Connecting Analysis of Speech Acts and Performance Analysis - An Initial Study

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ABSTRACT
This paper presents an initial case study on connecting the analysis of speech acts of students in discussion forums and the analysis of performance. At first, to understand better the posting pattern of this study, various statistical overviews of postings are presented. Participation is very skewed, a result well in line with observation of others. The overview also suggests a positive relation between posting in the discussion forum and, both, engagement and performance. The theory of speech acts is used to capture the role(s) played by posts. The results suggest that globally strong students tend to have a role of help-givers, and weak students a role of help-seekers, though giving help and seeking help among strong students could be balanced.

Categories and Subject Descriptors
K.3.1 [**Computers in Education**]: Computer Uses in Education– *Collaborative learning, distance learning.*

General Terms
Measurement, Human Factors.

Keywords
Forum, Engagement, Performance, Act of Speech.

1. INTRODUCTION
In online courses students and teachers exchange, discuss, collaborate and support each other mainly through forums. In some settings, participating in forums is mandatory and students earn marks for participation. When not mandatory, students are highly encouraged to post messages in forums, as it is widely believed that collaborating that way will enhance learning.

In the context of online-courses where posting in forums is not marked but strongly encouraged, which analyses can connect the following levels: engagement and performance in the course, and participation in forum? Different works taking place in diverse pedagogical contexts report various analyses and various findings.

Paredes and Chunk in [14] analyze students' participation in forums and performance from a social network perspective. Participation in forums takes place in the context of an online project management course taken by 36 full time working professionals from different geographical places enrolled in a postgraduate program. Students need to communicate through different forums to solve tasks, but there is no mark for forum participation. Performance is measured by different assessments. Assessments reported in the paper include an individual assignment, an online-quiz and a final exam. The authors have used the forums to construct the ego social network of each student and calculated several measures like density, contribution index among others. They have proposed and added another measure that they call the content richness score (CR). CR of a message can take the value 0 (empty), 1 (team building), 2 (dissemination), 3 (coordination) or 4 (collaboration). CR is manually calculated by inspecting each message. They have calculated the correlations between all measures and performance. Interestingly there is no strong correlation, strong means above 0.3, between final exam and any measure calculated from the social network. The final exam has a correlation above 0.3 only with the individual assignment (0.379) and the online-quiz (0.885). The next highest correlation is obtained with CR (0.285).

The study of Khan, Clear and Sajadi in [8] analyzes the students' access to an online discussion forum in a project management course of an undergraduate program. Students have to perform a group activity that requires collaborating through a discussion forum. This activity was not marked but was essential to a subsequent activity that was marked. The authors have analyzed two consecutive cohorts of 160 and 143 students respectively, and have identified two variables that characterize well the students' behavior in the discussion forum, namely the average duration of a session, and the average time between two sessions. They obtain meaningful clusters of students using these two variables for both years. They could not establish any correlation with performance.

Lopez et al. in [12] have the point of view that "the more students participate in a forum for a certain course, the more involved they will be in the subject matter of that course". They investigate whether they can predict if students pass or fail the final exam from their behavior in forums analyzing a first year course on computer engineering taken by 114 students. As a result they can predict pass/fail with an accuracy of 0.894 using an Expectation-Maximization-clustering algorithm and the following variables: the number of messages sent by a student, the number of replies, the number of words written by the students, two measures from social network analysis: degree of centrality, degree of prestige and an evaluation mark of forum participation given manually by the teacher. Students that are predicted as pass have higher values on all these six variables than those predicted as fail.

The two following works focus on MOOCs that are not cMOOCs, i.e. they do not emphasize connectivist theories. In such MOOCs students have access to learning material such as video lectures, slides, tests and assignments, communicate through forums, sometimes hangouts, and can obtain a certificate if they have solved and submitted the required assignments. They do not receive credits.

The work of Grünwald et al. in [7] reports about one MOOC on Internet Technology that took place in 2012 with about 10 000 enrolled students. About 1000 obtained the certificate at the end.

From those who obtained the certificate, more than half of them never posted a single message in the forum. However, the more students posted messages, the better their mark in the course certificate.

The work Kizilcec, Piech and Schneider in [9] investigates, among others, the participation in forum of students according to their level of engagement. To label a student according to his/her engagement in the MOOC, the authors proceed as follows. Each student is represented by a series that reflects the state of each assignment, like in track, behind, auditing (only watching materials but not doing any assignment) and out, when students do not participate at all. The authors cluster the students of three courses using these series, which leads to four clusters: Completing (students who attempted almost all assignments), Auditing (students who did very few assignments but watched regularly video-lectures), Disengaging (students who first did the assignments but at some point disappear) and Sampling (students who watched few video-lectures). In the three courses students from the group Completing post significantly more messages than students from the other groups.

