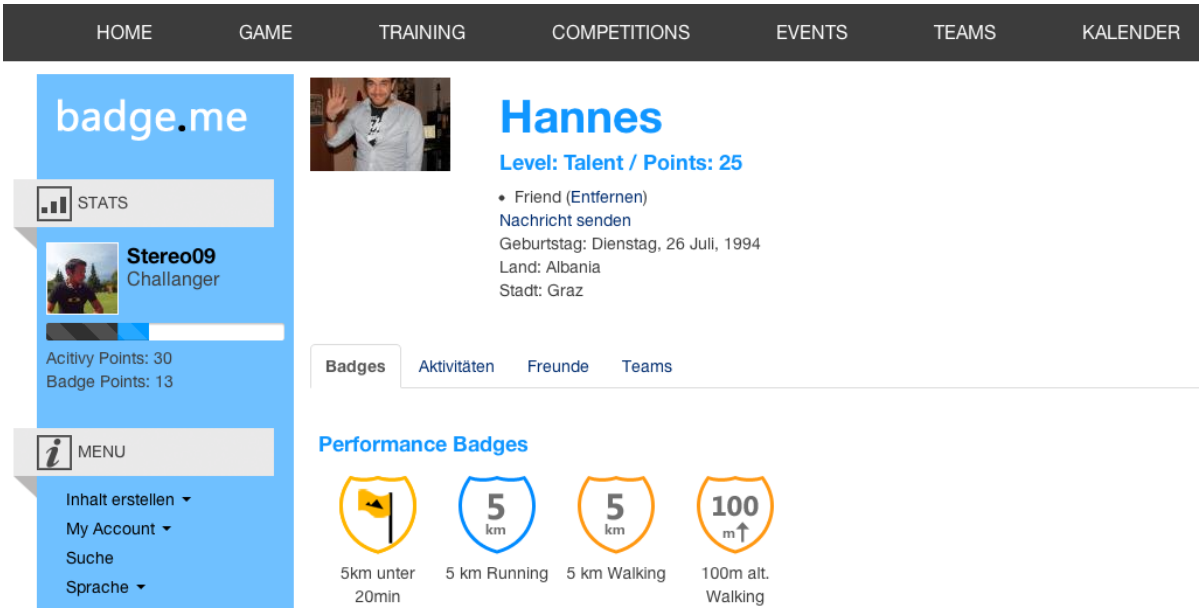


Figure 7.4: User's profile page.

The logged in user can also access its relevant information by the main menu entry "Training". Also a listing of past activities and of favorite or bookmarked activities can be found there.

Figure 7.5: Calendar view including activities, events and competitions.

Calendar

Figure 7.5 illustrates the portal's calendar view displaying all activities, events and competitions which belong to the current user. The calendar module is able to display

the calendar view in different time periods, per month, per year or per day. It is also possible to figure events which last over several days or other time periods.

Activity Creation

Figure 7.6 shows the form for the creation process of activities. The user is able to insert standard descriptive data of his training (title, date, time, sports type) and can choose how the track gets generated (Create new Route, Use an existing Route, Upload a GPX File). After the decision the map including the "editing tool" is shown to the user. In the case of an "existing route" or "upload route" the user gets the possibility to edit the old one or the uploaded one. If users want to create a new route, they can design it from scratch. The horizontal tabs at the bottom of the page allow the user to enter attending friends, the privacy settings, a description and tags.

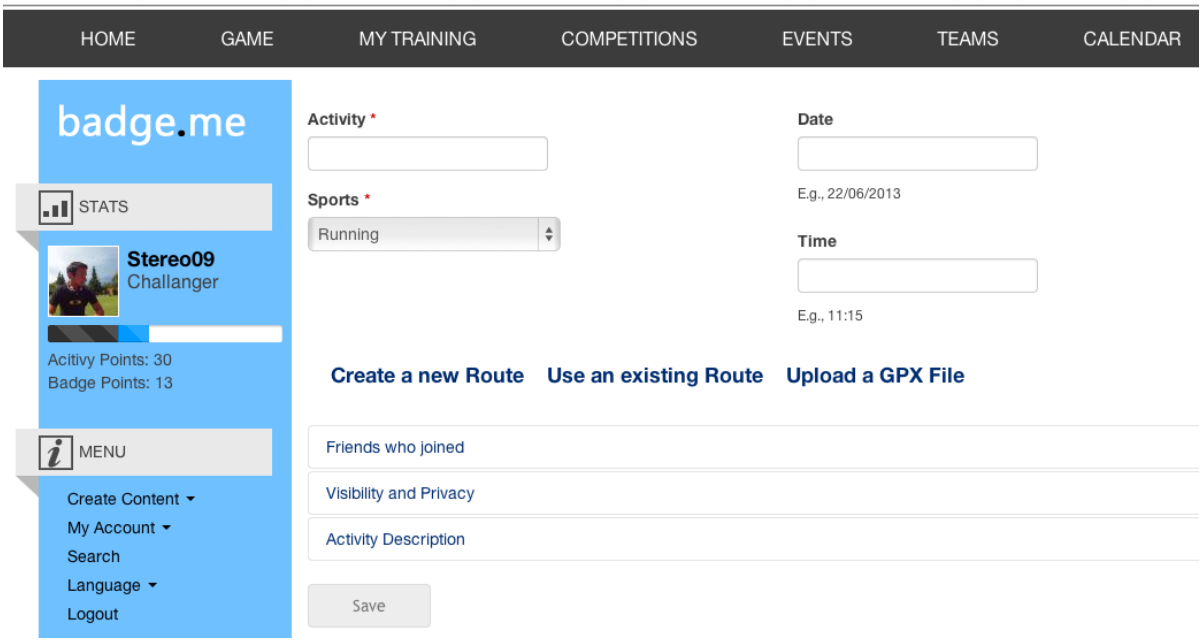


Figure 7.6: The activity creation form, before the map editor is displayed.

