User Profile Modeling in eLearning using Sentiment Extraction from Text

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Abstract. This paper addresses an important issue in the context of current Web applications because there are new ideas of providing personalized services to users. This part of web applications is a very controversial one because it is very hard to identify the main component which should be emphasized, namely, the development of a user model. Customizing an application has many advantages (the elimination of repeated tasks, behavior recognition, indicating a shorter way to achieve a particular purpose, filtering out irrelevant information for an user, flexibility), but also disadvantages (there are users who wish to maintain anonymity, users who refuse the offered customization or users who do not trust the effectiveness of personalization systems). This allows us to say that in this field there are many things to be done: the personalization systems can be improved; the user models which are created can be adapted to a larger area of applications, etc. The eLearning system created by us has as an aim to reduce the distance between the involved actors (the student and the teacher), providing easy communication using the Internet. Thus, based on this application students can ask questions and teachers can provide answers to them. Then, on the basis of this dialogue using the sentiment extraction from text, we built a user model in order to improve the communication between the student and the teacher. Therefore we built a user's model, but we helped the teacher to understand better the problems faced by the students.

Keywords: eLearning, Sentiment Extraction, User Profile Modeling

1 Introduction

Web pages are customized for specific users based on certain features such as: interests, the social class they belong or the context in which they access the pages. Customizing itself starts with creating a user model that includes modeling skills and the user's knowledge. This model can predict (as appropriate) normally carried out mistakes during the learning process because it is basically a collection of user's personal data.

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The models of users are found in social Web and are used to describe how people socialize and how they interact via the World Wide Web. For example, people can explicitly define their identity by creating a profile in social networking services like Facebook, LinkedIn and MySpace or tacitly by creating blogs to express their own opinions.

GNU Mailman[1] is free software for managing electronic mail discussion and e-newsletter lists. Mailman is integrated with the web, making it easy for users to manage their accounts and for list owners to administer their lists. Mailman supports built-in archiving, automatic bounce processing, content filtering, digest delivery, spam filters, digests (RFC 934 and RFC 1153), Usenet gateways and more. It provides a web front-end for easy administration, both for list owners and list members.

Our system is similar to the one presented before, but in addition we have approached the subject to achieve a user's model in the eLearning system and have exhibited different traits that underlie it, such as interests, knowledge, experience, goals, personal traits and work context. In addition, we describe the created patterns, the forms of representation (e.g., vectors or arrays of concepts), but we also discuss about the recommendation systems (systems that give users some recommendations depending on the created model or depending on their interests).

For creating the user model we used a module for extracting the sentiment from Romanian texts similar to [1], and so we emphasized the positive (*frumos* – En: *nice*, *excelent* – En: *excellent*), negative (*groaznic* – En: *awful*, *teamă* – En: *fear*) or neutral (*a merge* – En: *to go*, *masă* – En: *weight*) significance of terms from a text. Also, we identify the role of negation (*nu* – En: *not*, *niciodată* – En: *never*), of diminutive words (*mai puțin* – En: *less*, *probabil* – En: *probable*) and of intensification words (*desigur* – En: *sure*, *cert* – En: *certain*). To investigate the significance of each term we used Romanian WordNet[2] and after that we created our own resource with specific terms. Thus, we first add general terms about people, taken from Maslow's pyramid of human motivation[3] [6], then we add for each of these terms its synonym, hyponym, hypernym and after that we add to our custom resource the field's terms for which we built this system.

The application is a site created for second year students from our faculty (Faculty of Computer Science, "Alexandru Ioan Cuza" University of Iasi), where they could ask the teachers questions on certain subjects. The purpose of this application is to contribute to the strengthening of teacher-student relationship through ease of communication between them in moments when they cannot meet for various reasons. Of course, for each of the two types of users who interact with the application we provide specific functionality. Thus, a student may ask questions with a specific purpose stated explicitly or with a certain priority and can view the answers provided by the teacher, while a teacher can answer questions and can view a full report of each student's work on the site.

Using this theme (the teacher-student communication) we built a database of features which was modeled by our system for each student. To assess the quality of

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[1] GNU Mailman: http://www.gnu.org/software/mailman/index.html

[2] WordNet: http://wordnet.princeton.edu/

[3] Maslow hierarchy: http://en.wikipedia.org/wiki/Maslow%27s_hierarchy_of_needs

these results on the one hand and to improve the quality of the recommendation system on the other hand, we created two psychological tests which we have offered for students to complete. Finally, based on this information we were able to formulate a recommendation for teachers in order to improve the communication with students.