These works show diverse approaches of connecting participation in forum, performance and engagement and obtain different results: [14] and [8] show no obvious correlation between posting and performance whereas [12] and [7] show a strong correlation. However [12] does not describe whether good students and weak students are equally well predicted. Further [14] and [12] suggest that looking at participation in forums from a sole quantitative point of view might be limited. Taking into account the quality or the content of the messages through either content richness in [14] or participation evaluation in [12] seems important. Content richness and participation evaluation are specific to these studies and it is not clear how they can generalize to other contexts and which computational method can calculate their values.

The theory of speech acts [1] is general and can be used to associate some role to a message. The role of the messages might help to discover the role of participants in a forum, for example as help-seekers or help-givers.

This paper investigates connecting the analysis of engagement and performance in a course to the analysis of the role of the messages in the forum with the help of the theory of speech acts.

This paper is organized as follows. The next section presents the context of the analysis. Quantitative analyses relating posting, engagement and performance are given in section 3. Section 4 connects the theory of speech acts to performance. The last section concludes the paper.

2. CONTEXT OF THE ANALYSIS

The analysis presented in this study takes place in the context of a Java programming course taught online in a university as part of a regular degree, which means students earn credits when they pass the course. The online degree takes a blended learning approach. Students have access to learning material such as multimedia-based lectures notes, assignments and so on through a learning management system (LMS). Students and teachers communicate mainly via email and forums. Web-conferences take place approximately every two weeks where students and teachers communicate synchronously via chat and microphone. Two times in the semester students come for face-to-face teaching in the university during a weekend.

The discussion forum used by students and tutors in the course is very much like any help forum but restricted to the students enrolled in the course. The use of the forum is not compulsory, and also not marked but strongly encouraged as it replaces the classroom. Students do use the forum in a responsible way, and usually the discussion forum does not have off-topic messages as there are other forums in the LMS for other topics like organization etc. This study analyzes the messages posted in the discussion forum of the Java course by four different cohorts of students from 2010 till 2013.

3. POSTS, ENGAGEMENT AND PERFORMANCE

The box plots of Figure 1 present a statistical overview of posting and shows that participation is very skewed, as also observed by others, see for example [3], [7]. The line in the box is the median while the black square is the mean. The line up and down the mean is the standard deviation. Each year there is at least one student who writes exactly one message as the minimums show; notice that twice the minimum is the bottom of the box. The average number of messages written per student is higher than the median, except for the last year, and the maximum number of posts is much higher, which indicates a small group of prolific students.

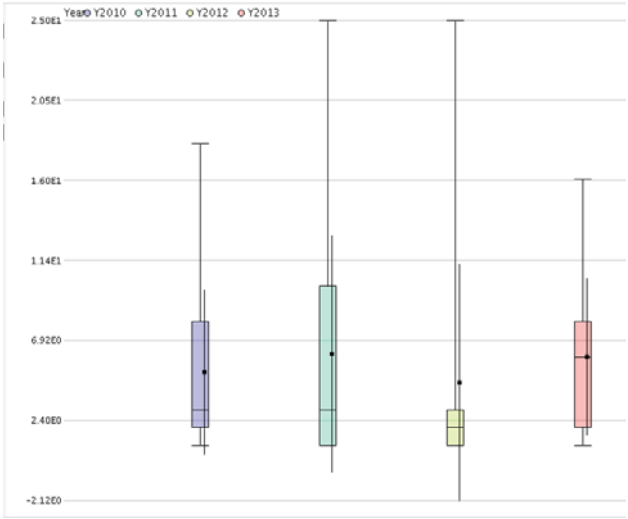

Figure 1. Box plots of the number of messages written by students.

Attending the final exam proves the engagement of a student in the course. Table 1 and Figure 3 investigate the connection between number of written messages and attending the final exam. The column #Stud. shows the number of enrolled students, the column #Stud_P shows the number of students who posted at least one message in the forum, the column #Stud_P_F shows the number of students who posted at least one message and attended the final exam and the column #Stud_F shows the number of students who attended the final exam. As observed in other studies, see for example [3], [7], many students, the majority for the last three years, do not post any message.