Figure 7.9 shows an activity site. Users can get detailed information about a section by putting the mouse over the altitude chart beneath the map. Information like time, altitude and distance according to the selected point is displayed. If the logged in user is the creator of the activity he or she is allowed to edit or delete it. Everyone who got access to this node can bookmark it or rate it. All the additional information including the won badges is displayed under the highchart. Written comments to this activity are not visible in the figure, they are normally found at the bottom of the page.

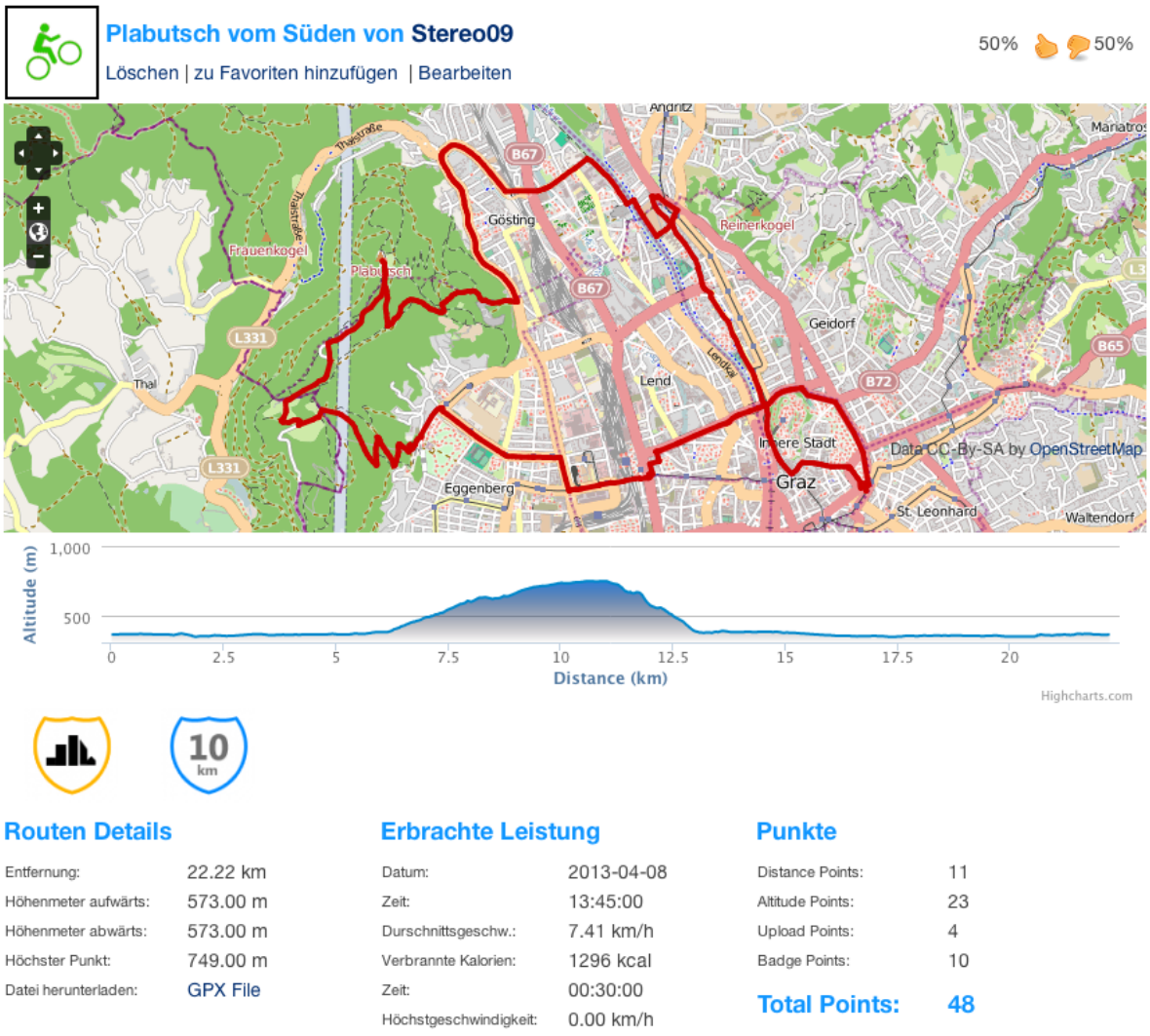


Figure 7.7: View of an activity which won 2 badges.

Badge Creation

As already mentioned users are allowed to create and distribute badges over the map. Currently users are not allowed to generate performance or other badges, concepts like this may be thinkable for teams in the future. Figure 7.8 shows how the badge can be placed by the user. In the first step they have to choose between point badges or route badges. Secondly they have to select the badge type between "Mountain Peak Badge" or "Normal Geo Badge", further types will be introduced in the future. After the users' selection they see a map where they can pin their badge. If they create a team badge, they can define privacy settings additionally. The points which users get by catching the badge are adapted on the user level of the creator.