2 eLearning Elements

Both teachers and psychologists have concluded that the activity of learning is a process which involves all the components of human personality, such as from the simplest to the most complex targets the entire human system is put in motion in order to achieve the reception, the processing, the interpretation and the exploitation of the information.

The eLearning concept involves combining art and psycho-pedagogy because the starting point in building such a system is the knowledge of learning mechanisms (in order to work more efficiently, so as to assimilate through these technical systems).

eLearning[4] (Electronic Learning) is a type of technology supporting education in which training takes place via computer technology. This form of education is used in many areas: in companies to provide training courses for employees, in universities to define a specific mode to attend a course (especially when students do not take any courses to date).

Although it is said it does not favors face-to-face interaction (the user uses only the computer to find the necessary information) as opposed to the standard education where there is always one teacher who teaches the student, this new educational technology can be used in combination with already established techniques: the teacher can enrich his speech by using such an educational system (he presents to his students information which have easier to assimilate representations associated by the system).

Distance learning includes different ways of deployment and technologies to provide instruction (correspondence, audio, video, and computer). This implies a physical distance between the education's actors (student-teacher). The eLearning systems recognize this distance and they are trying to substitute it with a variety of strategies to encourage the interaction between the student and the teacher by offering new possibilities: the exchange of messages, documents or answers to required tasks.

An eLearning system (for distance training or virtual education) consists of a planned teaching-learning experience and it is organized by an institution which provides mediated materials in sequential and logic order to be treated by students in their own way, without forcing the participants to be present in a certain place at a certain time and to carry out a certain activity. Mediation is done in various ways, from the material on CD (possibly sent by mail) to technologies for transmitting content via the Internet.

For example, AeL (Advanced eLearning)[5] is an integrated system for teaching/learning and content management, which facilitates the work of the actors involved in designing and deploying the educational process: teachers, students,

[4] ELearning: http://en.wikipedia.org/wiki/E-Learning

[5] AeL: http://advancedelearning.com/index.php/articles/c322

evaluators, content developers. Although initially it was built for universities (especially for the form of distance learning), currently it is used in school education being extremely suitable for studying different languages, regions, levels of knowledge or types of organizations. The AeL platform, designed in multilayer system, represents: a standard client application web browser type and an application server based on Java platform.

One of the main characteristics of our eLearning system is related to the possibility to provide a two-way communication between the teacher and the learner with aim to reduce this distance between them. So, after the students log in they can see the electronic material for current courses and labs, can ask questions and can see the answers to their questions or to another questions, and the teacher can see these questions and can provide answers to them, all acting in real time.

3 User Modeling

Because of the continuous expansion of the Internet and the WWW's (World Wide Web), interconnected system of documents accessible through the Internet, and of the increasing number of computer users, the software systems must be increasingly more adaptable and that means that the systems must adapt depending on its user's interests, skills and experience (the users can be from a wide range of areas).

Although there were built graphical interfaces for computers more accessible for different types of users (as work field and interests, age and experience), there were not yet built good interfaces for each user.

Creating user models (User Modeling) is a research area which tries to build models of human behavior in an environment where human-computer interaction is specific. The purpose is not to imitate the human behavior, but to make the program to understand the user's desires, needs and expectations during the interaction. Moreover, the aim is that the system to be able to help the user to solve certain tasks (available/proposed by the program). The computerized representation of the user is called user model and the systems which create and use such models are called modeling systems.

Our modeling system combines ideas from adaptive hypermedia systems [2] and from recommendation systems [3, 7], and additionally we come with techniques from computational linguistics which allow us to extract sentiments from texts or to identify "*similar questions*". Thus, our system comparable with an adaptive hypermedia system, built the user's models starting from user's interests, desires and levels of knowledge and also it adapts the program's interface accordingly during the interaction with the corresponding actors. Similar with the recommendation systems our system is able to recommend to students which professor is most appropriate to a certain type of question or to recommend similar questions with available answers.