Table 1. Overview of the number of students who write posts and attend the final exam

Year	#Stud.	#Stud_P	#Stud_P_F	#Stud_F
2010	26	15	9	14
2011	27	12	8	14
2012	35	11	9	18
2013	25	10	8	10

The number of students who posts at least one message and the number of students who attend the final exam are somewhat similar. The two groups have at least 50% overlap as the diagram Figure 2 shows. The line p(F/P) gives the probability of attending the final exam if one has posted at least one message, while the line p(P/F) give the probability that a student has posted at least one message if s/he attends the final exam. These two curves indicate that posting messages in the discussion forum is a sign of engagement as found in [9]. When aggregating the four years together, 62,5% of the students who attended the final exam did post in the discussion forum.

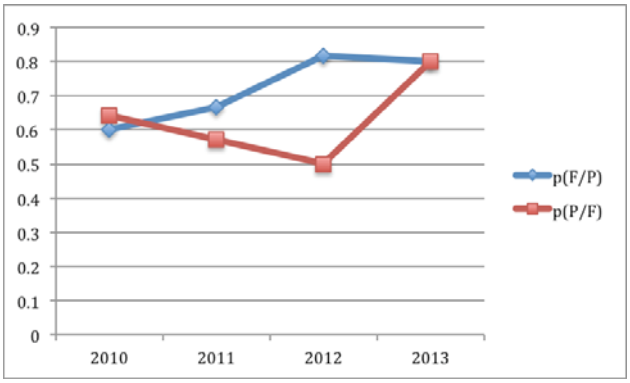

Figure 2. The conditional probabilities of posting and attending the final exam over the four years.

Figure 3 suggests that writing at least one message in the forum seems to have a positive impact on the mark in the final exam. The top line called Post shows the average mark of the students who posted in the forum. This line is always above the No Post line, except for year 3. The No Post line gives the average mark of the students who did not post any message in the forum.

On one hand Table 1 shows that not everybody who attends the final exam write messages in the forum. On the other hand, Figure 3 suggests that writing in the forum is beneficial for performance, hence could be a good strategy for students to follow. Do students who performed well in the final exam follow this strategy? And what about students who do not perform so well?

Figure 4 compares the average numbers of written messages per student in the three following groups: the group of the posters, the students who have written at least one message; the top 25% group, the students who have performed best in the final exam, and the bottom 25% group, the students who obtained the lowest marks in the final exam.

Figure 3. Average mark in the final exam of the students who posted and who did not post in the forum.

Figure 4. Average number of posts in the 3 groups.

Figure 4 shows that top students post less than average in the forum. One notices a singularity for the year 2012: average of the bottom 25% is the highest of the 3 groups. A manual examination revealed a highly motivated student determined to pass the course, but having difficulties and posting many questions in the forum. This student passed the course with a low mark. This observation raises the question of the art of participation: who raises questions and issues or who are help-seekers? Mainly weak students? Do good students primarily answer and give hints and therefore are help-givers? The theory of speech acts helps to investigate those aspects.

4. ACT OF SPEECH

When students post a message in a forum, not only they write sentences like “Hi, has somebody experience with Apache Ant?”, but also they do something, like asking a question, or giving an answer or an hint to a previously asked question, giving feedback, greeting their fellows students and so on. Following Kim, Li and Kim in [10] we adopt the theory of speech acts [1] to capture the role(s) played by messages in forums.

Table 2 takes a look at the data and shows an excerpt of a thread annotated with acts of speech. Greetings have been omitted. This thread is linear in the sense that each message answers the previous one.

Many threads as the one shown in Table 2 begin with a question concerning a concept or an assignment and a discussion follows. Some threads do also begin with a hint to some interesting material, mostly an Internet link, directly related to the subject of studies but without being prompted by an earlier message. Usually these references do not generate discussion.

Table 2. Excerpt of a linear thread

Student1: can somebody explain to me the example p. 7 of the implementation of a Listener through an anonymous class? Somehow I don't get it. […]. With the dot operator I invoke a method: `k.addActionListener(new ActionListener).` Where is the anonymous class? […] (**ques**)
Student 2: The explanations in the lectures notes are a bit succinct. I searched in the Internet. Here is another explanation: […] Also this explanation p. 7 is helpful. […] I hope it helps. (**ans**)
Student 1: Does it mean that the following is an anonymous class? `new ActionListener()).` If yes, I have understood. […] (**ques**), (**pos_a**)
Mentor 1: an anonymous class is a class without any name as explained p. 10. Could you understand the example? Right after `new ActionListener()` comes the body of the class. […] I insert the body of the class below. (**ans**)
Student 1: I still don't get the anonymity. If we take the example p. 20 is `"new MouseMotionListener()"` the anonymous class? (**ques**)
Mentor 1: `new MouseMotionListener()` creates an object of type `MouseMotionListener`. The object here is anonymous, has no name. […] The anonymous class comes right after and implements two methods. […] Here the code. (**ans**)