After the successful creation of a badge it is winnable by other users. The badge site is illustrated in figure 7.9. The page's head displays the badge name, how often the badge was won and if the current user has won it already. The availability of a badge defines how often one single user is able to win it. At the bottom of the page a view

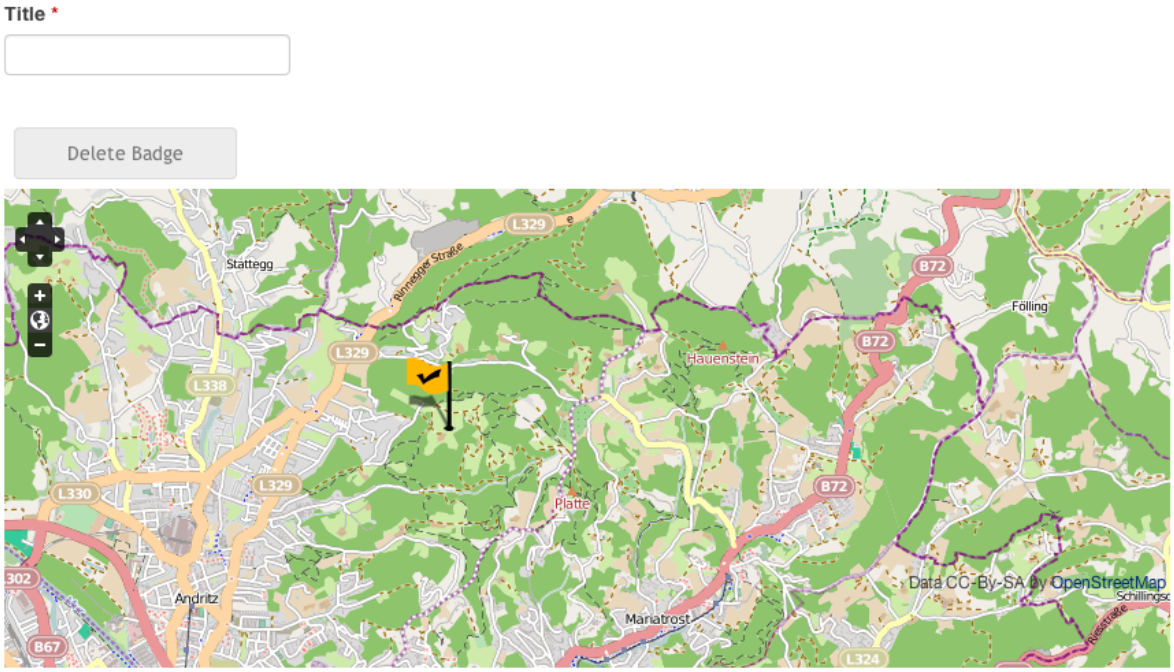


Figure 7.8: The badge placement on the map, after the selection of the badge type.

is shown, displaying users who won this badge at last.

Search for Content

Users have the possibility to search for content, illustrated in figure 7.10. The *advanced search* module extends Drupal's standard search functionality. Users can define key words, content types and language for their search. That will help the users to find the needed content. A geographical search for content is included in the map, placed on the front page where users can easily view their environment or other areas to search for routes, badges and competitions.

7.2 Evaluation

The success of a webportal depends on different factors, whereof every single one must be well realized, to enable a positive experience to users. Each web application operator probably prioritize them differently, but factors like "quality of the idea and basic concept", "benefit for users", "the quality of the implementation", "usability" and "look and feel" must be considered at each time and are important in relation to this project as well. Therefore the evaluation focuses on the following aspects:

- Demographic information, especially the general sport behavior of users
- The usage of software for training and leisure activities
- General experiences, usability and favor of the application

