Adaptive Social Media Skills Trainer for Vocational Education and Training: Concept and Implementation of a Recommender System

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Abstract

The use of social media in the private and professional context is continuously increasing. Particularly in the private context most users are competent in dealing with these technologies. However, when it comes to apply social media in the professional context (e.g. communicating or searching for relevant information or integrating social media in classes or the preparation of homework), most users still show a lack of competencies. Thus, students and teachers would benefit from tailored access to online educational resources such as concepts, training materials, lesson plans, tools, etc. that support the professional use of social media. This paper presents the concept and the prototypical implementation of a recommender system for vocational education that fosters the development of each individual’s social media skills. Hence, recommendations of social media contents are based on each individual’s social media skill level and the current step in the teaching and learning process.

1. Introduction

1.1 Motivation

Social media has established in many settings of private and professional life. Particularly student’s use of social media in the private context is continuously rising [1]. The educational sector has become aware of these developments and the resulting potential of collaborative creation and sharing of teaching concepts, learning materials and best practices [2], [3]. But also companies increasingly integrate social media in their daily activities [4], [5], particularly in terms of corporate communication like marketing, public relations or advertising activities [6]. Although most users are familiar with the technical use of social media (e.g. how to create a Twitter account), many users however still show a lack of competencies when it comes to integrate these technologies in the professional context. One reason therefore is, that the training of social media skills is not yet sufficiently integrated in vocational education and training [7]. Thus, being able to integrate social media competently in the professional context not only requires technical skills but also the soft skills related to traditional knowledge management. These skills comprise for instance the ability to search and select relevant information in the social web to solve a certain task in the teaching or learning context (e.g. searching for the right information to prepare a term paper). Thereby, it is important to evaluate the information according to its credibility and validity (e.g. who is the producer of the information?). Furthermore, social media skills also comprise the ability to create information or being able to communicate information to the right target groups [8].

The social web allows each user to generate and share information. Thus, in many cases information in the social web is barely structured and not necessarily validated or correct. To foster the required skills for professionally using information and channels in the social web (e.g. in terms of risks and opportunities) we aim at an integration of social media education in vocational education and training. The goal is to make social media education become an integral part of vocational education and training for teachers and trainers as well as for students. Especially in the IT domain this in an important aspect, where employees are confronted with channels like blogs, forums, and social networks on a frequent basis for both knowledge consumption and production. A report from the German Ministry for Education and Research already emphasized the importance of social media education as a requirement to stay competitive in a more and more digitalized world [9].

To meet these requirements, we are developing a social media recommender system to support the education of social media skills. The system offers stakeholders of ICT vocational education (students,
trainers and teachers) tailored access to online educational resources like concepts, training materials, lesson plans, tools, etc., which support the professional use of social media. The system adapts to the social media skills and contextual factors of all stakeholders and recommends appropriate educational resources that match to the current step in the teaching or learning process. This paper focuses on the design and the implementation of the recommendation functionalities. To be able to recommend search and recommendation results we developed several filter and ranking functions that enable an individualized and context-aware generation of search and recommendation results according to several criteria (e.g. year of vocational education, learning fields or social media skill level) in order to learn from the user's behavior by using ontology evolution. These filter and ranking functionalities form the core concept of the social media recommender system, as they allow to continuously improve and adapt search and recommendation results to each individual's social media skills.

1.2 Research method

The social media recommender is developed as part of an interdisciplinary research project, which aims at a deep integration of social media education in the vocational ICT education chain. The research in this paper follows a design science-oriented approach. According to the design science methodology an artifact is being created in a prototypical approach in order to meet collected requirements fitting to a specific problem description [10], [11]. The knowledge base in design science consists of foundations (development of theories, constructs, models, and frameworks) and methodologies (formalisms, measures and validation criteria) [11]. The designed artifact represents a novel concept that supports context-sensitive and personalized learning in vocational education and training with the goal to foster each individual's social media skills.

The outline of this paper is as follows: First the underlying concept of social media skills is explained in Section 2. It forms the basis for the generation of recommendations under consideration of each individual's social media skills. Furthermore, the results of the related work analysis about recommender systems in e-learning scenarios are presented. Section 3 derives the requirements for the search and recommendation functionalities of the recommender system. Section 4 introduces the concept, system architecture and domain ontology, which form the basis for the filter and ranking mechanism that are also presented in this Section. Section 5 describes the implementation of the developed concepts, whereas Section 6 presents the results of the first evaluation. The paper closes with a summary of the main results and an outlook on future research.