In this study we are interested in the role that messages play in building understanding and knowledge. We adopt the speech act categories proposed in [10] as the interest of [10], namely detect whether questions or issues have been left unanswered in a forum, is very close to our present interest. [10] considers 5 categories: questions about a particular problem (ques), misunderstandings or issues while solving a problem (iss), answers or suggestions with respect to a previous question or issue (ans), positive acknowledgements that show support to a previous message (pos_a) and negative acknowledgments that disagree or object to a previous message (neg_a). We add one more category that we call reference (ref) to qualify messages that give hints related to the subject without being an answer or suggestion to a previously raised question or issue. We choose the word reference and not hint as many works use hint for the speech act of a tutor responding to a previous incomplete answer of a student, see for instance [11]. Table 3 gives an overview of the 6 categories.

Note that a message may have several annotations like the second message of student1 in Table 2. The first sentence is annotated as a question and the second as a positive acknowledgment. Also one message containing several questions on different topics will have several **ques** annotations.

Two annotators annotated manually over 80% of the corpus with an agreement of almost 1. The remaining part has been annotated by one of the two annotators.

Table 3. Speech act categories

Category	Description
ques	A simple or complex question about a topic, including question about a previous message.
iss	Report misunderstanding, unclear concepts or issues in solving problems.
ans	A simple or complex answer, suggestion or advice to a previous question.
pos_a	An acknowledgement, compliment or support in response to a previous message.
neg_a	A correction or objection to a previous message.
ref	A hint or suggestion related to the subject and not answering any previous message.

Figures 5 to 8 compare the number of the different speech act categories written by the two groups, the top 25% and the bottom 25% with respect to their performance in the final exam as in the preceding section. For each act of speech, the column on the left shows the number written by the top 25% group, and the column on the right by the bottom 25% group. As the category negative acknowledgement was absent in these two groups, it is omitted in the diagrams.

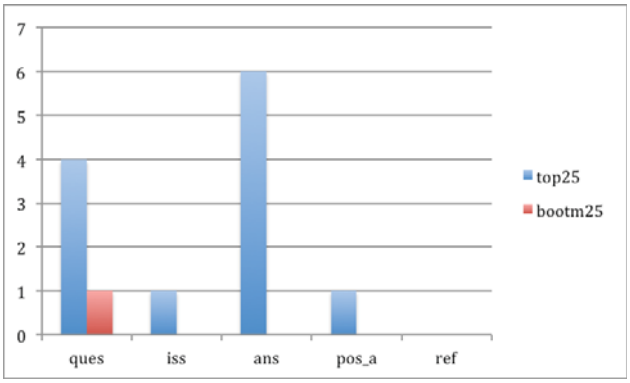

Figure 5. #Acts of Speech: Year 2010.

Figure 6. #Acts of Speech: Year 2011.

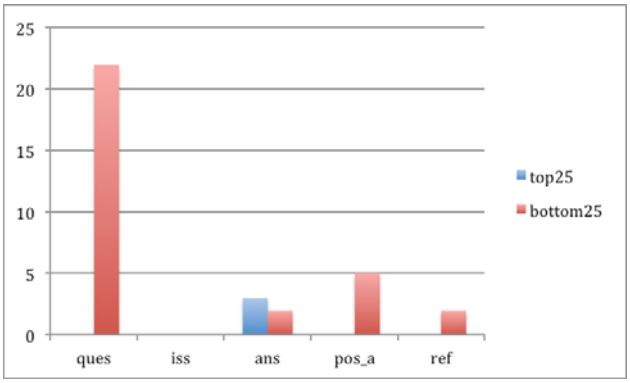

Figure 7. #Acts of Speech: Year 2012.

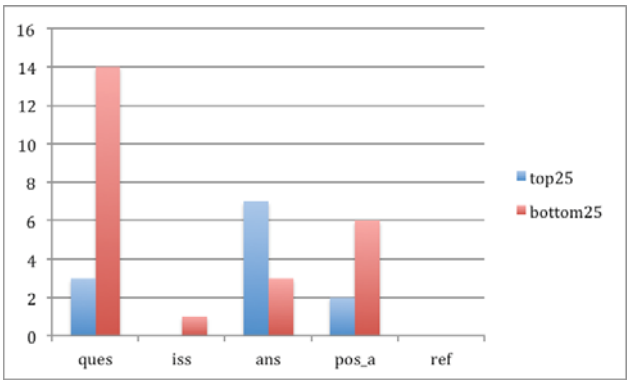

Figure 8. #Acts of Speech: Year 2013.

