Editorial

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Welcome to the Bulletin of the IEEE Technical Committee on Learning Technology, Volume 18, Number 4 issue.

This issue includes articles related to the theme of ***Social and collaborative learning supported through technology***. Méndez and Lloret analyse the motivation and perception of real users towards learning literary figures by means of a proposed application that includes gamification elements and provides a collaborative and social environment. Mosharraf and Taghiyareh present a federated search engine for open educational linked data. Finally, Hauswirth presents the results of a survey which investigates students' perspectives on team formation in collaborative learning environments.

We hope that the issue will help in keeping you abreast of the current research and developments in Learning Technology. We also would like to take the opportunity to invite you to contribute your own work (e.g. work in progress, project reports, dissertation abstracts, case studies, event announcements) in this Bulletin, if you are involved in research and/or implementation of any aspect of advanced learning technology. For more details, please refer to the author guidelines at http://www.ieeetclt.org/content/authors-guidelines.

Special theme of the next issue: **Technology Enhanced Language Learning.** Articles that are not in the area of the special theme are most welcome as well and will be published in the regular article section.

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Analysis of Gamification Techniques to Learn Complex Subjects through Collaborative Applications

Brandon Méndez and Elena Lloret

***Abstract*—Learning concepts about specific subjects may be regarded differently depending on the level of the difficulty of concept itself and the background or cognitive capacity of the student. This article analyses the motivation and perception of real users towards learning literary figures by means of a proposed application called GRAMA that includes gamification elements, and provides a collaborative and social environment. The results obtained show that this type of computer applications are motivating and useful to learn new and complex concepts in an easier and funnier manner.**

***Index Terms*—Computer Aided Instruction, Computer Applications, Creativity, Educational Technology, Social Computing.**

I. Introduction

NOWADAYS, there are many Websites and applications devoted to the educational field, where the aspects of knowledge acquisition and entertainment are combined together through gamification and collaborative techniques in order to allow users to learn new concepts/subjects in an easier and funny manner as well as sharing this knowledge and the progress achieved with other users. An example of these applications can be concerned with the learning of concepts or subjects that may be regarded as difficult, either because they are hard to understand and involve some level of complexity, or because they require to develop creative thinking, which may not be trivial. Learning specific aspects of language, such as the understanding and creation of literary figures may be within this category.

In this article, the motivation and perception of real users towards learning literary figures is conducted through the testing of GRAMA, our proposed application that allows a user to learn and create different types of literary figures integrating gamification and collaborative techniques. To the best of our knowledge, the proposal of language-based games for this subject is innovative, which apart from learning and reinforcing concepts, they may also contribute to develop the user's creativity. Creativity is important in the educational field, since it allows to catch the attention of the students and stimulate any kind of innovative idea in them [1]. Accordingly, creativity can be enhanced with technology through games, infographics or digital storytelling tools, which improve users' creative skills and help them explore the meaning of their own work and experience [2].

The remaining of the paper is organized as follows. In Section II, a brief background with the most relevant research fields related to our application is provided. In Section III, the web application is explained as well as its different modules, design and implemented options. Then, in Section IV, the results obtained during the evaluation process are discussed. Finally, the conclusions and the future work are outlined in Section V.

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II. Related Work

A. Gamification

Gamification consists of the use of techniques, elements and dynamics of games used in environments, applications or non-recreational activities [3]. Its main purpose is to enhance the motivational, cognitive, social and emotional aspect, favoring the concentration, effort and loyalty that people usually develop in a game. Gamification has gained popularity focusing on different areas, such as language learning (Duolingo[1]) or learning more about various subjects (Khan Academy[2]). The main purpose of gamification is to enhance the motivational, cognitive, social and emotional aspect, favoring the concentration, effort and loyalty that people usually develop in a game. Among the many advantages offered by this methodology are: the improvement in the acquisition and retention of knowledge; improvement in attention and reaction time; increased user participation and the implementation of knowledge without stress or risks [4].

One of the most recognized structures for designing gamification strategies is the one proposed by Kevin Werbach, known as DMC (Dynamics, Mechanics, Components) [5].

Previous studies on gamification have proven that these techniques can engage students in learning complicated concepts related to electronics, such as digital circuit course [6]. Moreover, providing proper feedback mechanisms is also important to enhance the participation and long-term motivation of users as it was analyzed in [7].

[1] https://duolingo.com/
[2] https://khanacademy.org/

B. *Collaborative Learning*

Collaborative learning is a didactic technique that promotes student-centered learning by promoting tasks in small groups, where students with varying skill levels use a variety of learning activities to improve their understanding of a subject. Each member of the working group is responsible not only for their learning but for helping their peers learn [8]. Online collaborative learning, on the other hand, involves learning cooperatively by sharing, with others, objectives and tasks, being the information and communication technologies mediating the process [9].

Recently, much attention has been paid to the effects that Web technologies have on commerce, the media, business and government. In particular, the interest in the impact that these tools can have on education is also growing, especially in educational institutions. The traditional approach to learning in this area tends to be driven more by the needs of the institution than by the needs of individual students [10]. A collaborative environment can be built using existing tools and APIs as long as they support some element of collaborative learning, like Mindmeister[3], Elgg[4], and Google Docs[5].

Different from existing works, our research is focused on complex linguistic concepts (i.e., literary figures), where, apart from learning, users can also develop their creativity and imagination by generating their own literary resources and sharing them.

III. Facilitating Learning of Complex Concepts through the Use of Technologies: Case Study in the Linguistic Context

The application proposed as a case study is called GRAMA (see Fig. 1), developed in the context of the linguistics field in Spanish. More specifically, it deals with the learning of some literary figures through gamification and within a collaborative environment. GRAMA is not targeted at any particular group of users, as it is intended to be useful to any user who wants to learn about literary figures, have fun and develop their creativity. However, it is recommended that users are older than 10 years to have a solid base in the use of language and have an interest in the subject.

A. *Literary Figures as Complex Concepts*

Literary figures are unconventional forms of using words, since they are accompanied by some phonetic, grammatical or semantic peculiarities, which differs them from their habitual use, and make them especially expressive [11]. These literary figures are considered complex because they play with the meaning of the words, using figurative language. They are mainly used for literary purposes, and their creation and use encourage creativity [12].

