Analyzing trends in academic papers about ubiquitous virtual worlds in education using text mining

Aliane Loureiro Krassmann, Fabrício Herpich, Magda Bercht, Sílvio Cesar Cazella
Federal University of Rio Grande do Sul
Brazil

Abstract

Contemporary teaching and learning processes increasingly require exploration and discovery activities, rather than the organized sequence of methods used in the twentieth century. This paper aims to describe a research that uses text mining techniques on a corpus composed of 10 current academic papers about educational ubiquitous' Virtual Worlds, aiming to obtain indications about the main trends in terms of development and applications in the area. As a result, some directions have been extracted and analyzed, which revealed research opportunities in the educational field.
Keywords: Virtual Worlds; Ubiquitous Computing; Text Mining; Education

1. Introduction

The 3D virtual worlds are environments that have many possibilities and offer different interactions than those available on web. Among the advantages of such spaces Chen et al. (2011) highlight the ability to escape the constraints of the physical classroom, encouraging feelings of presentation when students are geographically dispersed.

However, only adopting an approach considering the use of virtual worlds may not be enough, as we live in an increasingly dynamic society that seeks new paradigms using technological resources. In this perspective stands out proposals based on principles of ubiquitous computing, generating personalized treatment of the student. Researches have shown that it is possible to involve and to motivate students by providing autonomy and personalization in their studies, as in the work of Soflano, Connolly and Hainey (2015). Besides, Kellen et al. highlight that by "providing student with tailored information given their varied abilities and unique cognitive and non-cognitive traits, institutions can improve outcomes and reduce costs" (2010, p. 02).

Among the ongoing research in the Federal University of Rio Grande do Sul is the construction of a computational system that is adaptive, that is, dynamic and flexible to the individual characteristics of the student, using the technology of 3D virtual worlds to enhance learning by providing resources in tune with the cognitive process. In this project it is proposed to indicate means of recognition of mood states and cognitive style of the student while interacting with a virtual world, in a transparent, continuous and dynamic way. This study intends to support the mentioned project. In this regard, the research question is presented: how are the aspects of students' cognitive style and state of mood are being addressed and treated within the context of 3D virtual worlds in education?

In view of the foregoing, this paper aims to investigate some of the main tendencies in the aforementioned scope, aiming to obtain insights and a perspective of the subjects addressed and aspects treated in the works developed. On this purpose, papers of the area are analyzed using tools and techniques of text mining.

Considered a multidisciplinary field that involves retrieving and extracting information, grouping, categorizing, visualizing, and machine learning, text mining can be an even more complex task than data mining as it involves dealing with data that is inherently non-structured and diffused (texts) (TAN, 1999). With the support of text mining it is intended to achieve the goal without having to read all the selected papers in its full for it, that is, in an automated way, allowing more time to focus on the results.

In this context, as a related work is the paper of Nunes et al. (2015), that presents an exploratory study using educational virtual worlds and data mining, in which, through case study and simulated interactions, the possibility of identifying user behavior patterns within the virtual world was verified, relating it to their preferences according to the level of expertise.

On the other hand, the research by Nunes et al. (2016), with the objective of analyzing the scientific production connected to the virtual worlds applied to education, presented a systematic review of literature, showing that a growth of publications in the area between the years of 2010 and 2013 occurred, highlighting future opportunities. The study allowed to demonstrate the diversity of domains in which the virtual worlds were used and the educational theories with which they were applied.

This research uses the two types of approaches presented above. That is, the possibilities of data mining are explored, as in the work of Nunes et al. (2015), but using text mining tasks; and recent scientific productions related to the scope of research are analyzed, as in the work of Nunes et al. (2016), through the analysis of 10 selected papers.

This work is structured in the following way: in section 2 are approached the ubiquitous virtual worlds; in section 3 the research method is presented; section 4 discusses the results and in section 5 the final considerations are exposed, ending with the references.