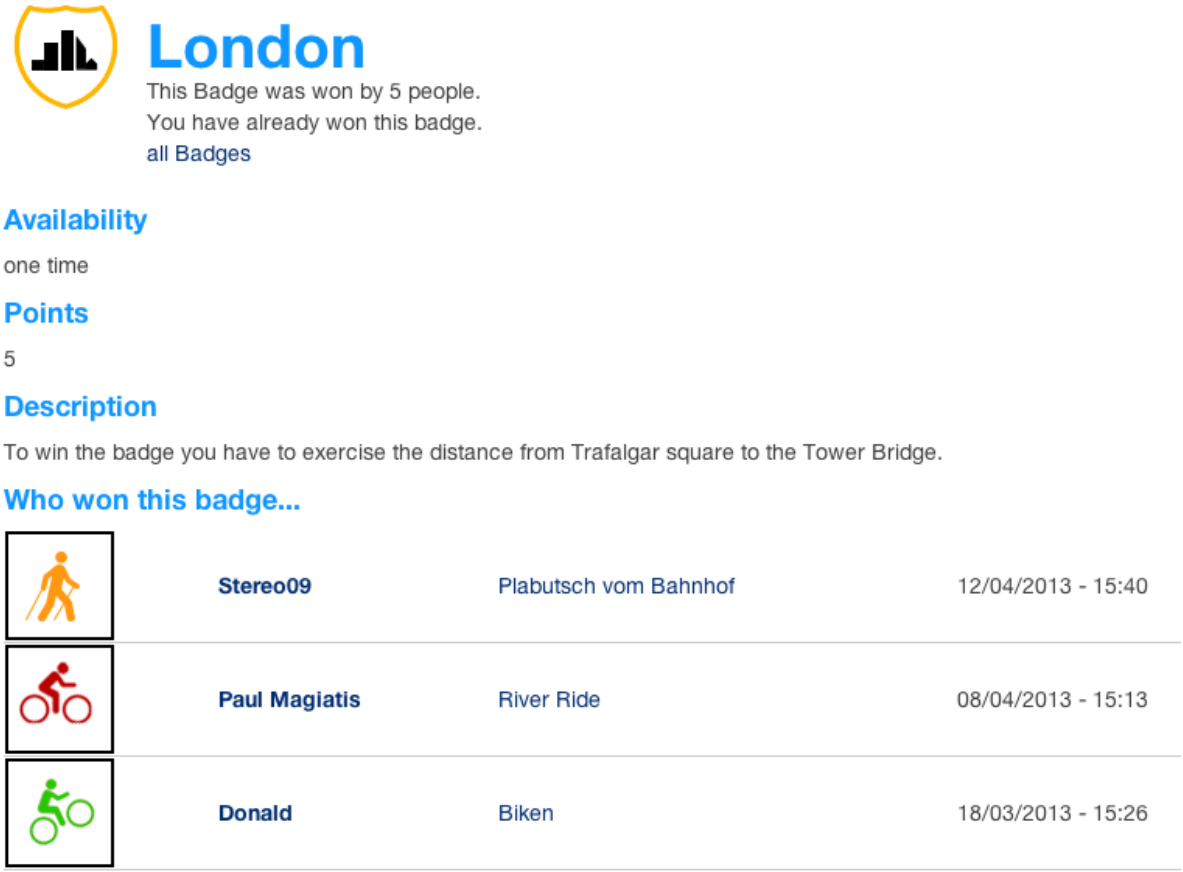


Figure 7.9: Badge site showing all relevant information in relation to the badge.

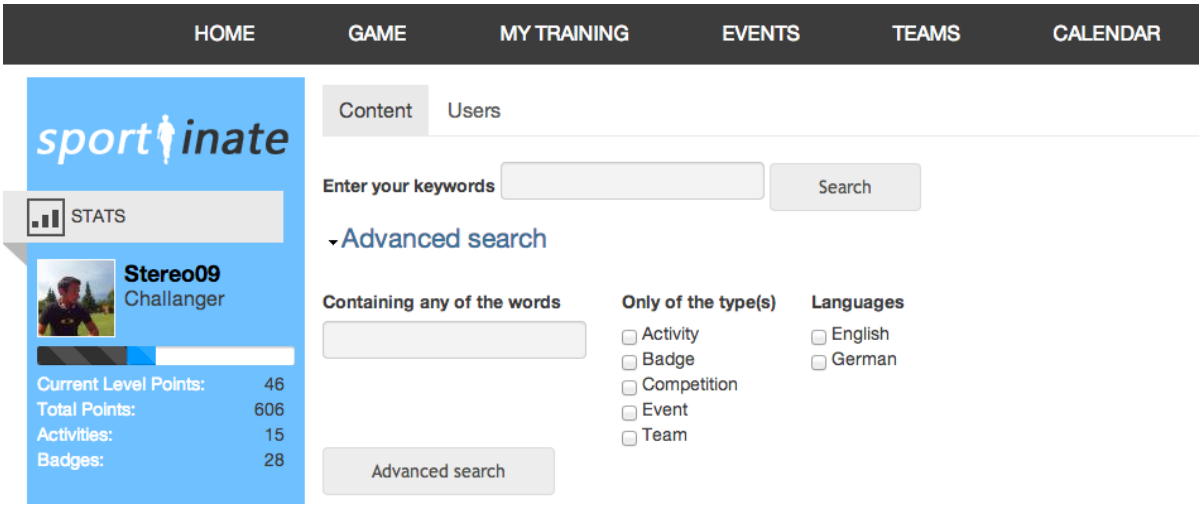


Figure 7.10: The advanced search form, users can search for all contents.

7.2.1 Participants

Basically the web application does not aim at any specific target group. It should be interesting for everyone who wants to improve training experience by social media

and gamification features. Aspects like age, gender, occupation, level of sport performance do not matter when selecting participants for the survey. Anyway, attempts were made to survey people who are experienced in doing sports. If they used any kind of sport applications before, they were ideal participants.

7.2.2 Setup and Procedure

The survey was executed with the software tool *LimeSurvey*[1], a software which has to be installed on a webserver and is able to run and analyze online surveys. The application provides all kinds of question and answer capabilities. The tool offers a detailed and graphical presentation of the surveys results. They can be easily exported into other data formats like CSV, XLS, HTML or PDF files. As mentioned above, the survey tries to focus on aspects which are interesting for the project, because they can reveal necessary changes, desired extension or other useful improvements. The survey consists of different kinds of answer possibilities, ratings (from "it applies" to "it is not the case"), "true/false" questions as well as free answer possibilities occur in the survey. The questions can be further distinguished by multiple and single choice, mandatory and optional answers. The participants got the possibility to explain each of their rating, if they wanted to. The structure and classification of the questionary is described in the following.

Demographic Data

Represents the "warm-up" phase for participants. As already mentioned, information like age, gender and occupation are not that important as for many other surveys. To retrieve information out of demographic results, a fair quantity of people have to be surveyed. But maybe the survey is able to reveal small trends in reference to demographic information.

Sport and Leisure Behavior

These data are closely coupled with the demographic ones, because people describe their favorite sport type, daily sport routine, sport capability and performance level. Basically the application should address all different kinds of sportsmen, but these data will definitely outline how the web application acts on different types of athletes.

Use of Software Tools for Sport Activities

This block queries peoples' use, opinion and knowledge of sport applications. The queries try to find out why people use software tools to analyze their training and which impact the social media aspect "sharing" on motivation has. It is also surveyed what kind of the applications' features are used by people and why.

[1] http://www.limesurvey.org/, visited on 9th June, 2013

Usability of the Web Portal

This section queries the usage of the web application in fact. Participants had to spend some time at the web portal and had to use main functionality. They evaluate and rate the website structures, navigation system and other standard user interfaces. Main processes and features like the activity creation, the route planner or the distribution of badges are discussed in detail. The users comprehension is surveyed repeatedly. "Does he or she understand the input possibilities, the point and level system and other displayed information?", are important questions to rate the simplicity of the usability.

General and Motivational Aspects of the Web Portal

The last section discusses general aspects like the website performance and the user interface design. Participants have the possibility to pass a remark in his or her own words. Finally it is queried if people are interested in using the web application in future, and if they can imagine to integrate the tool into their training routine. This part should reveal peoples' personal opinion according to the web application and features, because possible answers are not given here.