For our case study, we have selected 6 literary figures. The first 2 are the most popular and normally used for joy and entertainment; whereas the rest are less known, but they stand out for their expressive and creative character, where the user is bound by some condition that forbids certain things or imposes a pattern:

- Tongue-twister is a sequence of words difficult to pronounce, especially rapidly. E.g., "Can you can a can as a canner can can a can?"
- Cryptogram is a phrase or quote that has been encrypted by simple letter substitution. E.g., "2gether"
- Pun is a rhetorical figure consisting of the union of two or more syllables words, by varying the usual separation between them, in order to obtain a different meaning from its meaning in its normal position. In English, the definition of pun is different from Spanish and it refers to a word game in which two (or more) words have similar sound but different meaning. E.g., "Esconde vs. es conde" in Spanish, whereas "bears go barefoot" in English.
- Palindrome is a word, phrase, number, or other sequence of characters which reads the same backward or forward. E.g., "A man, a plan, a canal, Panama!"
- Lipogram is a literary figure in which one or several letters of the alphabet have to be avoided. E.g. (excluding letter e), "Mary had a tiny lamb."
- Pangram is a sentence using every letter of the alphabet at least once. E.g., "Pack my box with five dozen liquor jugs."

B. *Implementation of Gamification Elements*

Fig. 1. Main view of GRAMA. URL: http://www.grama.gplsi.es/

Gamification is implemented in GRAMA by various simple games, one for each proposed literary figure:

- Tongue-twister: The user has to pronounce, using a microphone, a tongue twister proposed.
- Cryptogram: The user has to decrypt an encrypted message with the aid of an alphabet of characters.
- Pun: The user has to choose words between several proposals and replace them in the original sentence to change its meaning.
- Palindrome: The user has to match all the proposed sentence pairs, which are read in reverse of each other.
- Lipogram: The user has to find the letters that do not appear in the proposed sentence.
- Pangram: The user has to choose a word among several proposals to replace it in the original sentence, so that the resulting sentence contains all the letters of the alphabet, repeating the least number of them.

In all of them, typical elements of gamification appear:

- Difficulty levels: There are 3 levels of difficulty (Easy, Normal, Hard), in which various complexity ranges are

[3] https://mindmeister.com/
[4] https://elgg.org/
[5] https://docs.google.com/

established adapted to each game.

- Countdown: There is a timer adapted to the chosen difficulty of each game.
- Score: Depending on whether the user surpasses or not the game, can win or lose points, whose amount is determined by the difficulty level selected in the game.

C. Implementation of Social and Collaborative Part

GRAMA has an important social part, which requires the collaboration of its users. On the one hand, a complete authentication system (registration, login, and password recovery) to access the content of the application. Once inside the application, the user can create literary figures, with the help of different resources (search for words that contain or not certain letters, that have a certain prefix or suffix, etc.), depending on the literary figure, to post and share them later. All publications can be viewed with the possibility of using several filters for it (more/less recent, better/worse rated, or only user's own publications). In addition, these publications can be evaluated positively or negatively, and reported, justifying previously the reason (incorrect category, syntactic error, grammatical error, inappropriate content, etc.). Furthermore, each user can perform a search to add other users to his/her friends list, manage their friend requests (sent and received), and view his/her friends list. The user can also view his own profile (which is visible to other users as well), edit it and exit the application.

In summary, apart from being able to search and add users, GRAMA offers the possibility of commenting on other users' posts, rating them or sharing them. Likewise, by way of correction, users can warn of any errors found in any post, either grammar or because it does not correspond with its category.

D. Design and Development of GRAMA

GRAMA is a web application, so it has been developed using the main techniques and web technologies, such as HTML5, CSS3, JavaScript, jQuery, Bootstrap, PHP, Ajax, and Speech Recognition, among others.

As for the design, several well known trends have been followed, such as Flat Design and Responsive Design, which allow the application to maintain a minimalist trend and adapt perfectly to the resolution of any device. In addition, we have followed the standards set and accepted by the W3C[6] in terms of accessibility.

Given its social and collaborative nature, as recommended by several studies on color psychology [13], different shades of blue and gray have been used for most backgrounds and containers, as well as simple but original and creative fonts for capture the attention of the user. In addition, User-Centered Design [14] has taken into account during the development of the application, where the Scrum-ban methodology [15] has been used.

The content is structured in several sections and subsections, where gamification techniques and social and collaborative aspects detailed above are implemented:

- Home: Literary figures, with the option to visualize, create and play, in each of them.
- Profile: View and edit the profile, with the option to exit the application.
- Friends: Search, add, visualize and manage friends.
- Statistics: Briefly visualize the total and specific score obtained in each literary figure, and view the history of actions performed.

IV. Evaluation and Results

Once the application was finished, it was necessary to evaluate the users' knowledge and opinion regarding the learning of complex concepts in collaborative environments through gamification, and more specifically literary figures. Furthermore, as part of our case study, it was also necessary to obtain the evaluation of GRAMA after its use.

A. Participants

The evaluation was aimed at users of any background (studies and occupation), age and sex. This is because we were interested in obtaining the general knowledge of different types of users in the field of linguistics and the use they make of applications dedicated to learning. Therefore, a sample size of 30 users was obtained as participants.

B. Instruments and Methods

A questionnaire was the main instrument to conduct the evaluation. A survey was created using Google Forms[7]. It was anonymous and it was composed of 20 questions (18 of them compulsory and with a single answer, and 2 optional ones for feedback and suggestions). The survey was divided in 4 sections:

- Preliminary information: it was intended to know the gender, age range and level of studies of the user surveyed to verify that the results were not biased by a specific type of users.
- Learning methodology: it was sought to know if the user used learning applications that employed similar methodologies, the concept and knowledge they had of this field and the literary figures and the utility they attributed to it.
- Use of GRAMA: the user was required to access the application and use it to answer the last part of the survey.
- Feedback: it was intended to know the assessment and the user's opinion after having tested the application.