The features used by our system to obtain a user's model are:

a. *Knowledge* – for that we consider a basis accordingly with the student's current year (e.g., 2nd year), but we consider additional information, like grades at taught courses for a specific domain. For example, to analyze the

questions related to an advanced course we consider grades from basic courses followed in previous years.

b. *Interests* – represent the competencies that the user would like to acquire. We suppose that the interests of the students are related with the areas in which they ask questions. For example, if a student asks a question about a discipline called "Advanced Java Techniques" we suppose he wants to assimilate more about some specific Java techniques.
c. *The intention* – represents the user's aim during its interaction with the adaptive system. The student's intentions are: asking questions, finding responses, consulting the recommendations proposed by the system, filtering the existent questions. Through these options provided by the system, the student can find support to resolve homework from different areas or for the projects work preparation.
d. *Previous experience* – this is relevant for the system: work experience, the ability to speak a language. The student's experience is supposed to be in accordance with the year of study (e.g., A student in the third year has experience in courses from second year as opposed to a second year student who only studies these courses).
e. *Individual traits* – the components which define the user as an individual are: personality, cognitive traits, learning style and these are extracted through personality tests. In terms of individual features, the system focuses on each student's type of character and on identifying the appropriate scope of his work and they were extracted by two personality questionnaires.
f. *Work context* – it is approximated by elements such as the following: user's platform, location, physical environment, personal background.

We gave to users a list of areas about which to ask questions to a specialist and we considered that their interests are the areas that they choose to raise the question with the aim of finding out more information about it. The list contains the following subjects: current courses (*Software Engineering*, *Advanced Programming in Java* etc.) and general information courses (*Work License*, *Research Projects*, etc.).

The eLearning system collects explicitly information about the user on basis of two psychological tests. Thus, the system retrieved some personal traits of the student that couldn't be taken otherwise, namely, the type of character (*nervous, emotional, violent, passionate, sparkle, phlegmatic, amorphous or melancholy*) and the type of area in which they would like to work (*conventional or conformist, entrepreneurial or persuasive, investigative or intellectual*).

Additional to information's extracted explicitly from a user we used a software agent to extract information automatically. In this way, we have enriched the knowledge base about the user drawing some conclusions on the information entered explicitly (e.g., if a user explicitly specifies that he needs a response immediately and he receives it in less than 24 hours we may conclude that he's a happy user). Also, a professor can be informed by an agent about the student's grades from previous years, in order to help him to understand better why the student addressed some question.

4 Sentiment Extraction

The proposed system is based on the idea that in a text the words have no emotional charge (they describe facts and events), but they are emotionally charging according to the interpretation of each reader and each author's intention (in accordance with their interests) [1]. These interests are usually composed of personal needs, concepts that meet these needs, motivational factors, social and historical knowledge of facts, information circulated in media. These factors are called "knowledge base", which is generally composed of the general knowledge of words and their meanings, affective terms and emotion triggers.

An *emotion trigger* is a word or a concept in accordance with the interests of the user which lead to an emotional interpretation of the text's content. With these words, we built a database which enables us to classify and determine valency and feelings from text.

We will now present how we identify and how we classify the valences and the emotions presented in the texts written by students. To do this similar to [1], first we build incrementally a lexical database for Romanian language (which contains words that trigger emotions) to discover the opinions and emotions in the text at the word level (recognizing in it the positive, negative or neutral side of the sense). The second step is to assign valences and emotions to the terms from the database, and the third step is to identify the valency modifiers.

First step: In order to build a database with words that represent emotion triggers, we start from terms presented in "Maslow's pyramid" (it contains the hierarchy of human needs which are about 30 in English) and we translate them to Romanian. Because the number of terms is relatively small we disambiguate them using Romanian WordNet [8], and after that we associate with every term the set with synonyms accordingly with words sense. In this way we are sure that henceforth each new word will hold the meaning for which was added.

After that, we used again Romanian WordNet in order to add for every term all corresponding valid meanings and valid grammatical categories from Maslow's pyramid. For these new words we add hyponyms and the words which are in entailment relation.

Similar, we apply the same steps to the terms that are parts of the Max Neef's matrix [5], who believes that human needs are equally important, few, finite and classifiable.

Additionally, we consider that the terms related to exams or to dead-lines are also emotion triggers and we added to our database terms like: *punctaj* (En: *score*), *notă* (En: *note*), *termen limită* (En: *dead-line*), *examen* (En: *exam*), *parțial* (En: *partial exam*), etc.