7.2.3 Results

The following sections outline the evaluation results grouped by the above mentioned classification.

Demographic Data and Sport Behavior

31 participants took part on the survey, 28 questionnaires can be taken, 3 were not completed. Out of 28, the amount of men was 20 (71.43%), 8 (28.57%) were women. 18 of the participants (64.29%) were between 26 - 35 years old, 4 (14.29%) were younger than 26 years and 6 (21.72%) older. The participants' had to following qualifications: 11 (39.29%) students, 1 (3.57%) high-school graduate, 10 (35.71%) academic, 4 (14.29%) apprenticeship and 2 (7.14%) employees.

The survey revealed that the selected participants are keen on sports, 14 (50%) train between 3 and 4 times, 9 (32.14%) two times and 5 (17.86%) one time a week. That displays, the chosen people were relevant for the survey. The participants do different types of sport, what was surveyed by a multiple choice query. Out of 28 people, 23 (82.14%) go running, 12 (42.86%) are cyclists, 9 are Mountainbikers (32.14%), 6 (21.43%) does weight training, 5 go swimming (17.86%) and 3 like hiking and walking (10.71%) what is illustrated in Figure 7.11. Generally people like to do their training alone (80%) and sometimes they train collaboratively with friends (48%), only a few (10%) train within a club, what was also queried by offering multiple choice answers.

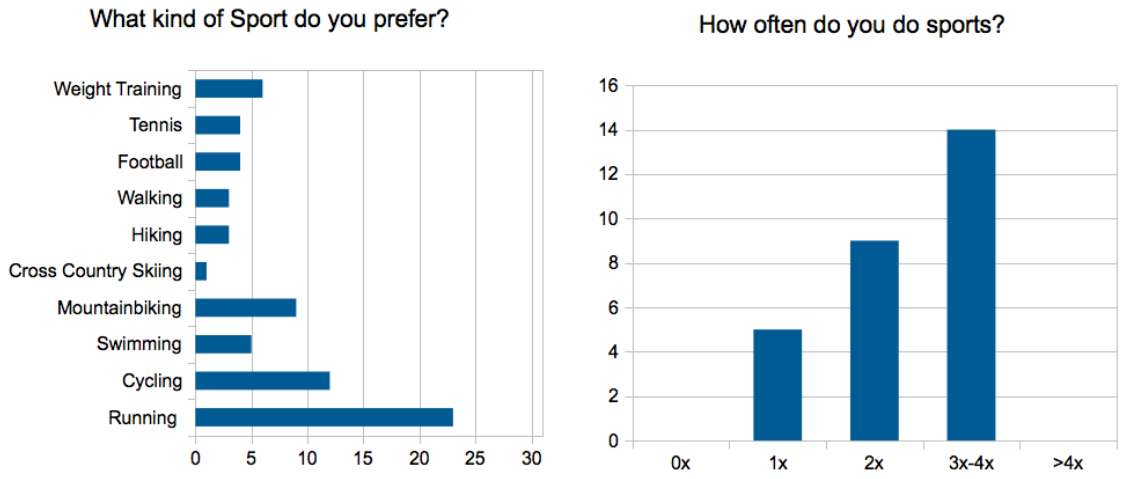


Figure 7.11: Chart of the participants' leisure and training habits.

Use of Software Tools for Sport Activities

Out of 28 participants, 3 (10.71%) use permanently sport software for their training, 21 (75%) do this sometimes, 4 (14%) never use sport apps. The absolute majority is using *Runtastic* (13) followed by *Endomondo* (6) and *Garmin* (3), *Sportstracker* and *JAFF Military Workout Trainer* were mentioned once, 4 people answered with "none". It's interesting that only 2 people (7.14%) permanently share their training with a community, 11 (39.29%) of the surveyed people do this sometimes, 15 (53.57%) keep their training private, see Figure 7.12. 15 (53.57%) of the people think that the application does not motivate them, 13 (46.43%) feel confident that software features increase their motivation. The participants think the following features are motivating (multiple choice answer): measurement and analysis of data - 25 (89.29%), display of the personal training process - 17 (60.71%), sharing of information - 7 (25.00%) and virtual competitions - 6 (21.43%). The search for training partners and routes does not play an important role, only 3 (10.71%) people think that these features are helpful.

Usability of the Web Portal

On a scale from 1-5 (where 1 means "very simple", 5 means "very difficult"), the simplicity of the activity creation process was rated following (Figure 7.13): very easy - 11 (39.29%), easy - 8 (28.57%), normal - 9 (32.14%). 26 (92.86%) participants understood all input fields, 2 (7.14%) did not. Out of 28 participants 18 (64.29%) were able to exactly create their desired route, the rest recognized small problems, but nobody was not able to create the conceived track. The route planner's handling and speed were evaluated indifferently, the results showed an uniform distribution over all answer possibilities see Figure 7.13. 25 (89.29%) understood the concept of badges, 3 did not. Only 20 (71.43%) knew how their level is calculated, 8 did not understand the calculation. 8 people (28.57%) out of 28 would use the route planner