Another method used during the evaluation process was the preliminary observation of a small group of users, different from the 30 participants, to know how to interact with the application as well as their initial opinion. This method allows to obtain important data that with other methods goes unnoticed.

C. Results

The online survey was distributed via several channels (social networks, mailing, orally, etc.) and we finally got the answers of 30 users, who used the system for a while (spending most of the time on the games). The users were

[6] https://w3.org/standards/

[7] https://goo.gl/wmMhC8

balanced according to their gender and they belong to the age range between 20 and 50 years old. Most of them had at least university studies in fields such as science or education. As far as the remaining sections of the survey (learning methodology, and use of GRAMA), positive and encouraging results were obtained, which are discussed in more detail in the next section.

Finally, regarding the feedback provided, users think that GRAMA is very nicely designed and useful for the society. As for the method of observation, it was confirmed that the application was entertaining and easy to use, as the users found everything quickly and repeated some of the actions, like playing, for fun. As suggestions, users encourage the adaptation of the application to other languages, as well as to include more literary figures and more types of word games for each one.

D. Discussion

We focus now in the results obtained with respect to the learning methodology and use of the application.

Concerning the learning methodology, only the 53.3% of the participants had previously used applications that integrate the gamification aspect (e.g., Duolingo). However, 80% of the users thought that the use of the Web 2.0 would be very useful for sharing doubts, questions it they had difficulties for learning a complex subject. With respect to their previous knowledge about literary figures, 40% of them did not have any idea of them. Moreover, we also confirmed that literary figures are not frequently used, since 86.7% of the responses stated that literary figures were never or seldom used, being only studied at school by the 6.7% of them. This confirms that this is very specific subject not normally used, and therefore it could involve some level of difficulty when learned.

Regarding the evaluation of GRAMA, 73.3% of the users found it really helpful to be able to see examples of literary figures created by other users so they can better understand the concept and create their own ones. All the participants fully agree (100%) in the usefulness of being able to rate other's literary figures and get comments about the ones they created. This reinforces the collaborative aspect within GRAMA that allows users to publish and share their own literary figures and get comments from other users.

Also, the integration of gamification is seen very positive by all the users (100%), since they think that it is a funnier manner to learn and acquire new knowledge in which they would not be interested in without this type of games. These results indicate that gamification techniques increase the motivation of users towards learning new concepts and their engagement with the application. In addition, users find the system useful because the games and resources offered have also enabled them to develop their creativity and improve their expressive skills in some ways. About the societal impact of this type of applications, 66.7% of the participants thought that it would be a good idea to integrate and use them at education centers (e.g., schools, learning centers) to reinforce and practice the concepts taught about this subject. Finally, there is full agreement among the users (100%) in the fact that the existence of similar applications for learning complex concepts applied to other subjects would be necessary and desirable.

V. Conclusion and Future Work

We have introduced learning methodologies based on gamification as well as including social and collaborative aspects in a web-based application called GRAMA to facilitate the knowledge and use of complex concepts, such as literary figures. The application has been tested with real users to know their opinion and assess their motivation towards learning these concepts through a computer application. The results obtained clearly show the benefits of gamification and collaborative learning to acquire new knowledge about unknown concepts, as this issue was noted by all the users who tested the application.

In the future, we plan to take into account the feedback given by users to improve the application, as well as to conduct a more exhaustive and longer evaluation with targeted user groups, such as students.

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Federated Search Engine for Open Educational Linked Data

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***Abstract*—Driven by the success of linked data, interlinked web of data is a best infrastructure for distributing open educational resources (OERs). Hand in hand with this structure, immense technological challenges are arising in every phase of their publishing, maintaining, discovering, and accessing. Utilizing OERs licenses and principals of linked data, this paper proposes a federated search engine to retrieve OERs published on web of data. Transforming natural language queries to the SPARQL form using a desirable interface and several pre-prepared queries, parsing each query and broadcasting the sub-queries to several appropriate open repositories, merging retrieved results, and presenting to users in an appropriate user friendly interface are processes of this system. It has successfully passed primary tests and started to be used in a technology enhanced learning laboratory; however, its development is still on-going.**

***Index Terms*—Federated search engine, linked data, OER, SPARQL**

I. Introduction

Introducing the concept of Open Educational Resources (OERs) and subsequently changing the approach of educational service providers leads to positive steps to eliminate economic, demographic, and geographic barriers of education [1]. The appearance of MOOCs, which is a paradigm in learning process, and promoting lifelong learning programs are propounded by presenting this concept [2].

Like other learning resources, OERs are distributed on the web and can be accessed through different mechanisms adjusted by providers. It is essential that learning resources, storages, providers, and services be organized in such a way that instead of being single-use or accumulating worthless, have the ability to be re-used. Such a possibility has also been achieved for some open source software [3]. In addition, according to the importance of OERs and especially documents in knowledge transferring and self-regulated learning [4], their management and retrieval are so important. On the other hand, the thought behind OERs is maximum sharing. However, inconsistency in content management approaches applied in various repositories leads to lack of resources interactivity. The lack of interactivity is the origin of other problems such as losing resource discoverability, reusability, remixability, and adaptability [5].

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Providing a basic recipe for connecting and publishing data on the web, linked data helps to solve these problems. Linked data principles proposed by Berners-Lee are [6]:

1. Use URIs as names for things
2. Use HTTP URIs so that people can look up those names
3. When someone looks up a URI, provide useful information
4. Include links to other URIs, so that they can discover more things

While the primary units of the hypertext web are HTML documents connected by un-typed hyperlinks, linked data relies on data described in RDF format. Using several vocabularies, each entity can be described and related to other entities in the world of linked data. Each vocabulary is a collection of classes and properties, which are described by RDF, models domains of interest in various degrees of expressivity [7].

Although resources are structurally described on the web of data, different providers use various vocabularies for modeling and publishing them on linked data. For this reason, using resources originated from various repositories requires to know several vocabularies. Also, each provider describes different properties of their data and models them using different features. Utilizing these resources can be accomplished through either web interfaces which have many limitations or SPARQL endpoints. Obtaining data through SPARQL queries also needs to know this language.