2. Related work

2.1 Social media skills in vocational education

Social media skills describe the capability of adequately applying several types of social media technologies [12]. This comes along with the ability of their constructive and receptive use (social media production and consumption) [12]. Thus, a person having social media skills uses social media technologies with the goal to reach specific objectives. Social media skills and knowledge about social media can be described according to four facets [8]:

- **Skill facet 1:** The ability to select and manage information,
- **Skill facet 2:** The ability to understand and rate information,
- **Skill facet 3:** The ability to communicate and comment information,
- **Skill facet 4:** The ability to create and edit information.

The facet **select and manage information** describes the ability to select relevant information from a large amount of information and being able to critically evaluate its credibility (e.g. type of website, author(s) / originator(s) of the information, etc.). The skill facet **understand and rate information** describes the ability of effectively collecting and categorizing information (e.g. assigning keywords or tags, creating a collection of links, etc.). It also describes the ability to use the correct resources to stay up-to-date. The skill facet **communicate and comment on information** describes the ability of effectively sharing information with relevant target groups and being able to adequately comment on contents in the web (e.g. forum entries or articles in the web). The skill facet **create and edit information** describes the ability of actively creating, augmenting or modifying information contents.

Further, it comprises the ability to synthesize and consolidate information from multiple sources and to prepare information for specific target groups regarding content and language. To each of the presented facets, several media types are classified, which forms a basis for the social media recommender system to derive recommendations.
2.2 State of the art of recommender systems in e-learning scenarios

We analyzed several tools and research projects about recommender systems in e-learning scenarios. Thereby, one important aspect was the consideration of the user's social media skills while using these tools. TEDEd supports teachers to create lessons by searching for videos at Youtube that match the topic of a specific lesson. Teachers can enhance videos on Youtube by adding context or defining specific learning objectives for the students [13]. Thereby, multiple choice exercises or free text answering fields can be added to the selected video [13]. The tool supports to check the students' learning progress over a certain time span. However, the focus is rather on aspects related to content instead of fostering the skills of dealing with social media. The tool does not recommend already enhanced contents to users. Hence, aspects about personalization and context-awareness are not considered. TeacherTube is designed to allow stakeholders in the educational sector, particularly teachers, to share educational resources such as videos, audio, documents, photos, groups and blogs [14]. The tool contains a mixture of classroom teaching resources and others designed to aid teacher training. A number of students have also uploaded videos which they created as part of K-12 and college courses [14]. Although teachers can communicate with their students this tool does not take into consideration aspects about fostering social media skills. Furthermore, the tool does not take into consideration personal profile data or aspects about context-awareness. India Web 2.0 is a platform that contains teaching scenarios for the use of wikis, podcasts and blogs in vocational training for IT application specialists [15]. The teaching methods developed in this project are freely accessible and can be adapted to the requirements of each vocational education school [15].

He and Chu [16] present an algorithm framework that generates recommendations based on user's preferences, the general acceptance and opinions from social friends. Therefore, they carry out a semantic filtering of social networks. Their research mainly focuses on the correlation between user preferences and ratings to the preferences of friends. These correlations are used to design a better recommender system. However, the recommendations do not take into consideration each individuals' social media skills or the current step in the teaching or learning process. Fazeli et al. [17] present a trust-based recommender system for teachers. It describes how teachers can take advantage of learning networks as an infrastructure to support lifelong learning. The tool considers collaborative filtering methods to analyze interactions and collaboration between teachers within a social environment [17].

Although the tool monitors and analyzes the teacher's interactions, recommendations are not derived with the aim to foster the users' social media skills. Manousleis et al. [18] present generic architecture layers of adaptive educational hypermedia systems under consideration of the research of Karapiperis and Sampson [19]. The first layer includes the representation and organization of knowledge about educational content (learning resources, domain ontology and user model). The other two layers include the adaptation mechanisms as well as the provision of adaptation results to the user [18]. Figure 1 gives an overview about the results of the literature analysis.