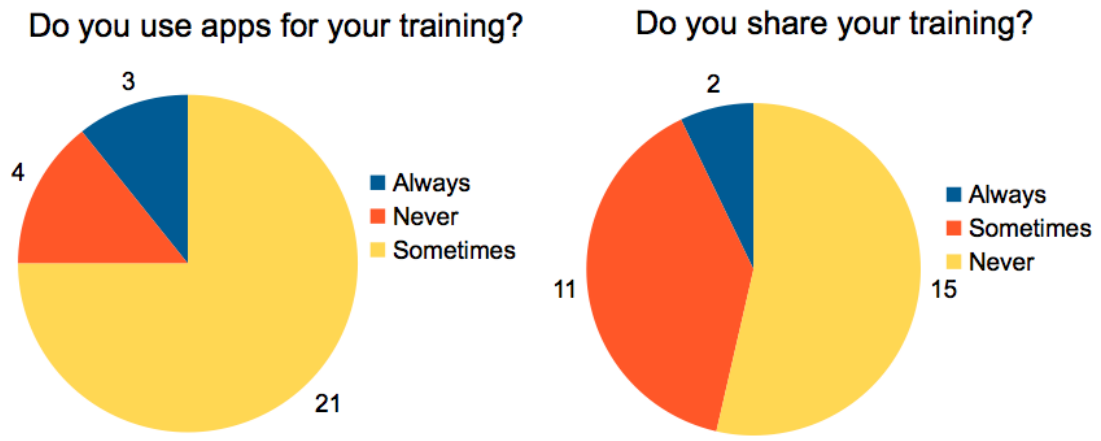


Figure 7.12: Pie chart showing the usage of sport-apps and the social habits of participants.

every time, 20 (71.43%) would use it sometimes, for example as a replacement, if they forget or can not use their smart phone.

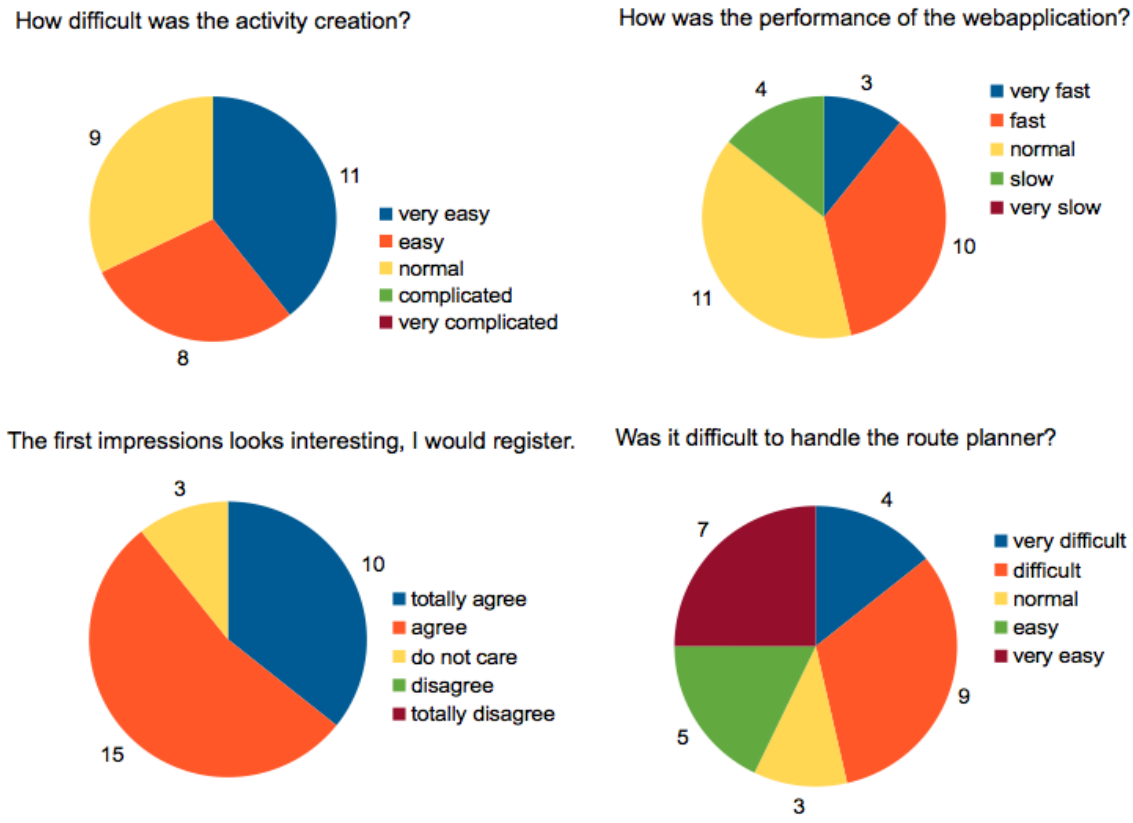


Figure 7.13: Pie chart of 4 selected evaluation queries according to the application's rating.

General and Motivational Aspects of the Web Portal

"Do you understand the sense and usage of the web application?", answered 22 (78.57%) "yes, totally" and 6 (21.43 %) with "yes". 10 (35.71%) say that the concept looks interesting and they would definitely register, 15 (53.57%) answered with "yes - maybe", 3 (10.71%) are not sure. The websites speed was rated indifferently see Figure 7.13. The participants' evaluated websites "look and feel" on a scale from 1-5 (where 1 is very positive and 5 is very negative) as follows: 1 - 12 (42.86%), 2 - 11 (39.29%), 3 - 3 (10.71%), 2 - (7.14%), 5 - 0 (0%). 26 (92.86%) out of 28 participants can imagine to use the web portal in future, 2 (7.14%) said no, because of the missing mobile app. The "free-answer" question about the personal general impressions of the web portal revealed that nearly everybody liked the web application, the idea and features were emphasized positively. Examples of answers are:

"*I like it very much*", "*Very positive, looks interesting*", "*Nice idea, but the user interface can be simplified*", "*Clear structured, motivating, innovative features, sometimes too slow, nice basement for further extensions*", "*Great idea, I will try it in the future*", "*Attractive design, great idea, well structured*".