Using search engines can facilitate the problem of accessing open educational linked data. However, the retrieval mechanism of existing search engines is based on document indexing. In addition, they cannot benefit from the features of linked data and answer some complicated questions. In the scope of eLearning two of these queries are:

- Open educational slides in the domain of eLearning which have been produced by Iranian professors.
- Learning contents related to personalization which have been produced in 2010 and has been re-edited.

Retrieving resources which are described in these questions is possible only with the use of linked data and navigating through several links between different repositories. In addition, linked data provides a monolithic index that must contain all the content and relationships for an extremely expansive body of resources. So, it comes with some indexed based discovery engines limits. Fig. 1 shows a brief overview of metadata and relations of different resources published in linked data.

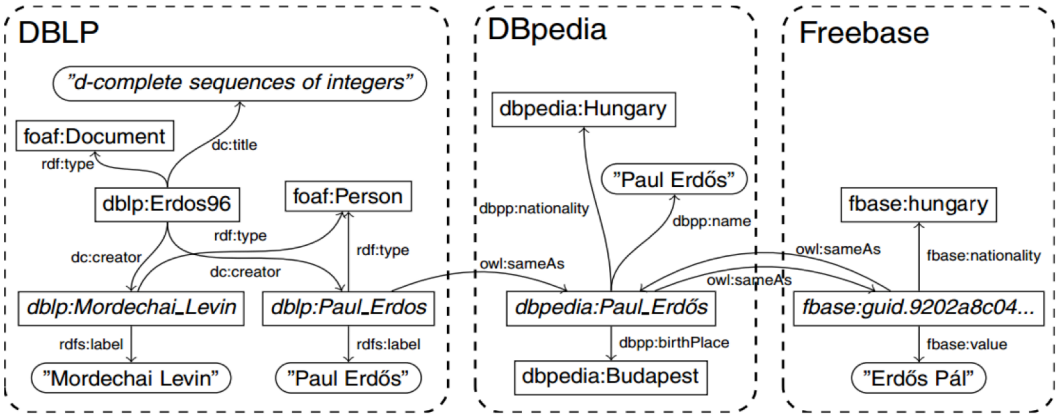

Fig. 1. RDF triples from three Linked Open Data sources [9]

According to [8], Linked Open Data offers new solutions for educational resources, partly solving some of the OER limits. (1) Open data are interlinked by definition, so a semantic layer is created to describe OERs, (2) federated search to find resources belonging to distinct datasets are the most important outcome of linked data.

In this paper, we propose a system to answer different queries about OERs published in linked data. In addition to search on educational resources which are modeled in the web of data, this system can federate queries on separated resources and answer to complicated questions. The implemented system can also be beneficial in these situations:

- Reducing users confusion in searching different repositories
- Reducing time of search
- Facilitating access to resources distributed in different repositories
- Providing different options related to users' queries from different repositories and specifying type of relations
- Focusing on metadata and full text from open access repositories
- Offering appropriate resources which are not in the query language of users. (Sometimes inadequacy or lack of quality of the retrieved resources makes users to fetch resources provided in other languages. Doing it can be possible through navigating links between multilingual data published on the web of data.)

The implemented system has many applications. Integrating with Learning and Content Management Systems (LMSs and CMSs) in order to provide free access to various resources, with authoring systems in order to help to reuse and generate new contents, with library systems in order to retrieve related resources to entered quires can be useful. In addition, it can be a step towards the expanding universe of open linked data.

The rest of the paper is organized as follows. Section 2 presents the architecture of our proposed federated search engine and functions of its components. Section 3 describes the implementation details and repositories utilized in the primary evaluation. Finally, section 4 concludes the paper and outlines areas for future research.

II. PROPOSED SYSTEM

Our system is being developed to provide an efficient solution for federated query processing on open educational linked data. The word "federate" means "to join together" or "to unite". The federated search system allows a user to submit a single query and receive results from multiple sources, without having to query each of the sources individually. This system consists of (1) mapping a user query to one or several SPARQL queries, (2) broadcasting the SPARQL query to a group of disparate repositories with the appropriate format, (3) merging the results collected from different repositories, and (4) presenting the results in a unified and user-friendly format with minimal duplication. Fig. 2 shows the architecture of the implemented system.

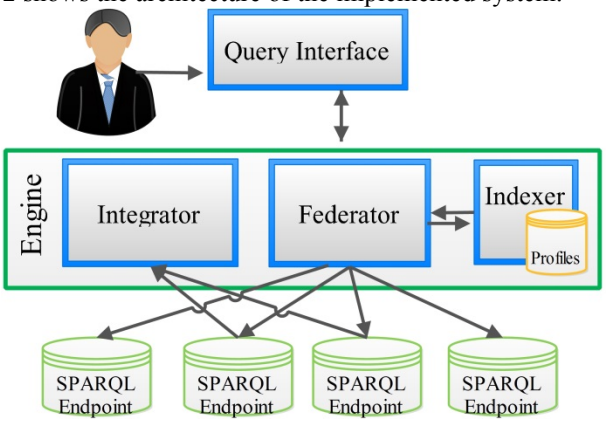

Fig. 2. Architecture of the federted query search engine

In the following each part of this engine is presented.

A. *Mapping the input query in the SPARQL format*

Transforming users' queries in natural language to SPARQL is a complicated task and requires knowing complexities, rules, terms, phrases, and exceptions of natural language. Natural language processing techniques, which our system should be enriched to, use large corpuses contained examples of natural language queries as well as logic rules. To avoid natural language processing, users' queries are entered into the system using the specific fields provided in the user

interface. In an interview conducted among different users, we ask them to determine all the information may need in the learning or research activities through searching the internet. Accumulating demands of these survey participants, including 5 high school students, 5 undergraduate students, 5 graduate students, 5 teachers, and 5 researchers, all the educational questions can be categorized in 5 groups (or combination of them): Requests resources or data by specifying a set of specifications, Requests information about a/several persons by determining a set of characteristics, Questions about dates, Questions about publishers, and Questions about subjects.