The second step has as an aim to assign valences to the emotion trigger terms from the database built in step 1. For this the following rules presented in [1] were taken in account:

- The main trigger emotions and their hyponyms are given a positive value.
- The antonyms of the above terms are given a negative value.
- The term's valence is modified according to the modifiers (terms that deny, emphasize or diminish a valency) of which are accompanied.

At **third step** we define a set of valence modifiers (shifters) in Romanian starting from English modifiers from [1] in order to determine the changes in meaning of above emotion triggers. Additionally we add specific shifters accordingly with the courses followed by the students. The shifters can change a term's meaning radical, from positive to negative or vice versa, or can change a term's meaning and to make it neutral. We consider the following set of shifters that contains:

a. Negation words: *niciodată* (En: *never*), *nu* (En: *no*) that change the valance's sign.
b. A set of adjectives that enhance the meaning of a term: *mare* (En: *high*), *mai mult* (En: *more*), *mai bine* (En: *better*), *profund* (En: *intense*).
c. A set of adjectives that diminish a term's meaning: *mic* (En: *small*), *mai puţin* (En: *less*), *mai rău* (En: *worse*), *mai degrabă* (En: *rather*).
d. A set of modal verbs *a putea* (En: *can*), *a fi posibil* (En: *to be possible*), *a trebui* (En: *should*), *a vrea* (En: *to want*). They introduce the concept of uncertainty and possibility distinguishing between events that have occurred, could take place, are taking place or will take place in the future.
e. A set of adverbs that emphasizes the meaning of all content: *cu siguranţă* (En: *definitely*), *sigur* (En: *certainly*), *cert* (En: *sure*), *în definitiv* (En: *eventually*).
f. A set of adverbs that change valence and diminish the entire context's emotion: *posibil* (En: *possible*), *probabil* (En: *probable*).
g. The terms which add a note of uncertainty to the context: *abia* (En: *hardly*). These terms may add uncertainty to the positive valence of context, even if in the text does not exist other negative terms.
h. Connectors: *chiar dacă* (En: *even if*), *deşi* (En: *although*), *dar* (En: *but*), *din contră* (En: *the contrary*) can enter information, but can influence the text they belong.

Negations are used to switch to the opposite meaning of a term while intensifiers and modifiers have role to increase or to decrease the valency degree of a term.

The main observation to be mentioned here is the following: for a valency modifier to fulfill its purpose (to alter the term's valence), in the text must be expressed an attitude (who's understood to be modified).

5 The System

From the beginning we established the site's purpose: to build a consistent database with models for students, after investigation steps, in order to identify and to interpret sentiments from student's questions. To achieve this objective we built two interfaces: one for second year students from our faculty (the Faculty of Computer Science, the Alexandru Ioan Cuza University of Iasi) and one for their professors. The system's architecture is presented in Figure 1.