2. Ubiquitous Virtual Worlds

The virtual worlds are an innovative educational technology with great potential in education, emphasizing in particular distance learning and higher education, as they enable different activities such as experiments, lectures, debates and games, as well as favoring collaboration and social interactions among students (SILVA, 2012). In addition, they allow the simulation of real or fictitious situations, reducing costs with acquisition and maintenance of physical laboratories, as well as risks inherent in the experiments.

However, some students' lack of interesting for persistence in the educational environment may occur, even in approaches that use virtual worlds platforms, due to the shortage of relationship or identification from the user with the system, coming as evidence that users present very different needs, requirements and experiences.

In attempt to solve the idiosyncrasies among students' profiles, ubiquitous systems are highlighted, which according to Barbosa (2007) allow omnipresent processes, learner autonomy and the context integration.

The ubiquitous 3D virtual worlds emerge as solution, as they can adapt to the students' reality, becoming motivationally more attractive and potentially more effective in the pedagogical proposal.

This paper aims to base a bigger research project in progress, which aims to address student's context in 3D virtual worlds. The aspects of ubiquity treated in the scope the mentioned research project are presented below in order to justify its choice:

- **Cognitive Style**

According to Mozzaquatro (2010) cognitive styles are related to the way data are perceived and the knowledge formulation from them, describing the typical way of one's thinking, remembering or solving problems. Lemes (2012) emphasizes that studies about cognitive styles have contributed to educational qualification, due to respect and understanding of differences, individuality and potentiality of each subject.

- **State of Mood**

According to Bercht (2006) emotions are responses to the meaning of events and are linked to individuals' goals and motivations, and therefore correlate with their learning process. Santos et al. (2007) affirm that, in the field of emotions, the state of mood have a longer duration in the time, besides being more stable and expressive, which allows it to be more representative and to acquire more subsidies for its identification.

In this way, it is hypothesized in our research project that when contemplating these aspects of the student (cognitive style and state of mood) within the context of 3D virtual worlds, using transparent and adaptive procedures, following principles of ubiquitous' computation, it is possible to obtain better results within students' motivation and consequently with learning.

3. Method of Research

A collection of written text can be defined as a corpus. To obtain the corpus of this research the following five terms were used in the composition of a search string: "virtual worlds", "3D", "cognitive style", "emotion", "education". They were inserted in Google Scholar web tool, where it was stipulated that these terms should appear in all (any) fields of the paper. It was also defined the period from 2010 to 2016 aiming to return recent publications, and the English language to broaden the scope of the search. It was decided to insert the term "emotion" instead of "state of mood", in order to widen the scope and reach more papers that deal with the theme.

Through the application of the search string the first 10 papers were selected for analysis. Table 1 summarizes this corpus showing details such as year of publication, country of origin, journal or event where it was published and an assigned identification number (ID) that was attributed to each paper to facilitate the reference of the same in the course of this paper. It is worth noting that it was not defined a criterion for ordering them in Table 1.

Table 1. Selected papers for the corpus composition

ID	Paper name	Year	Country of Origin	Where it was published	Number of words
1	Pedagogical Immigration to 3D Virtual Worlds: a Critical Review of Underlying Themes and their Concepts	2010	United Kingdom	International Conference on Information Society	6.436 (5%)
2	Turning immigrants to citizens: merits of the pedagogical shift in 3D Virtual Learning Environments	2011	United Kingdom	International Journal for Infonomics (IJI)	7.343 (6%)
3	Hype or Help? A Longitudinal Field Study of Virtual World Use for Team Collaboration	2012	United States of America	Journal of the Association for Information Systems	20.159 (17%)
4	The Viability of Virtual Worlds in Higher Education: Can Creativity Thrive Outside the Traditional Classroom Environment?	2012	United States of America	Brigham Young University BYU Scholars Archive	32.974 (28%)
5	The influence of computer self-efficacy, metacognitive self-regulation and self-esteem on student engagement in online learning programs: Evidence from the virtual world of Second Life	2014	Greece	Computers in Human Behavior	13.740 (12%)
6	E-learning continuance: The impact of interactivity and the mediating role of imagery, presence and flow	2016	Spain	Information & Management	13.273 (11%)
7	VILLAGE—Virtual Immersive Language Learning and Gaming Environment: Immersion and presence	2015	Canada	British Journal of Educational Technology	8.863 (7%)
8	Generation I(mmersion) – How to meet learner expectations of tomorrow	2016	Austria	The International Conference on E-Learning in the Workplace	5.549 (5%)
9	UNITE Enhancing Students' Self-efficacy through the Use of a 3D Virtual World	2015	United Kingdom	Journal of Universal	7.572 (6%)