Considering some specified fields in the system user interface, all the simple and complex queries can be constructed. Knowing educational repositories and sets of vocabularies which model OERs, several SPARQL queries which have not been initialized are determined as the system default. Entering each field of a user request, the proportional variable in the SPARQL queries is set. Fig. 3 illustrates part of a not initialized query.

```
PREFIX ...
SELECT ?title ?date ?name ?subject ?abstract ?link
WHERE{
        ?author foaf:name ?name.
        ?author dbo:notableWork ?work.
        ?work rdfs:label ?title.
        FILTER (regex(str(?name), "", "i"))
        FILTER (regex(str(?title), "", "i"))
        ?work dbp:releaseDate ?date;
        dcterms:subject ?subject;
        dbo:wikiPageExternalLink ?link;
        dbo:abstract ?abstract.
        FILTER (regex(str(?suject), "", "i"))
        FILTER (regex(str(?abstract), "", "i"))
}
```

Fig. 3. Part of a SPARQL primary query which is not initialized

B. *Broadcasting the SPARQL query to different SPARQL endpoints*

Each primary query can be parsed into sub-queries that can be answered by individual repositories. Indexer and Federator, as the two main modules of our system, are the responsibility of determining suitable repositories and parsing the query in accordance to their metadata, respectively.

Profiling each repository, Indexer determines types of resources and other information which can be accessed through it. Types of metadata that can be harvested using vocabularies are other fields of repositories profiles stored in Indexer. This data is defined manually after checking each repository metadata. Using repositories profiles and both variables and vocabularies of each query, Indexer determines repositories that the query should be sent to.

Considering vocabularies applied in the determined repositories, Federator parses the primary query. For each repository, Federator filters parts of the query that contains vocabularies not being used in it. The primary query consists of several triples. Each triple utilizes one, two, or rarely tree vocabularies. Each triple remains in the sub-queries, if all of their vocabularies are applied in the repository.

Let's explain this phase with an example. Checking the profile of DBLP shows that vocabularies used for describing resources of this repository include “Swrc”, “rdf”, “owl”, “d2r”, “xsd”, “dcterms”, “rdfs” ,”map”, “foaf”, and “dc”. Therefore, after initializing the primary query using user requested values, each triple that consists of another vocabulary is removed before sending the query to DBLP. “dbo” and “dbp” are vocabularies used in the primary query illustrated in Fig.3 and not engaged in DBLP profile.

C. *Merging the results obtained from each SPARQL endpoint*

The results obtained from the distributed sub-queries are merged in Integrator and finally returned in an aggregated form. In this respect, all the results retrieved from each repository are saved in the temporary database of Integrator. These results are in the form of RDF and with the understandable meta-information for machines. Navigating these typed triples, distributed results are linked using “owl:sameAs” and “rdfs:seeAlso” relations. At best, a connected graph is created by integrating all the distributed results. Applying the primary query in the generated graph, this module prunes all the extra information, which is non-relevant to the input query.

D. *Presenting the results*

The retrieved results of query execution should be represented to the user in a uniform and understandable format. It is possible that contrary to the usual representation method, the user wants to see the RDF graph of the results to obtain other information. Therefore, the results are represented to the user in two interfaces:

- The results are displayed in a typical way as other search engines. In our approach, all the main information is displayed in one phrase. Clicking each phrase, all the other meta-information is provided for the user. The user can adjust the displaying order by subject, date, and alphabetical.
- The RDF graph of the results is displayed. This view is basically an adequate way to establish an abstraction for the underlying data schema. Its’ benefit is providing the possibility of easy reuse and exchange of sub-graphs, recursive view definitions, and applications for data integration from distributed repositories.

III. Implementation and Evaluation

For implementing the federated search engine on linked data, Microsoft ASP.NET MVC 3 framework and Microsoft Visual Studio 2012 as IDE was chosen. In addition to default libraries and packages of ASP.NET MVC 3, many other free and open source java and JavaScript libraries such as jena, jQuery, jQuery UI, and jScrollPane are were used. The main reason for choosing ASP.NET MVC 3 framework was its MVC based (Model-View-Controller) pattern and object-oriented aspect of C# programming language which makes it reasonably easy to build standard and scalable web applications.

TABLE 1
SOME SPECIFICATIONS OF SOME OER REPOSITORIES

Repository	Address	#Resources	#People	#Triples
DBpedia	http://dbpedia.org/sparql	12325452	1840596	438038746
DBLP	http://dblp.l3s.de/d2r/snorql/	10038	10036	444184
ACM	http://acm.rkbexplorer.com/sparql/	Not defined	Not defined	Not defined
Charles University in Prague	http://linked.opendata.cz/sparql	Not defined	444536	557106351
University of Southampton	http://sparql.data.southampton.ac.uk/	4812696	341764	6749073
University of Muenster (LODUM)	http://data.uni-muenster.de/sparql/	56034	11657	4248725
Aalto University	http://data.aalto.fi/endpoint	21794	226572	1649357
OxPoints (University of Oxford)	https://data.ox.ac.uk/sparql/	11644	91	631546
ASN:US	http://sparql.jesandco.org:8890/sparql	1358	0	7497309

Up to now, many OERs in different formats have been published in the web of linked data. Datahub[1] as a free, powerful data management platform from the Open Knowledge Foundation provides a tool for accessing many of them. Using this platform, we can find many SPARQL endpoints covering data from different domains and integrate them with our search engine. In addition, our system directly connects to some of open repositories through their SPARQL endpoints. In these repositories, providers of educational data publish their data or its model freely on the web of data on their own. Table 1 shows specifications of these repositories.

The system passes the primary test by applying on the introduced educational linked data. Depending on the internet bandwidth and the availability of resources, time of query execution and retrieved results are different. In eleven different test queries, 1200 milliseconds and 29 seconds are respectively the minimum and maximum times spent from receiving the user queries to representing their results. Although, experiments showed that increasing number of repositories used in this system can increase execution time; the retrieved results are more desirable. This system is being used as a pilot for promoting other research focused on semantic processes enhances educational technologies.

IV. CONCLUSION

The federated search engine offers a scalable mechanism for querying open educational Linked Data. However, there are some challenges in its processes that should carefully be examined.