The question "What do you particularly liked?", brought quite similar answers. The whole concept, "route planner", "geo-caching features" and "badges" are honorably mentioned by different participants. Anyway, the question "What can be improved?" was diverse answered as follows:

"*Mobile app is missing*", "*The game*", "*Explanation of features*", "*Explain symbols and icons*", "*Performance/speed*", "*Design and performance*", "*Performance of route planner*", "*Help and explanation for complicated features*".

7.3 Summary

This chapter describes the application from users' viewpoint. The application's main features are illustrated by screen shots and the users' possibilities are described in detail. The images show the web portal's current "look and feel". The user interface design changed during the different development phases and will probably be edited in future too.

Basically the evaluation was successful, all selected participants are active sportsmen and nearly everybody of them had experiences of using training applications, what made the evaluation more valuable. However, the survey confirmed the results of the practical research in reference to motivation aspects, current popular applications and reasons for their usage. The prime reason to use such applications is to view, store and compare personal sport performances. The analysis of these data cannot be extensive enough. The second cause for usage is "sharing", nearly everybody shares his or her performance sometimes, nobody of the survey does it permanently, maybe they just want to share special performances. Games and competitions are interesting and maybe motivating concepts, but currently do not play a main role. This is probably based on the small number of applications, providing these features. Furthermore they are not well known in Austria for now.

The evaluation of the application states that the concept arose interest by all participants. The concept of gamification, especially badges is responsible for a new and positive user experience. The survey confirmed the valuation that many people do know the combination of "training app" and "game play". A main aspect of the survey was to query the usability of the application. Nearly every participant was able to handle the application and found the needed features, but the rating of simplicity showed that there is still potential to improve the input options. Especially more complicated input forms like "activity creation" including the route planner were judged indifferently. Speed and usability of the route planner were mentioned as improvable. The evaluation can be taken as a good basement for changes in the near future as well as for long-term planning. A further detailed interpretation of the evaluation results can be found in section 8.3.

8 Lessons Learned

This chapter discusses experiences and issues which occurred during the different project phases. These perceptions are split into the theoretical part and a practical one. The former part discusses chapters 1-3 and the latter one focuses on chapters 4-6. Some of the following experiences are also explained in the particular chapter's summary.

8.1 Theory

According to the project's goals, to build a social sport community including gamification, theoretical parts researched different application domains. These areas are: general social media concepts, social game play applications, sport motivation theories and fitness applications. At the beginning it seemed that some of the researched domains, especially the social media aspects, are nothing new, but their detailed research revealed some valuable experiences. These were flown into practical procedures later. The positive affect of game play appendages can be totally confirmed by the research. Serious games, gamification and other social games are able to bring new experiences to users, who are dealing with a non gaming issue. Especially gamification (the usage of game elements for non gaming activities) for sport and health, is up to date these days. The research of common sport and gamification applications confirmed this. It explains their success, shows strength as well as it displays issues and other possibilities of improvement for another product in this area. Such an approach would be an extensive combination of game play elements and GPS functionality. A deeper look into theory of psychological sport motivation brought further interesting input for the creation of game play elements. Because concepts which motivate people in the real world and which are used for example in physical education, can be ideally adapted by an virtual game.

8.2 Implementation

The decision to use a content management framework to implement the Web portal brought positive experiences as well as negative ones. Some of them directly belong to Drupal and others would probably also occur within any other CMS. For example, it seems that the usage of such a tool simplifies the design and architecture process, what is just partly true. Because the usage of tools and features offered by the software has to be well considered. Questions like "Which modules are included and

how are they used?", "Which components are self-developed?", "What kind of content types are introduced?" and many other questions are significant points. They have to be made early in the implementation phase and if they are wrong decided they will lead to constraints later. The implementation phase showed that many occurring tasks, were already solved by other Drupal developers before. In practice it depends on details if their solutions can be included or not. If the necessary adaption would be too extensive, the development of the component probably is the better solution. However, the quality of open source modules proves itself good and stable. Extremely rare occurring issues have been reported to the community, which were always answered and solved quickly. During the developing phase the application ran on different servers with very different performance results. Especially shared hosting servers were not able to bring enough performance, what made the web application unusable slow. Of course, the configuration and structure of the website is pretty extensive, although such slow response times were not expectable. The exact reason was not always recognizable, it is probably an interaction of different factors. The issues were solved by changing settings, the usage performance tools (Memcache, Boost) and a server change. Anyway, the independence of Drupal to its server, mentioned by literature, could not be confirmed in practice.
It was very important that the software was tested by different athletes during the whole implementation phase. Requirements described the product very well, but in practice of things look different. Their input was helpful especially in relation to the usability of the route planner and the management of training data. The wishes of those users who tested the system with different sports, could be directly considered and realized.

8.3 Usage Viewpoint

The evaluation was executed to fulfill different tasks. The demographic part has to query what kind of sportsman the participants are and how the application is perceived by those different athletes. The theoretical part surveyed the reasons of usage and motivational factors of different features provided by existing training applications. It was interesting to see that the web portal addresses beginners as well as advanced athletes in the same way. It makes also no difference if they train alone or collaborative and how often they do sport, because everybody can find an other usage of the sport software. The survey of application which are currently in use by the participants brought no surprise. As expected, Runtastic and Endomondo are the best known and are used by the majority. The last section rated the web application itself according to concept, functionality and general aspects. This part showed that concept is well received by the people, what is of course important. It is positive to see the gamificational approach brought new experiences to users. The usability is chugged as quiet good, but not perfect and improvable. This concerns primary the "route - creation" phase, according to speed and simplicity. This moderate result is probably attributable to the participants' first usage of the route planner, because the extensive functionality requires a short learning curve. However, this aspect is already known and mentioned in the chapter 9.2. Usability is one of the major success factors and the route planner is a core competence of the application, so the

critics have to be considered in the near future. Finally it was surprising that all the improvement suggestions concern details, no one expressed missing features or unnecessary functionality.