				Computer Science	
10	The use of 3D virtual learning environments in training foreign language pre-service teachers	2015	Turkey	Turkish Online Journal of Distance Education-TOJ DE	3.417 (3%)

Papers that were selected for the text mining techniques application.

Table 1 shows that from the 10 papers selected, three are from the United Kingdom and two are from the United States, representing half of the corpus, which may be an indication that this subject or topic may be more discussed on these countries. This information can be considered relevant to researchers who wish to seek for events or journals to read or even to publish their researches, since at the same time it is observed on Table 1 that there was no repetition of the publication vehicle, showing that the topic is approached in several journals and in interdisciplinary areas.

It is also possible to identify in Table 1 the distribution of each paper within the corpus, revealing discrepancies on text sizes, where 28% refers to paper of ID 4, 17% to the ID 3, and the 21% to papers of ID 5 and 6. The other six publications together represent the remaining 34%. This is a factor that makes it impossible to generalize the results, as it is observed the predominance of certain papers in relation to others, as well as an alert to care when analyzing graphs on this corpus.

Figure 1 shows the corpus visually, identifying the slice corresponding to each publication of a corpus composed of 119.326 words.

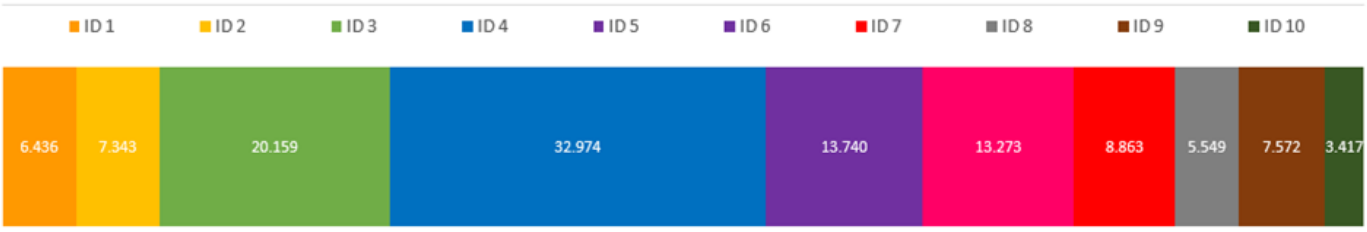

Figure 1. Papers distribution on corpus.

It is worth mentioning that text mining can consist basically of two phases, according to (TAN, 1999): 1. Text refining, which transforms unstructured text documents into a chosen intermediate form; and 2. Knowledge distillation, which deduces patterns and produces knowledge.

Following these procedures, in phase 1, to improve the text mining technique, the cleaning of the data contained in the corpus was performed. Words such as adverbs and conjunctions, called “stop words”, and repetitive words that have no direct relationship with the publications content have been manually removed. Also, headings, footers, informative data of authors and their academic linkages, acknowledgments and bibliographical references were removed. The texts were saved in “.txt” format, widely accepted by text mining tools as the ones used in this study.

In phase 2 the free tools presented in Table 2 were used, which also indicates the purpose adopted for each one and where can be found their results on this study.

Table 2. Tools used in text mining

Order	Tool name	Description	Goal
1	WordCounter[1]	Online and free that calculates the number of words, sentences and characters, among other aspects.	Analysis 1: incidence calculation of search terms and more general terms (Tables 3, 4 and 5).
2	TagCrowd[2]	Online and free that allows create clouds of markers (tag clouds).	Analysis 2: extraction of the most incident terms (Tables 6 and 7).
3	Sobek[3]	Developed in Java language, free, with educational focus, which generates graphs with the most relevant words.	Analysis 3: graphical representation of the terms with the highest incidence (Figure 5).
4	Voyant[4]	Online and free that allows to generate diverse formats graphs for analysis.	Analysis 1, 2 and 3: incidence variation of predominant terms (Figures 2, 3, 4 and 6).