- There may be some natural language queries which cannot fit in the search fields of the user interface. Considering mechanisms of entering these types of queries and transforming to the SPARQL format are of the future works of the project.
- Increasing open repositories as well as their variance and execution time will increase the time cost of system processing. Grouping resources and changing in the Indexer approach can be beneficial. It is worth stating that the main cost of our system is the query execution time and cost of transmitting query and results between the system and linked data repositories. The worst-case cost of integrating results is defined as complexity times $O(N^2)$, where N is the number of graph nodes.
- The query execution time in each repository and retrieving non-related responses are challenges originated from the simple mechanism of query parsing in Federator. Applying some logics for optimal and efficient execution of sub-queries in each repository can be beneficial.
- Indexer contains profile information of repositories. So, it should be updated synchronously with any changes in each repository.
- Another challenge is SPARQL endpoints availability and timeout. It is hoped that this problem will be resolved with advances in research and applications of linked data.

Considering these challenges in the future works of this project, improving the implemented system may continue in other different ways. Enriching to mechanism for crawling links and finding resources described by specified relations, and promoting by the process of semantic query expansion using different domain ontologies are samples.

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Team Formation in a Blended Learning System: Student Perspectives

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***Abstract*—While the social interaction in collaborative learning contributes to knowledge construction, its exact mechanisms are not yet fully understood. In this paper we present the results of a survey that sheds some light on one aspect of this issue: the students' perspectives on team formation in collaborative learning environments. We surveyed a class of undergraduate students studying in a blended learning environment using team-based lab assignments. We solicited the students' perspectives on four different computer-supported team formation approaches, and we asked about their views on different factors shaping their team formation preferences. We hope that the results of our survey will help researchers and learning system designers to better understand the perspective of students and the reasons why students generally prefer team self-formation over instructor or system formed teams.**

***Index Terms*—Collaborative learning, learning management systems, team formation**

I. Introduction

The social interaction in collaborative learning is known to contribute to knowledge construction, but its exact mechanisms are still uncertain [1]. As Miyake and Kirschner state, "fruitful collaboration is not merely a case of putting people with relevant knowledge together. We must understand the factors that make up successful collaboration" [3]. They propose a "team learning model" which serves to explain a team's willingness to engage in learning behavior. The model combines a view of collaboration as a social process of knowledge building with a view of the social environment in which learning takes place. The model is driven by five team learning beliefs: interdependence, social cohesion, task cohesion, group potency, and psychological safety. Three of those beliefs, *social cohesion* ("the nature and quality of the emotional bonds of friendship such as liking, caring, and closeness among group members"), *group potency* ("the collective belief of group members that the group can be effective"), and *psychological safety* ("a shared belief that the team is safe for interpersonal risk taking"), are directly affected by team formation. In an evaluation of their model they found that social cohesion was not related to team learning behavior, but that group potency and psychological safety were clearly related.

In this paper we investigate *team formation*, an aspect of collaborative learning that directly affects group potency and psychological safety. While evidence-based guidelines for team formation recommend instructor-formed teams [2], a survey of 6435 engineering students found that 67% of their teamwork experience was based on student-selected teams [1]. Thus, despite the recommendations against it, a majority of instructors seem to favor student-selected teams. The survey also found a (weak) negative correlation between instructor team selection and students' satisfaction with the team. That is, students seemed to report a worse teamwork experience for instructor-selected teams.

Besides surveys and guidelines like the ones above, there is also a rich body of work on approaches to *automatically* form teams to achieve the best performance (e.g., by combining learner profiles and context [4] or by using learner strategies [5]). In this paper, we do *not* focus on the effect of team formation on performance, but we shed light on students' opinions about different team formation approaches. We survey a class of undergraduate computer science freshmen studying in a blended learning environment using team-based lab assignments. We solicit their perspectives on four different computer-supported team formation approaches, and we ask them about their views on the different factors shaping team formation preferences.

Section II presents the context in which we conducted this study. Section III introduces the four proposed team formation approaches. Section IV discusses the students' perspectives on the different factors affecting team formation, Section V presents their views on the four team formation approaches, and Section VI concludes.

II. Background: Informa Blended Learning System

Informa[1] is a learning platform that supports various forms of blended learning. A key feature of Informa is its team-based lab assignments. A lab assignment in Informa is a web page that interleaves problem descriptions with various questions. Some questions ask students to simply enter a textual answer, while others require that students upload an artifact. Instructors can configure labs to be solved in teams, and they can specify the team size for each lab.

Before an instructor can assign a lab, they need to form teams. The initial implementation of Informa required that instructors create teams manually, which was laborious for large classes. Later versions provided automated random team formation. Our expectation was that instructors would create

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[1] Informa is deployed at the Università della Svizzera itailiana at https://informa.inf.usi.ch/ and most of the content of the ongoing courses is publicly accessible.

different teams for each individual assignment. The advantages of this random assignment approach are that students get exposed to a diverse set of peers that use a diverse set of problem solving approaches, and that the randomization pairs each student with a balanced set of stronger and weaker peers over the course of a semester. However, when we created randomized teams for the first time, we were surprised by the amount of negative feedback from the students. We decided to better understand the students' perspectives on team formation by conducting a survey. This paper reports the results of that effort.

III. Team formation approaches

In our survey, we confronted the students with descriptions of four different team formation approaches. These approaches describe *how* students are assigned to teams, but they do not describe *when, or how often* teams are formed.

The question of how long teams should last is somewhat orthogonal to the approach used to form teams. On one extreme, teams could be formed once, at the beginning of the course, and be kept stable throughout the course. This is the situation targeted by Oakley et al.'s best practices [1]. On the other extreme, teams could be formed for each assignment and last just for the duration of that assignment. This is a situation where team formation needs to be lightweight and fast, and where the consequences of a suboptimal team assignment are less dramatic. Any intermediate point between these two extremes is possible, too.

A. Random Assignment

The first approach represents the initial implementation available in Informa: The learning system randomly assigns students to teams. In the extreme case, neither the students nor the instructor has any influence on the team composition. Alternatively, the instructor might be able to modify the team assignments, possibly based on requests from students.