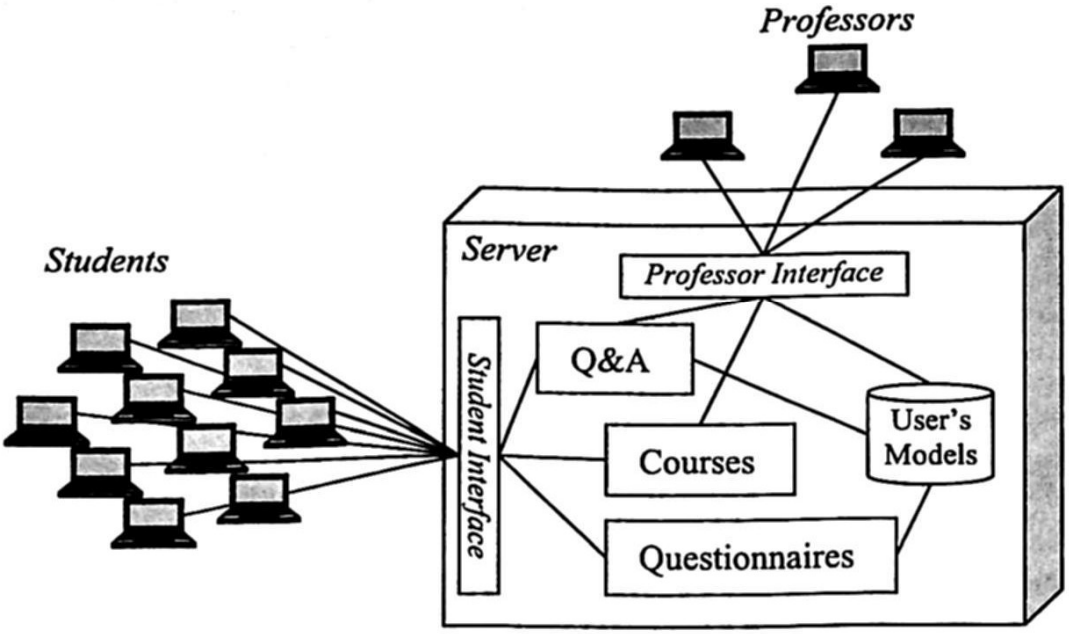

Fig. 1. The system's architecture

Student's Interface: after registering, every student receives an account that allows him to communicate with his professors. A student has access to the following components:

a. *Courses page* – here a student can find the available courses and can assist to a preferred course. For every course there are electronic materials, presentations, practical or theoretical exercises and useful links.
b. *Question&Answering page* – allows and facilitates discussions between students and professors. Here, the students can ask questions related to current courses or general questions (regarding the work license etc.). Every question has additional information about priority (*normal*, *urgent*, *trivial*) and about the student's motivation (*to solve problems*, *to have more knowledge*, etc.). Moreover, the students may request a meeting with the teacher when they believe that a discussion face to face would help them more.
c. *Questionnaires* – that help our programs to build the user's model. Here we consider two types of questionnaires: first is for the character type *(nervous, emotional, violent, passionate, sparkle, phlegmatic, amorphous or melancholy)* and the second one is related to the area where they would like to work *(conventional or conformist, enterprising and persuasive, investigative or intellectual)*. The first test is composed of 12 questions and the second test of 25 questions and it was constructed following the Holland test[6] model.

The Professor's Interface: after registering, every professor receives an account that allows him to communicate with his students. A professor has access to the following components:

[6] Holland test model: http://www.hollandcodes.com/my_career_profile.html

a. *Courses page* – in order to add new courses and new materials for them. Also a professor can see a student's comments related to courses, the number of students that attend the courses and the number of students that resolve exercises and their proposed solutions.
b. *Question&Answering page* – the professors can answer to questions related to their courses, but they may also respond to general questions or to questions related to other courses. The order of answers depends by the priority of the questions and the answer's content depends by a student's motivation (a simple answer if the student wants to solve an exercise or a detailed answer if the student wants to use some techniques in order to implement complex projects, etc.). In addition, the teachers can arrange meetings with students who have requested it explicitly.
c. *User's Models* – this page can be accessed from Question&Answering page with aim to understand better the question and in order to identify which is the desired answer.

Both the teachers and the students have the opportunity to filter the questions according to certain criteria. Therefore the teachers get a list of questions:

- Sorted in ascending/descending order by date the student addressed the question.
- Sorted according to the priority specified by the student.
- Addressed on a particular subject by all students.

Students get a list of their own questions:

- Sorted by date when the professor offered the response.
- Sorted by priority specified by them.

On Question-Answering page, we add a specific module that analyzes the question and shows to student the similar questions with their answers. This module processes the question and identifies the *question type* (which can be *Definition*, *Factoid* or *List*), the *answer type* (which can be *a date, a number, a link address, an organization, other, etc.*) and the *keywords* (which are the most relevant words from the question) similar to [4]. Having these values we used two methods to search *similar questions* for a given question:

1. The first method considers previous questions and concludes that they are similar if they have the same values for question type and answer type and if they have common keywords. For example we consider the following questions: the initial question is: *Care este termenul limită pentru alegerea temei proiectului?* (En: *What is the deadline for choosing the theme of the project?*) and the current question is: *Până când trebuie ales proiectul?* (En: *Until when should be chosen the project?*). We can see that both questions are Factoid questions and expect an answer of type Date. Also, we have one common keyword: *proiect* (En: *project*). For these reasons we consider that the questions are similar and we offer to that student for analysis the answer to the initial question.
2. The second method is applied when the question or the answer types are different, but the questions are from the same period and are related to the same course. Again, in this case we offer for analysis the answer of the initial question.

6 Statistics

During a semester we offered to our second year students the possibility to ask the teachers and to find out new things in certain areas. 132 students have created accounts, representing over 50% from the total number of students and 112 put at least one question. The total number of questions was 305, meaning that on average each student asked about 3 questions. The maximum number of questions asked by a student was 11. In Table 1 we can see the distribution of questions for professors.