9 Conclusion and Future Work

The application includes a couple of various features at the moment. However, to run a successful community they all have to be enhanced and extended from time to time. This process can be seen in every successful Web application, to keep them attractive for their users. As discussed in section 2.4 providers of web applications can react on phases and development stages of their product by adapting functionality.

9.1 Conclusion

Motivating people to do sport activities is differently hard, someone has the intrinsic motivation to do it, someone else needs external motivational factors to start. Different sport and fitness applications established that they could be such a external trigger for people to do sports. But that does not mean that only beginners are interested in such an application. It can be seen on current successful fitness applications that they include members of all performance levels. The concepts, social training and collaborative training are getting extended by gamificational training nowadays and that is exactly where this thesis affiliates.

This thesis describes the design, the implementation and the usage of a web community combined with gamification appendages to motivate for sport activities. The main feature of the application is the creation and handling of GPS data, representing routes which are passed by sports. The prime motivation factor is the "social feeling", if people see the sporty behavior as well as the success of friends they will be motivated to do it in the same way. The second motivational aspect is the gamfication approach. The main game play element are levels representing the user's current performance capability. Athlets can increase their points by winning badges, the second big gamification concept. They exist in different types: geo-badges, performance-badges, sum-badges and fun-badges. Geo-badges are distributed over the map by users and can be won by everyone. All the other badges can be received by performing defined tasks. The system is designed that every athlete, from the beginner to the professional, gets challenges according to his or her current strength. That means that geo-badges are more or less bonus awards which help to increase or keep the user's level. But they are also an incentive to try new routes or areas near by the user's home base. A further important feature is that users are able to organize themselves in "teams". These groups provide the possibility of collaborative training as well as the distribution of content internal. Although the application is aligned to provide the whole usage simplified in a Web browser, an additional mobile application is unavoidable in the future. Users expect such apps and would not use the product without it.

9.2 Suggestions for Future Work

There are some additional features representing new functionality which would positively effect the portal. Some of them are just suggestions, which could be interesting for some user groups, others are absolutely necessary extensions, which would improve everyone's benefit. Examples for such extensions could be:

Mobile Applications

Are more or less must haves in practice. Each mentioned example in the application domain of sport and fitness provides applications for different mobile platforms. The Web portal would adapt an enormous improvement of usability and of user experience by mobile apps, although it is 100% usable without them. It is important that such apps would implement all the main concepts of the application mobile. That means that users are directly informed about a badge winning during their training, users can drop badges quickly wherever they are and users are getting indicated if they enter a competition track. These are only a couple of possibilities which functionality could be implemented. A search showed that Drupal's community provides different frameworks and tools as basements for mobile application. They exist for every common platform and allow base procedures like the interaction with the webserver.

Application Programming Interface

An API could be useful for different scenarios, because it opens the system and provides external applications access to existing resources. An example for a beneficial external usage of the data are recommender systems. If they could query the database they would be able to recommend suitable GPS tours to their users. If each foreign developer could access the data, it would force the system's distribution as well as its awareness. An interface for external parties is also standard for Web services today.

Extension of Internal Concepts

Beside uncoupled features the extension of existing functionality is always possible. The requirement process revealed some possibilities which were not discussed further because of effort or importance. The system's architecture is ready to integrate them but a selection has to be made, which of them bring benefits and are useful. Extensions of existing concepts could be:

- **User Performance Badges:** Users are also able to distribute performance badges to friends and the community. They are currently just able to create geographical badges. They would be able to generate own training plans or other badge combinations. The idea was discarded for now, because that may lead to countless, meaningless badges.
- **Team Competitions:** Is an idea which will be implemented in the near future. Teams should be able to compete in different types of challenges. Scenarios

could be that teams have to perform over a defined period of time, to beat other teams in collecting badges, run a distance or something else.
- **Exercises:** Are predefined tasks provided by the system to boost the user to reach a goal. The user has to do them periodically. The difficulty increases from time to time, and if the user skips or passes a task he or she would loose points. Such exercises have to be adapted on different performance levels and sports. That leads to a huge effort of elaboration for such training plans. To guarantee that they are serious, sport experts have to be included.
- **Personal Commitments:** Are personal challenges created by users for themselves. A user should be able to define a period of time and a goal. During this period he or she gets remembered and forced to reach the self defined goal. If the user fails he or she looses points. Because this concept is totally decoupled from the remaining game play and is already implemented by other fitness applications, it was not considered for now.

Recommendation Approach

Beside external recommender system, accessing the sport portals database, internal recommendations would be useful as well. This approach should not be a full fledged recommender system, but some content suggestions for users would be very helpful. The map, showing all the activities near the user's region is a first step to provide suitable routes to him or her. But they can be further filtered according to the user's skills, performance and usual behavior. The necessary data are already at the database. Another idea could be to recommend suitable training partners to athletes, doing the same sport, on a similar performance level and live in the same region.

However, the study of literature as well as the evaluation results of this project established that game based applications may have a positive future, if they implement the features in the right way. Furthermore these services have to be refined from time to time by small steps, to guarantee a positive user experiences always. Different application fields like education, sports, health and business are using their benefits, but an entering into each other digital domain may be thinkable in the near future.

Appendix

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CD Content

The attached CD contains all relevant data relating to this thesis. The folder structure and resources are described following.

Documents

Contains all documents structured as follows:

- PDF version of this document
- All referenced papers

Source Code

Contains the application's source structured as follows:

- Application's source code
- Database as MYSQL file

Evaluation

Includes all information in relation to the evaluations structured as follows:

- Evaluation form
- Summary of results
- Every single questionnaire