B. Do-It-Yourself Assignment

The second approach is to completely delegate team assignment to the students. In a computer-supported environment, the learning system allows every student to modify the team assignment. Students might be able to place themselves in any team they want, or they might even be able to re-assign other students (e.g., move other students into or out of their team). At a certain deadline, the system would disable the feature for students to modify team assignments, would randomly remove students from teams that have more than the maximum number of students, and would randomly assign students who are in no team.

C. Buddy Preferences

The third approach would allow students to specify a set of preferred buddies. The learning system would then try to create a team assignment that satisfies the buddy preferences to the degree this is possible, and then randomly assign the remaining students.

D. Performance-Based Assignment

With the fourth approach, the learning system would automatically assign students to teams based on their past performance (e.g., based on past quiz and assignment scores). This is a form of group formation based on learner profiles [4]. This probably would have to be redone for each assignment, because a students' performance is not known in the beginning, and it will change throughout the course.

IV. Perspectives on Teamwork

We asked 55 students who used Informa in a second-semester Bachelor programming course to complete our survey. We conducted the anonymous survey after the first lab assignment, where we had used random assignment for team formation. We received 47 responses (85% response rate).

A. Working Alone vs. Teamwork

Given that not all students like to work in teams, the first question we asked was "Would you prefer working on labs on your own, or working on labs collaboratively?" Students answered on a scale from 1 (more individual) to 5 (more collaborative). Fig. 1 summarizes the 47 responses. It shows a clear preference for teamwork, with a notable minority of students who prefer to work on their own.

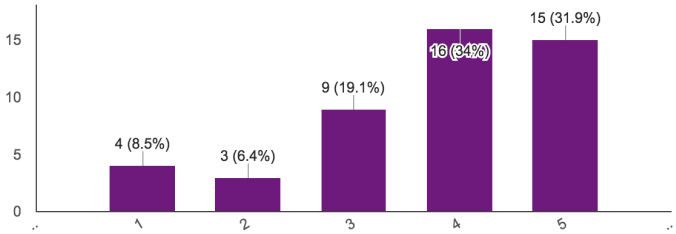

Fig. 1 Number of students preferring more individual (1) or more collaborative (5) work

B. General Team Assignment Preferences

Our survey then listed a set of potential advantages of different team formation approaches and asked students to rate each advantage on a scale from 1 (unimportant) to 5 (very important). If not stated otherwise in the following paragraphs, all 47 participating students provided a response.

The first advantage was "Don't get stuck with a team member I don't want to work with". As Fig. 2 shows, the students overwhelmingly found this to be an important aspect.

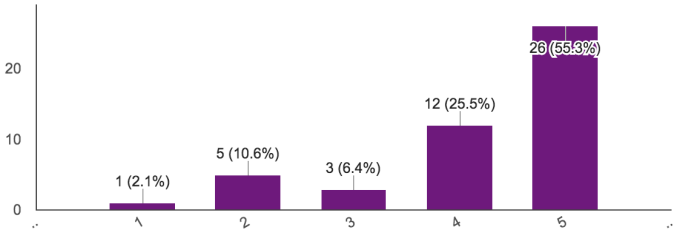

Fig. 2 Don't get stuck with a team member I don't want to work with

The second advantage was "Possibility to work with a friend". Fig. 3 shows that students still found this to be an important

advantage, but they placed less importance on this than on not getting stuck with a suboptimal team member.

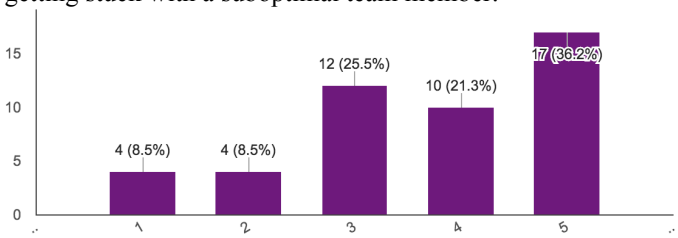

Fig. 3 Possibility to work with a friend

Note that these first two advantages are related: the first is about excluding undesired team members, while the second is about including desired team members. Apparently, students are somewhat more concerned about the former.

The third advantage was "Advantage of not having to change teams each week". Fig. 4 shows that a majority of the students found this to be an important aspect.

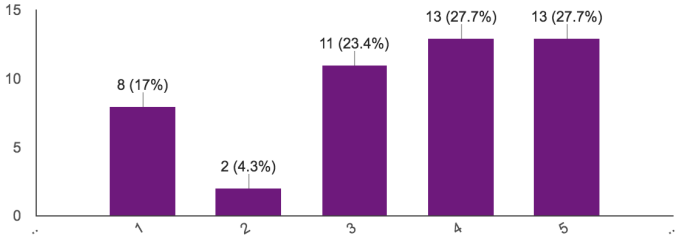

Fig. 4 Advantage of not having to change teams each week

The fourth advantage was "Opportunity to experience different people's problem solving approaches". Only 46 of the 47 responding students answered this question. While we see this as a central aspect of team formation, Fig. 5 shows that the students found this aspect to be less important than the previous ones.

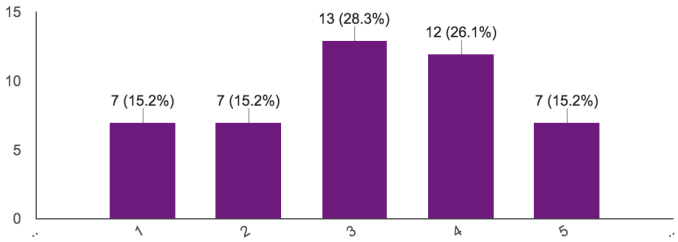

Fig. 5 Opportunity to experience different people's problem solving approaches

As Fig. 6 shows, the fifth advantage, "Opportunity to improve my own understanding by explaining things to a 'weaker' partner" found even less support. We suspect students did not appreciate the idea that teaching something is a great way to learn, and they primarily worried about a weaker partner slowing them down.