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<th>Supported functionalities</th>
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<td>Fostering social media skills</td>
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<td>Creation of private and public learning areas</td>
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<td>Provision of several content types</td>
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<td>Focus on vocational education and training (which ideally reflects in the knowledge model)</td>
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Figure 1. Results of the literature analysis about recommender systems in e-learning scenarios
The analysis of the related work has shown that so far, most tools focus on the recommendation of contents rather than the fostering of social media skills. Although some of the analyzed tools take into consideration usage behavior, so far no tool focuses on fostering social media skills based on each individual's skill level. Furthermore, most of the analyzed tools do not consider context-awareness and aspects about personalized learning and teaching, particularly in terms of vocational education and training.

3. Requirements derivation

In addition to the state of the art analysis and the developed social media skills model we carried out a workshop with teachers, trainers and students of vocational education to find out which tools are already used and which requirements would be helpful in the context of vocational education and training. Based on these findings we derived the following requirements for the social media recommender system.

Requirement 1: The social media recommender system should enable a multi-dimensional classification of media content: Thereby, it has to incorporate several different media types. Recommendations about appropriate media types should be derived based on the social media skills model, which reveals that several media types are assigned to each of the four facets (see Section 2.1).

Requirement 2: Users should have the possibility to create personal learning areas in which they can create, upload and group own learning or teaching materials and share it with other users. Furthermore, the social media recommender system should support a browsing and filtering of media resources.

Requirement 3: The social media recommender system should take into consideration the social media skills of each involved stakeholder by adapting search and recommendation results to each individual’s social media skill level. Media contents should be individually provided through a recommendation stream that is embedded within each part of the system.

Requirement 4: The social media recommender system should be able to be easily adapted in terms of pluggable and easy extension of rankers. Configurability of evaluation functions enables easy extension. Particularly in terms of considering each individual's social media skills it is important to continuously adapt recommendations to each individual's skill level.

Requirement 5: The social media recommender system should derive recommendations based on the content of vocational education and training. To fulfil this requirement adequately we restrict our focus on the scenario of vocational education and training in the IT sector as all vocational apprenticeships in the IT field are characterized by similar learning and teaching contents.

Requirement 6: The social media recommender system should be able to evaluate complex, semantic interdependencies. This can be ensured by ontology matching mechanism that enable additional evaluation criteria based on semantics [20], [21].

4. Concept overview

The social media recommender system represents a novel concept for teaching social media skills according to the four facets described in Section 2.1. It is not a classic producer-consumer system, where pedagogical units such as courses, lectures or tests are taught to the user. We analyze the social interactions of different actors in vocational education, in order to identify their strengths and weaknesses in certain knowledge areas. This serves as input for novel support facilities helping users to deal with social media. This social media recommender system both provides methodological guidance as well as specific contents and resources to help users improve their social media skills. Figure 2 depicts the architecture of the social media recommender system.

Figure 2. Architecture of the social media recommender system

The system architecture follows a classical three-tier architecture, including a data layer, an application layer, and a frontend layer. A detailed description of the core architecture can be found in [22]. As can be seen, the search and recommendation engine takes a central role within the application layer of the social media recommender system.

First, to compute search results and recommendations, it builds upon the data corpus stored
in the data layer. To this end, it uses dedicated APIs for ontology and data access to retrieve content metadata (e.g. about expert information, descriptions of social web tools, experience reports, training material, etc.) as well as static user profile information including user role and interests and dynamic user behavior data like user-system interaction logs. Data may be stored internally in databases or retrieved from external resources via crawlers, making it possible to connect and index external web pages.

The search and recommendation engine represents the central component of the social media recommender system. Within the application layer, it is tightly integrated with other modules like the authentication and personalization module, which is responsible for personalized information delivery that is optimized for desktop PCs, laptops, but also mobile devices such as tablets. The search and recommendation engine contains the filters and rankers which are going to be explained in more detail in the Sections 4.2 and 4.3.

From the frontend layer, the search and recommendation engine receives permanent input through the visualization and interaction API, which forwards user events through an event API to an internal event processor. Events include basic user-system interactions such as registration, login, and logout of users, but also may indicate that users consumed certain pieces of content, rated learning objects, or participated in discussions within a certain context. In this line, the events are a central source for personalization and enable proactive recommendations.