Tools that were used for the text mining techniques application.

After presenting the method used for this research development, as well as the tools adopted to accomplish its objectives, the next section will present the text mining results achieved with these tools. It will also be held analysis and discussion of the knowledge evidenced from the applied text mining techniques and the graphic representations generated by the tools, interpreting its results.

4. Results and Discussion

The first analysis of the selected papers, using the Word Counter tool, identifies the incidence percentage of the searched terms in the corpus. As shown in Table 3, the paper that most used the search terms corresponds to the ID 9, with 13% of its text corresponding to the terms “virtual worlds”, “3D” and “education”, suggesting that it was the one that most approached the scope sought. In second place it is paper ID 4, containing in 10% of the text the term “virtual worlds”. It is also possible to identify that papers with ID 6 and 10 did not present in a relevant way any of the searched terms in their texts (less than 1%).

[1] Available in: https://wordcounter.net
[2] Available in: http://tagcrowd.com
[3] Available in: http://sobek.ufrgs.br
[4] Available in: https://voyant-tools.org/

Table 3. Percentage of incidence of search string terms per paper

ID	Search string terms				
	"virtual worlds"	"3D"	"cognitive style"	"emotion"	"education"
1	5%	4%	Less than 1%	Less than 1%	Less than 1%
2	5%	1%	Less than 1%	Less than 1%	Less than 1%
3	3%	Less than 1%	Less than 1%	Less than 1%	Less than 1%
4	10%	Less than 1%	Less than 1%	Less than 1%	Less than 1%
5	Less than 1%	Less than 1%	Less than 1%	Less than 1%	2%
6	Less than 1%	Less than 1%	Less than 1%	Less than 1%	Less than 1%
7	2%	Less than 1%	Less than 1%	Less than 1%	Less than 1%
8	Less than 1%	Less than 1%	Less than 1%	Less than 1%	4%
9	10%	2%	Less than 1%	Less than 1%	1%
10	Less than 1%	Less than 1%	Less than 1%	Less than 1%	Less than 1%

Where the search string terms most appeared.

In relation to the terms with the highest incidence in the corpus, Table 4 presents a classification of the nine general terms found, as well as the number of times and the percentage in which they appeared. In this analysis, with the Word Counter tool, all texts were grouped into a single file for analysis.

Table 4. General terms of greatest incidence on corpus

Order	General terms of greatest incidence	Percentage of incidence
1st	Virtual (981)	4%
2nd	Group (926)	3%
3rd	Students (854)	3%
4th	Learning (795)	3%
5th	World (661)	2%
6th	Education (626)	1%
7th	Creativity (530)	1%
8th	Environment (489)	1%
9th	Interactivity (347)	1%

Terms that were common on corpus.

Through Table 4 it is possible to infer that approaches through experiments or case studies with the separation by groups of students can be a recurrent technique in the researched area, due to the great use of the word "group", representing 3% of the corpus. It is noted that researchers often use control and experimental groups to perform and analyze approaches that use ubiquitous' virtual environments, such as the work of Soflano, Connolly and Hainey (2015).

Another important word in Table 4 is "interactivity" in 9th position, which appears as an evidence that

this aspect has been addressed within the scope of this research, reinforcing its importance. Pellas' (2014) research is an example of priority in this regard in a virtual world approach, indicating that the behavioral involvement of students presented not only a linear correlation of cognitive engagement but also a positive association with emotional involvement in collaborative learning tasks.

Figure 2, generated through Voyant Tools, aims to complement this analysis by dividing the corpus into 10 segments of equal size (which does not correspond to the proportional size of each paper, as identified in Table 1 and Figure 1) to show the incidence variation of the three prevailing terms throughout the text ("virtual", "learning" and "group"). This shows a little contradiction from the Word Counter tool, as that considered the word "students" as more incident than "learning". However it should be noted that the frequency of both is very close in the corpus (854 for "students" and 795 for "learning").