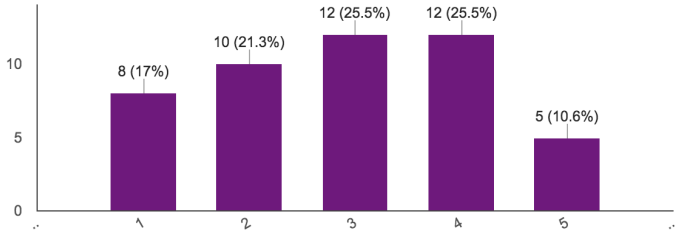

Fig. 6 Opportunity to improve my own understanding by explaining things to 'weaker' partner

Fig. 7 shows that the sixth advantage, "Opportunity to learn from a 'stronger' partner," was considered more important than the opportunity to learn from explaining to a 'weaker' partner. However, students only seemed to consider this aspect to be of secondary importance, as only 12.8% of students ranked it as "very important".

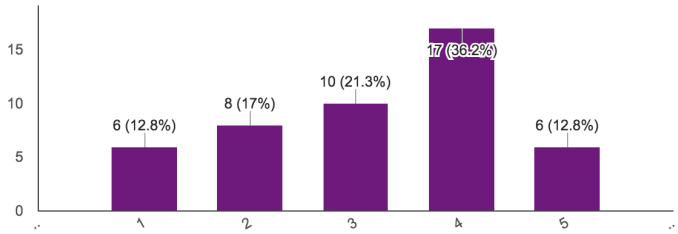

Fig. 7 Opportunity to learn from a 'stronger' partner

Overall, this first part of the survey showed that students first and foremost are worried about being stuck with a partner they do not want to work with, and that they do not see a significant benefit in explaining things to a weaker partner.

V. Perspectives on Team Formation

The second part of our questionnaire concerned the four proposed team formation approaches. We asked students to comment on each of the four approaches, and we then analyzed the comments using an open coding approach. We did this by tabulating the free-text comments about the four presented approaches, going through the table, and assigning tags to each comment. We then iterated until the set of tags stabilized. We also assessed whether a comment was mostly in favor or mostly against an approach.

A. Random Assignment

The students did not like random team formation. Of the 42 responses to this question, 6 were mostly in favor and 15 were mostly against using random team assignment. There was a strong concern of getting stuck with a suboptimal partner: 9 students argued that for the reason of fairness, random team assignments would require repeatedly changing teams. This argument was countered by the great concern about the cost of repeatedly changing teams: 13 students brought up the significant organizational and scheduling costs to students whenever they get assigned to a new team. Moreover, two students mentioned the benefit of working with their peers over a longer duration, to get to know them better, and to grow into a well working team. A small number of students appreciated the diversity of students (5) and problem solving approaches (5) they would get exposed to in randomly assigned teams. A larger number of students were concerned

that a random assignment might pair them with peers they would not like (9), that would not have an appropriate work ethic (14), or that would be significantly weaker (10).

B. Do-It-Yourself Assignment

This was the students' favorite approach. Of the 41 responses to this question, 29 were mostly in favor, and 5 were mostly against using do-it-yourself team assignment. A few students explicitly brought up the advantage of forming teams in which they get along with their peers (3), in which their peers had similar work ethics (2), or in which peers were similarly strong (1). Three students explicitly mentioned the potential reduction in organizational overhead. However, a small minority mentioned the loss of diversity in terms of people (4) and problem solving approaches (3). And two students mentioned that such student-driven team-formation would potentially be bad for the weaker students amongst them, because they would have little chance to end up in a team with a strong peer.

C. Buddy Preferences

Team formation based on buddy preferences was the second strongly favored approach. Of the 38 responses to this question, 24 were mostly in favor, and 7 were mostly against using buddy preferences for team assignment. Like in the do-it-yourself assignment approach, also here in the buddy preference approach, two students commented on the potentially negative consequences for weaker students who might not appear in any buddy list, and thus might get randomly paired with other weak students. Two students proposed to use the approach as an "anti-buddy list", where students would essentially include most of their peers in their buddy list, and would only exclude those peers they clearly did not want to work with. A small number of students saw a reduction in diversity of people (3) and diversity in problem solving approaches (2) and thus recommended to re-assign teams periodically (based on the potentially changing buddy lists and on some degree of randomization) to add diversity. One student proposed to ask teammates to assess their teamwork performance after each assignment, and to re-assign teams that do not work together well.

D. Performance-Based Assignment

Quite surprisingly, this was the least favored approach. Of the 40 responses to this question, 7 were mostly in favor, and 24 were mostly against performance-based team assignments. We did not specify whether we would use homogeneous or heterogeneous grouping, and 9 students commented on that point. Four students mentioned that the academic performance of a student was not very important when looking for teammates, but that other factors were more important to them. Two students mentioned that the aspects of performance that would affect team effectiveness were difficult to measure. Eight students mentioned that performance-based assignment was bad for weak students. On the other hand, three students commented that it would be bad for strong students in case of heterogeneous groups, in that strong students would do all the work and learn nothing from the weak students.

VI. Conclusion

The results of our survey showed that the students preferred a do-it-yourself approach to team formation. Buddy preferences, which still gives students a say but automates much of the process and uses randomization to break ties, came in as a close second. Students clearly disliked randomized assignment and performance-based assignment. While students were worried about having to work in suboptimal teams, they were less concerned about the academic strength of their peers than about getting along with them on a personal level and about their motivation and work ethic. Moreover, students repeatedly mentioned that organizing a schedule for their team was a significant cost, and that thus teams should be built based on their preferences (which presumably would include the ability to find a common work schedule). This indicates that students appreciate context-driven team formation [4]. Finally, students strongly rejected performance-based team formation; this correlated with their comments that the academic strength was not necessarily a major factor in choosing teammates.

The method of this study, a survey asking students about their opinions and preferences, is clearly limited. Its validity is threatened by the small number of students, in a single course, with a single instructor. The reliability of the open coding is limited because the coding was performed by a single person. Moreover, the study does not evaluate the *effectiveness* of different team formation approaches. It focuses exclusively on eliciting and understanding *students' perspectives* on team formation. Our results help to understand *why* students oppose or favor certain kinds of team formation approaches, and what factors they consider most important. We hope that our results help learning system developers and instructors to better communicate and explain their chosen team formation approach to their students. This way, instructors can select those team formation approaches that have been shown to lead to the best team performance and learning outcomes, and they can better help their students understand the benefits of the most promising approaches.

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