A gap analyzer component evaluates usage data in real time and leverages information from the domain ontology to identify knowledge gaps related to social media skills or weaknesses within the process of searching for the right media, neglect of guidelines for the creation of certain content, etc. Based on the usage behavior the social media recommender system identifies knowledge gaps (e.g. a student has problems while s/he is creating a blog entry). The statistics in the knowledge base for the respective push recommendations are adapted accordingly, causing the recommender engine to be aware of these changes and to trigger a push recommendation towards the client. Whenever the gap analyzer discovers knowledge gaps for a user, push recommendations are sent to the user via the frontend.

4.1 Domain ontology of the social media recommender system

Figure 3 shows the domain ontology of the social media recommender system which is modeled using the W3C standard OWL. It depicts the most important concepts as well as the semantic relationships of the involved concepts and stakeholders.

In previous work, ontologies have been proposed for representing learning object content [23] and context information supporting adaption and personalization [20], [24], [25]. With the goal to build a domain-specific ontology covering all the concepts and challenges behind the social media recommender
4.2 Filtering components

The search and recommendation component depicted in Figure 2 serves as a central entry point for all information needs and requests users might have in their teaching and learning processes. Search and recommendation requests are triggered through the visualization and interaction API, which allows users to manage media and to use the domain ontology of the social media recommender system. In doing so, users are either enabled to actively carry out searches or to receive context-aware recommendations. In a first step the received query from the client is enriched with contextual data that can be derived from the user's individual or working context. These relationships are extracted from the domain ontology. Within the information retrieval process, the choice of possible return entities has to be narrowed down (e.g. “only show videos”, “only show material for specific skills”, etc.). The filtering component carries out a first selection of retrieval candidates. The following subsections describe the filtering components of the social media recommender system.

4.2.1 Competence Model Filter. The Competence Model Filter refers to the selected facet of the social media skill model. It rejects media types that do not match to the selected facet. For instance, matching media types to the skill facet create and edit information are forums, social networks, chats, IM and media sharing sites. Items of another category are not recommended when users carry out interactions within this skill facet. It is particularly relevant, when users use the social media skill model as entry point to receive recommendations. Here the system provides in the frontend an overview about the four facets of the social media skill model where users can select a facet regarding the social media skill in which they are most interested. After selection of the skill facet users are provided matching media types through the recommendation stream.

4.2.2 Document Filter. The Document Filter filters contents according to the different media types within the social media recommender system. In the ontology, the required content classification for this filter is depicted as ContentObjectCategory (see Figure 3). The Document Filter filters documents types according to training material, learning documents, field reports, web resources, websites, web portals, social web channels, social web tools, expert information, training concepts, lesson plans, reports, scientific publications, concepts and MOOCs.
4.2.3 Trainer Filter. Some contents rather match to teachers than to students. The Trainer Filter carries out a first pre-selection of contents that match either to teachers or to students. For instance, it separates items of the category "expert information" for students. Instead of recommending expert information to students, the social media recommender system recommends appropriate training material such as learning documents, exercises, courses or learning games, whereas teachers rather receive recommendations about appropriate educational concepts, curricula guidelines, scientific articles or teaching scenarios. These contents for teachers are classified in the ontology as ExpertInformation.

4.3 Ranking components

After a first selection of search and recommendation results by the presented filters, the ranking component evaluates these retrieval candidates to bring the recommendation results in a certain order. The goal is to provide the most relevant content for the current situation in the teaching or learning process. To achieve the best search and recommendation results, the social media recommender system uses a plugin-based ranking system. It follows a multi-criteria approach, i.e., several aspects are taken into account when deciding which object should be recommended. For each data type within the social media recommender system specific ranking configurations exist. Hence, it can be defined which plugins are used together with a certain data type and how the plugin should be weighted. This allows us to easily extend and adapt our system. The different partial ranking of certain ranking plugins are combined in a global ranking function of a ranker:

$$R_u(c_i) = \prod_{m=1}^{k} \alpha_{m,u} \cdot p_m(c_i,u) \cdot \sum_{n=k+1}^{j} \alpha_{n,u} \cdot p_n(c_i,u)$$  

(1)

$R_u(c_i)$ denotes the overall ranking value for a specific content item $i$ of a certain user ($u$). The overall ranking function itself consists of various ranking plugins $p_n(c_i,u)$ that are weighted by a personalized ranking weight. Depending on the specific characteristics of the search scenario, ranking plugins can be added in a multiplication or addition mode. The multiplication mode can serve as a specific filtering within the overall ranking function.