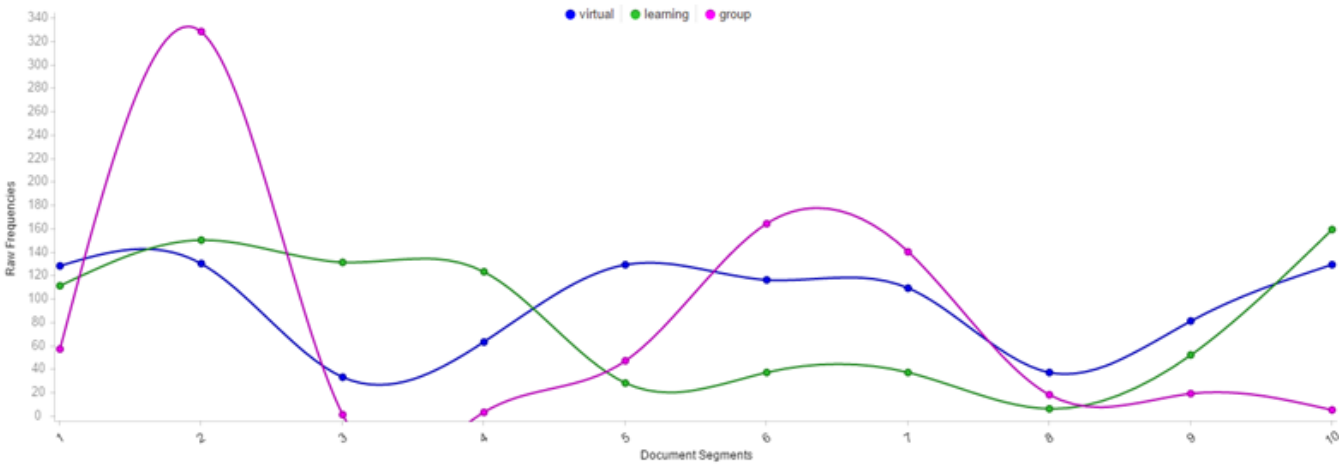

Figure 2. Variation in the incidence of prevailing terms on corpus.

It is also possible to verify in Figure 2 that the term "group" is practically nonexistent between segments 3 and 4, and briefly incident between segments 8 and 10, allowing to infer that the beginning of ID 4 paper could have not approached that word, and the publications with ID 7, 8, 9 and 10 hardly mentioned it. On the other hand, the paper with ID 3 stands out as the one with the most use of the term, showing an indication of a reading instrument for researchers who wish to apply group approaches to ubiquitous' virtual worlds applications.

It is worth noting that the term "creativity", which ranks 7th among the most incidents, appearing 530 times in the corpus, is directly related to the paper of ID 4, where it was mentioned 519 times (as shown next in Table 6), which prevents it from correlating with all the corpus, since its relationship remains restricted to the mentioned paper.

Figure 3, likewise generated with the Voyant Tools, supports this finding, revealing that the term "creativity" reached its highest indexes between segments 4 and 8. Thus, it is possible to infer that the publication with ID 4 corresponds to this range of segments. The tool allows to select any word generated on the chart to highlight its variance by color. Figure 3 also shows on the upper axle the variation of the three terms with the highest incidence in the corpus.