Table 1. The distribution of questions for professors

Professor ID	Questions number	Percent
1	7	2.29 %
2	20	6.56 %
3	124	40.66 %
4	83	27.21 %
5	21	6.89 %
6	41	13.44 %
7	9	2.95 %

We studied the questions and we noticed that the teachers who received more questions are professors who perform additional research activities with students or professors who have complex problems at laboratory practical activities. We discussed with the professors who received a large number of questions (IDs 3, 4 and 6) about the advantages and disadvantages of using the system that makes the user's model.

The system has seven teachers involved: two teachers did not used the system at all (IDs 1 and 7), two of them used the system very little because they didn't believe in the effectiveness of the system (IDs 2 and 5) and three teachers used the system long enough (IDs 3, 4, 6).

The third professor believes that the system has improved his communication with the students and would also use it in the future to give students more opportunities to keep in touch. The same professor is the one who regularly used the models created by the system for users before providing answers for questions. The professor said that about 50% of the models were useful (he was satisfied with the way they were created and their contents) and about 50% of the models were unnecessary (the created models were incomplete or contained no useful information to answer the questions).

The system has 112 students involved, but we have done the research studying 40 of them (each of these students put more than 5 questions). Our models for users are built iteratively from question to question, using additional information obtained on questionnaires basis. When professors receive a question, they receive additionally the user's model built from previous questions and an analysis of the current question. Let's see few examples.

For this question "*Aș putea să fac un proiect cu informații despre hoteluri?*" (En: *Could I make a project with information about hotels?*) the student specified that the question is urgent and that he needs mandatory an answer. Because the student used

in his question "*aş putea*" (En: *could*) our application identifies the uncertainty of the student who does not know the possible alternatives. This question has a higher positive valence and it is different from the previous types of his questions that have a lower positive valence or even are neutral. In this kind of situation our application mentions that something happened and that the student needs more information. After some verification we identified that our supposition was correct: the student missed one week because he was at a student contest.

From 305 questions our system marked 114 questions that have emotion triggers terms and calculated the valences for them. In 9 cases the positive valences were higher than the rest of the marked questions. One of these questions is "*Dacă pentru realizarea aplicaţiei pare mai uşor să încalc un design pattern, decât să îl respect, trebuie totuşi să urmez patternul respectiv sau e în regulă să fac aplicaţia cum consider de cuviinţă, atât timp cât rezultatul final funcţionează?*" (En: *If in order to implement an application seems easier not to respect a design pattern, instead to respect it, must I still follow that pattern or is it ok to make the application how I think, as long as at the end the application works fine?*). For this question we identified the following emotion triggers: *pare* (En: *seems*), *mai uşor* (En: *easier*), *decât* (En: *instead*), *trebuie* (En: *must*), *totuşi* (En: *still*) and in this case we obtained the highest value for valence. Interesting is the fact that this question was the first question asked by that student and the rest of his questions, even if they were without emotions triggers, were influenced by this question.

After several discussions with professors, we decided to offer at request for a new question the user's model for the student who asks the current question, obtained from all his questions. Additionally the system remarks differences between the valence values obtained for the current question and for previous questions. Also, the professor receives the user's comportment type and the user's future goals.

7 Conclusions

Adaptive hypermedia is the answer came to help the user who is "lost in space" because there are too many links from which to choose or because he doesn't know how to find the shortest way to achieve the personal goal. In the application we created we tried to help the user using natural language techniques.

Thus, we helped a student by suggesting him the answers to similar questions offered by a teacher and we helped a teacher to understand better the question giving him the opportunity to access a user model which we created for that student. In the first case we used the question-answering techniques and in the second case we combined the psychological profiles of students with profiles built on feelings drawn from the questions submitted by students.

In recent years there have been various methods to identify feelings in a text: the explicit request of a transmitter's opinion, identifying the feelings directly related to different areas of interest. In this paper, the emphasis was placed on the role of emotions and on triggers terms and more than that those feelings were identified in the text by identifying the positive, negative or neutral aspects of words.

The assessment regarding the opinion of the students about the created system was not realized but we want in the future to create a questionnaire that would allow this. Also we want to talk with the students who used the system more because we want to improve the components dedicated to them according to their preferences.

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