4.3.1 Competence Ranker. The Competence Ranker describes which social media skills should be individually fostered according to the four facets of the social media skill model (see Figure 3). The information is gained via gap analysis to gain information, which media types have not been used or fostered by a certain user so far. If e.g. a user often comments on information or uploads information within the social media recommender system, it recognizes that this user is able to competently deal within the facet communicate and comment on information. If however the same user has not gained any information about selecting and managing information the social media recommender system recognizes this knowledge gap and derives recommendation results that are classified to this facet of the social media skill model.

$$co(c_i) = \sum_{x=1}^{r} co(\text{comp}_x, u)$$

(2)

4.3.2 Lucene Ranker. The Lucene Ranker performs a simple full text search over the objects description containing all available profile information and search query terms using term frequencies and categorizations. Apart from the ranking, Lucene is also used for stemming and normalization throughout query evaluation of natural language search queries.

4.3.3 Usage Ranker. The usage ranker refers to the amount of times an object was used by the users of the social media recommender system.

$$u(c_i,u) = \frac{\text{use} (c_i)}{\text{max use} (c_i)} \forall j = 1,...,n_j \in \mathbb{N}$$

(3)

The usage of a content item is represented by a numerical value that is adapted over time. The usage count for the given object $c_i$ is divided by the maximum usage counts of all objects. However, as the usage count might be distributed quite asymmetrically, we use quantiles as a compromise between accuracy and computational complexity.

4.3.4 Rating Ranker. The Rating Ranker considers the average user rating. In doing so, likes that have been carried out by teachers and trainers are weighted stronger than likes carried out by students.

$$r(c_i,u) = \frac{\overline{r(c_i)}}{\lambda}$$

(4)

The rating function puts the average rating of a given content object ($r(c_i)$) in relation to the maximum
rating of the rating scale $\lambda$. The baseline assumption for this is, that the higher the rating the better the ranking.

Figure 2 shows the display of recommendations in the social media recommender system based on the presented filters and rankers. The design and the placement of the functionalities has been derived based on the workshops with representatives from the German vocational education sector (see Section 3). Furthermore, a first evaluation of the design and the usability of the recommendation widget has been carried out (see Section 5).

Figure 4 shows the display of recommendations in the social media recommender system based on the presented filters and rankers. The design and the placement of the functionalities has been derived based on the workshops with representatives from the German vocational education sector (see Section 3). Furthermore, a first evaluation of the design and the usability of the recommendation widget has been carried out (see Section 5).

Users are able to optimize the recommended search results by scroll bars (left side of the recommender stream). The aforementioned rankers determine the weighting of the recommended items. Within each tab of the recommender system, different rankers are used. All user interactions within the system are logged to be used for the generation of future search and recommendation results.

4.4 Implementation

In order to provide the recommendation and search functionalities on the web as well as on mobile devices, where limited computational power and slow Internet access is an issue, a client/server architecture has been realized. The client/server architecture allows a clear separation between the user interface and the information retrieval and data mining logic. The client side is implemented using pure javascript and html and only provides the user interface, e.g. the recommendation and search widget. A REST interface enables the data transfer between client and server. In a first step the filtering mechanisms reduce the number of media objects by eliminating irrelevant entries. Relevant filter criteria are for example the specific content type or the user’s social media skills as described in Section 4.2. Afterwards, the ranking mechanisms assign a ranking score to each remaining entry according to its relevance, so that an ordered list of suitable media objects can be derived. Filtering and ranking run encapsulated. This led us to the decision to use Java Enterprise Edition (JEE) which further separates the business logic from the data tier and the client side. Expensive operations are moved to the server. Every module on the server is implemented as an enterprise bean. Despite the fact that this approach provides the envisioned modularized structure, it is easy to leverage the power of the JEE platform. Furthermore, to reduce the traffic only the IDs combined with the scores calculated by each ranker are sent to the client, where the IDs are mapped to the actual media objects.

Figure 4 shows the overall recommendation process and respective screenshots from the implemented solution. A search is triggered from the client applications. The internal recommendation processes the query and converts it into an internal representation. Furthermore, it performs the filtering and ranking operations as described in the preceding subsections.