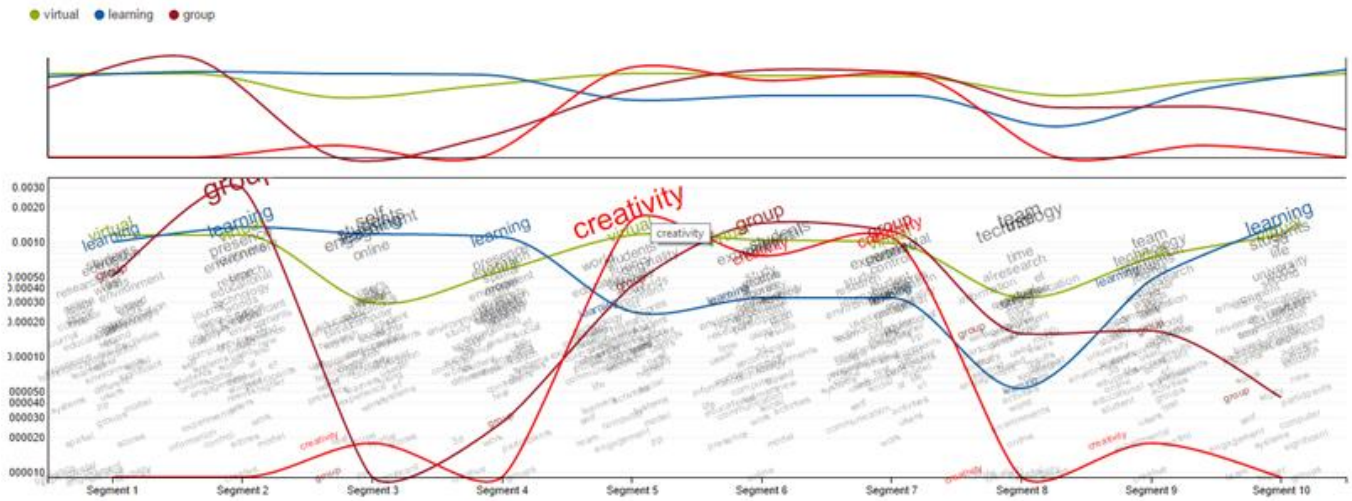

Figure 3. Incidence variation of terms on corpus.

Also with the Word Counter tool it was possible to verify the terms composed by two words more frequent in the corpus. Table 5 shows the term "experimental group" as very frequent, corresponding to 3% of the corpus, reinforcing the indication that this technique or method can be recurrent in educational approaches of ubiquitous virtual worlds. This aspect may be based on the need of researchers to demonstrate that this type of approach can present differentiated or more positive results, generating good results in students in comparison to others, proving their hypotheses and encouraging their adoption.

Table 5. Compound terms with the highest incidence on corpus

Order	Compound Terms (2 words)	Percentage of incidence
1º	virtual world / virtual worlds	10%
2º	experimental group	3%
3º	second life	2%

Compound terms that were common on corpus.

Table 5 also reveals the virtual worlds platform most used on these researches, with 2% of the compound terms corresponding to "second life". The Second Life, according to Warburton (2009), is a proprietary multi-user platform developed in 2003 that simulates real-life and social life, and is currently one of the most popular educational virtual environments. This statement is supported by the systematic review by Nunes et al. (2016), which showed that between the years of 2010 and 2015 Second Life platform was the most used (in 30 of 58 papers). Among the options currently available, such application can be considered as the most established and widespread, both in academic, professional and personal areas, but it requires financial investment.

The second analysis starts using the TagCrowd tool to identify the terms that appeared the most in each of the papers, classifying them in three instances according to the incidence order. Table 6 presents highlighted with an asterisk that the term "learning" is among the predominant ones in 6 of the 10 papers analyzed, which may be an indication of concern and / or the focus of the scientific community that

studies ubiquitous virtual worlds with learning. In second place is the word "students", which appeared in four papers, possibly associating learning with student behaviour, reaffirming the educational focus of the investigated publications.

Table 6. Terms of greatest incidence per paper

ID	1st Term	2nd Term	3rd Term
1	students (79)	learning (67) *	life (53)
2	learning (115) *	virtual (77)	3dvles (63)
3	team (366)	technology (256)	systems (199)
4	creativity (519)	group (462)	students (380)
5	students (199)	learning (178) *	engagement (158)
6	interactivity (139)	presence (133)	e-learning (109)
7	group (341)	learning (134) *	presence (103)
8	education (95)	learning (56) *	generation (49)
9	virtual (124)	world (99)	students (79)
10	environment (52)	learning (63) *	virtual (43)

General terms that were common per paper.

Also in this analysis we sought to empirically identify words that may have been used as synonym or technique, that can be associated with the search string terms, listing four main words found. It is possible to observe on Table 7 the associations that can occur in the area. For example, agents (Herpich et al., 2014) and virtual reality (Janssen et al., 2016) are commonly incorporated into virtual worlds, as are often related topics of peer collaboration approaches (Maratou; Chatzidaki; Xenos, 2014).

Table 7. Recurring terms near to search string

Search string terms				
"virtual worlds"	"3D"	"cognitive style"	"emotion"	"education"
"agents"	"three-dimensional"	"learning style"	"gamification"	"learning"
"virtual reality"	"graphics"	"mental structure"	"interaction"	"students"
"virtual environment"	"immersion"	"meaningful"	"mood"	"teaching"
"collaboration"	"visual"	"context-aware"	"feelings"	"knowledge"

General terms that approximated of the search string.

It is also possible to infer from Table 7 some research tendencies, as in the case of the terms next to emotion, where the words "gamification" and "interaction" appeared, identifying that these techniques may have being explored to gauge or stimulate the student's emotions. In this sense, an example that addresses these themes is the work of Soflano, Connolly and Hainey (2015), which used gamification techniques to propose an adaptive to the learning style of the student game, whose objective is the teaching of Structured Query Language (SQL) in computer science courses.

In order to expand this analysis, the bubble chart from the Voyant Tools was used to identify where some of the terms mentioned on Table 7 are found in the corpus. Figure 4 shows that the term "learning style" might be associated with the paper ID 2, the term "mood" occurred at various times in the corpus, with some emphasis on publications ID 4 and 5. The word "interactivity" is predominant on paper ID 4, as well as the term "feelings", which may also have occurred on publication ID 7. Figure 4 also points out that the word "collaboration" occurred several times throughout the corpus, especially on papers with the ID 1, 6 and 7.

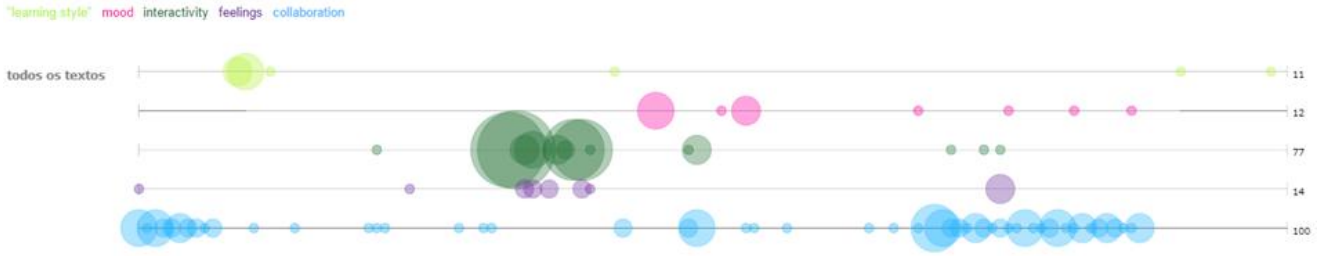

Figure 4. Incidence distribution of the terms close to the search string

The third analysis refers to the graphical representation of the most relevant terms of the corpus, using the Sobek tool. Figure 5 shows that the terms are a bit different than those revealed with the Word Counter tool, perhaps because Sobek disregarded the stop words inserted in the software, which would exclude words like "technology" and "research" because they do not bring strong contributions or significance to this research objective.

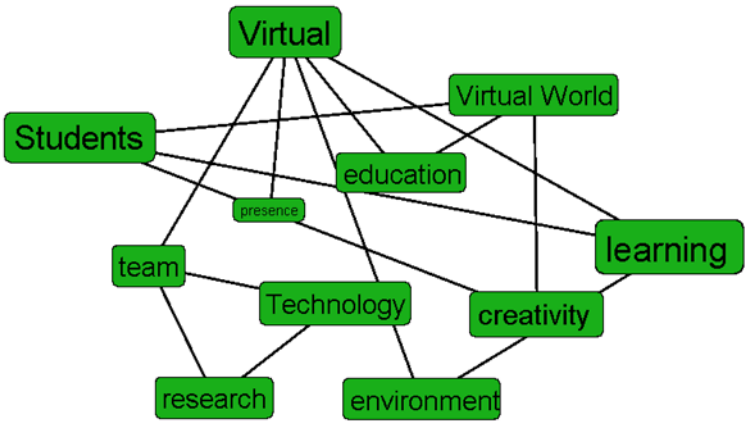

Figure 5. Graphical representation of the most relevant terms on corpus.