The results are returned to the user for selection. Afterwards s/he is able to tweak the results by changing the significance of the different rankers for the query. This can be achieved by changing the sliders of the rankers in the recommendation (see Figure 5). Hence, no additional Rest request is needed, but it can be computed on the client side by accessing the cached data. As described in Section 4.3 the score of a media object is then calculated by the ranking function taking into account the pre-calculated ranker scores and the updated ranker weights. Furthermore the selection of
the results as well as any other explicit or implicit actions of the user are tracked in the backend and are used to improve upcoming searches of the users as well as proactive recommendations.

5. Evaluation

Several iterations of the evaluation are planned to ensure an incremental development of the prototype. The concept of the GUI was evaluated by carrying out several qualitative interviews with students from vocational education and training. In doing so, aspects about usability like the adjustment of symbols, interaction fields and the designs of the welcome page and the recommender stream have been evaluated. The feedback we gained has been integrated in the design of the prototype. In the second evaluation we carried out lab tests with students from the IT field. In this round, we also carried out a first evaluation of the developed filters and rankers. The questionnaire was divided into four major parts: In the first part we evaluated the design and the usability of the prototype. Therefore, the students had to accomplish several minor tasks. In doing so, we gained feedback about the usability within the registration at the system, the navigation to contents, the creation of learning areas and searching for contents. The question about the adequacy of the task when registering to the system and downloading contents has been evaluated with 3.9 on a scale from 1-5, where 5 represents the highest score and 1 the lowest score. The usability of carrying out a search within the system has been evaluated with 4.7. The question about the usability of creating a learning area has been evaluated with a total value of 3.8.

The second part of the evaluation focused on the quality of the search results and the embedment of the recommendation functionalities (see Figure 4). The test persons had to carry out a walkthrough. First, they had to search for information about the use of Twitter in teaching. In doing so, we analyzed the usage behavior (which search terms have been used, etc.) as well as the quality of the search results. The Lucene Ranker has been evaluated according to the question, whether the most relevant results have been shown on top of the result list (sorted list by relevance). The value was 3.9. The question whether search criteria have been considered was evaluated with a total value of 4.8. We also asked the participants whether results have been shown that were unclear for the user (why especially these specific results have been shown). This question gained a total value of 4.4. The recommender stream has been evaluated according to design / usability as well as the quality of the recommendation results. The question whether the adaptation of recommendation results is self-explanatory has been rated with a total value of 2.91 whereas the question whether it would be desirable to classify recommendation results according to more criteria gained a total value of 2.1. The results have shown that particularly in terms of the usability, the recommendation stream has to be designed more self-explanatory and functionalities of the recommender functions should be sharpened.

The last part of the evaluation consisted of the determination of the System Usability Scale (SUS) and ISONORM. The total value for SUS was 70.45 whereas the total value for ISONORM was 94.0.

6. Conclusions and Outlook

This paper presented a personal recommender system that supports teachers, trainers and students of vocational education to carry out teaching and learning processes under consideration of each individual’s social media skills. First, the underlying concept, domain ontology and system architecture have been introduced followed by an explanation of the filter and ranking mechanisms that enable to evaluate search and recommendations results under consideration of the user’s personal profile and the current step in the teaching or learning process.

The feedback of the first two evaluations has already been integrated into the social media recommender system. The next evaluation is going to be carried out in form of a large field test in a real-life environment to have a sufficient sample size, which ensures a qualitative evaluation. In doing so, aspects about usability like effectiveness, efficiency and satisfaction as well as a functional and a performance evaluation are going to be carried out. The functional evaluation will be carried out according to state of the art information retrieval metrics such as precision, recall and fallout. The functionality of the recommendation results will be evaluated by use of the Discounted Cumulative Gain (DCG) which measures the usefulness of a recommended item based on its position in the result list (in the context of this paper the position in the integrated recommender stream).

The authors are aware of the risks that may occur particularly in the initial testing phase, as the amount of uploaded and linked contents determine whether the social media recommender system will be successful or not. For this reason, the project members are currently uploading and linking media contents to the platform. Following iterative research and development principles, all steps can have back-loops to previous steps, to align requirements from users with results from the conceptual work.
7. Acknowledgments

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8. References