Figure 5 shows the connections between the terms of greatest incidence in the corpus, identifying a direct association of the term "virtual" with "presence", "team", "environment", "education" and "learning", which may indicate that aspects such as the student's virtual presence and the work in teams or groups are treated in these virtual environments with educational focus, reinforcing previous analysis.

It is also observed on Figure 5 that the term "creativity" was directly connected to the words "learning", "environment", "students" and "virtual world", possibly associating creativity with learning in ubiquitous virtual worlds. This term appears as a possible indicative of tendency, since few studies suggest the aspect

of creativity in these approaches, revealing a research opportunity. In virtual worlds users are able to create their digital media and three-dimensional objects, characteristic which can be exploited to engage them in learning while building educational content. However, it is important to emphasize once again that this term is linked to only one of the selected papers (ID 4).

To conclude, Figure 6 shows a cloud of words with the most incident terms in the corpus, making it possible to visualize and instantaneously identify the subjects covered and the corpus' focus as a whole, obtaining a panorama.

Figure 6. Cloud of words with the more incident terms on corpus.

Figure 6 was obtained with the Voyant Tools and graphically reinforces some of the findings from the analysis carried throughout this research, such as the strong use of groups and the concern with student learning.

Other terms presented on Figure 6 are worth mentioning because they are directly associated with the virtual worlds dedicated to education:

a) "Online", "flexibility", "experience" and "engagement", in so far as they enable users to access a virtual environment and interact with different elements which are not normally found in a regular classroom, an aspect that impacts on users' involvement with the environment itself and with activities aimed at learning;

b) "Experimental", since virtual worlds allow the generation of simulations, in which users can visualize the occurrence of some phenomenon related to the educational topic addressed;

c) "Participants" and "collaboration", because it is possible that users discuss content presented to them, to understand concepts or even to solve activities in a collaborative way.

In this sense we can observe that automatizing the analysis of a great volume of text allowed to obtain some insights and trends about 3D virtual worlds and its applications, in a quickly and more efficient way than it would be by manually reading papers one by one.

5. Final considerations

The research described throughout this paper demonstrated the potential of using text mining techniques to bring contributions to the academic community through analysis and discovery of standards and new

knowledge in a textual corpus. Some possibilities of online and free text mining tools were explored, applying them to papers from the area of ubiquitous virtual worlds in education, aiming to support a research project in development at Federal University of Rio Grande do Sul.

In response to the research question it can be observed that the context aspects of cognitive style and students' mood in approaches that use 3D virtual worlds in education may not yet have been contemplated in its totality, verifying that although the terms "cognitive style" and "emotion" were searched, they did not appear in their literal form. Other terms appeared as "learning styles", "mental structure", "mood" and "feelings".

On the other hand it is observed that the selected papers dealt with aspects such as interactivity, gamification and creativity, indicating that these characteristics may be paths that are being followed in the case of ubiquitous virtual worlds. Also evident was the recurrent division of student classes into groups or teams for application and validation of experiments, and the concern with student learning.

The use of text mining techniques demonstrated to be an automated, fast and efficient, as well as simple and intuitive, way of analyzing a considerable volume of data without the need for analytical reading of each paper, which would require a lot of time to read and to tabulate the obtained data. As a limitation of this study it is important to highlight that only 10 articles were analyzed, preventing results generalization.

As future work the authors intends to expand the research, increasing the number of papers selected and using other text mining tools, in order to obtain more precise results and to discover new knowledge and trends of what is yet to come.

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