For all years on notice three invariants: (1) In the two groups, the most frequent acts of speech are questions, answers and positive acknowledgments; issues and references are rarer; (2) the top 25% group produces more answers than the bottom 25%, a result which is not surprising as one excepts the top 25% to have more knowledge than the bottom 25%; (3) in each year the number of questions plus issues is bigger than the number of positive acknowledgment, which might have several interpretations: some problems are intensively discussed and thus many successive questions are acknowledged only once, or not all questions are answered in some helpful way, or students simply forget to acknowledge the answers.

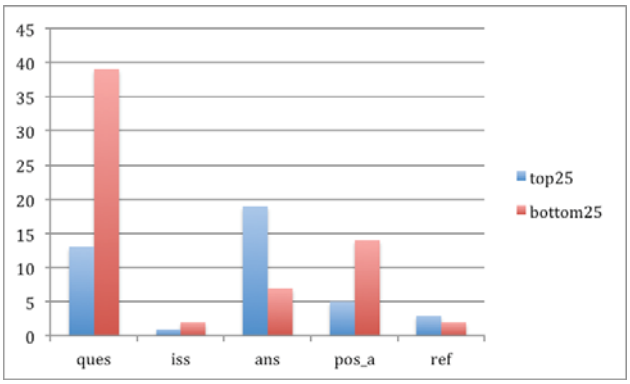

Figure 9. Number of speech acts aggregated.

Associating asking a question or raising an issue to a help-seeker role for the student, and providing an answer or a reference to a help-giver role, the following picture can be drawn. Figure 9 shows the 4 years aggregated. One notices that strong students answer more questions than weak students, and answer slightly more questions and give more references than they raise questions or issues, and thus tend to have a role of help-givers. Weak students have clearly the opposite, and, hence tend to have a role of help-seekers. However Figure 6 and to some extend Figure 5 suggest that strong students can be quite balanced between giving and seeking help

5. CONCLUSION, DISCUSSION AND FUTURE WORK

In this initial study we have analyzed the posts of four cohorts of students in a discussion forum of an online course, connecting the number of posts with engagement and performance, and connecting performance with speech acts.

Concerning posting, the results corroborate the findings of others: participation is skewed. About half of the students do not post. Average of the numbers of posts is higher than the median, indicating outliers that post much more than the majority of the students. As observed in [9], posting in the discussion forum is a sign of engagement, as altogether 62,5% of the students who posted attends the final exam. Figure 3 suggests a positive impact of posting on the final mark, as the average final mark is higher in the group of the students who posted than in the group that did not post in three out of four years, as also reported in [7] or [12].

The theory of speech acts allows for qualifying messages: is a message asking a question, raising an issue, answering a question or issue, giving a positive or negative acknowledgment, giving some hint or reference that complements the course or doing several of those? Figure 5 to 8 suggest that globally strong students tend to have a role of help-givers, and weak students a role of help-seekers, though giving help and seeking help among strong students is not too unbalanced.

This study shows that not all weak students have the strategy of seeking help in the discussion forum, and that this strategy might be a winning strategy for struggling but highly motivated students.

This study raises also the question of the benefice of participating in the forum for the top 25% students. In this group some students are self-sufficient, they do not post and obtain top results. For top students, the benefit of being help-givers, apart from social integration, might not be clear, though some do take over this role as Figures 7 and 8 suggest. The work in [16] uses the argumentative knowledge construction framework of [17] to analyze messages in an online open help forum on Java. The authors report that experts profit more than newcomers from posting. It would be interesting to investigate whether a similar result is transferable to our context, whether and how top students do benefit from being help-givers in constructing and consolidating their knowledge of the field being taught.

A limit of this initial study is the small number of students enrolled in the course each year. Therefore this study needs to be pursued and extended. However because the initial statistical overview on posts, engagement and performance matches well the findings of others, it is hoped that the trends discovered in the speech act analysis generalize.

An immediate future work is to replace the manual annotation of speech acts by a computational approach building on the work initiated in [10], perhaps integrating unsupervised methods as described in [6] and [15]. Another future work is to investigate whether and how top students do benefit from being help-givers in discussion forums for their own performance and learning.

Another interesting future work is connecting analysis of speech acts to other analyses, in particular SNA, and explore relations between well known measures such as centrality or prestige and roles of postings. Further, speech act analysis could be integrated in existing frameworks like [13], or in learning analytics tools such as LeMo [2]. The analysis of speech acts of mentors / teachers should be considered too as this could help them to reflect on their own behavior. As mentioned in [5], there are not many indicators that collect and present teacher data.

6. ACKNOWLEDGMENTS

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7. REFERENCES

[1] Austin, J.L. 1962. How to do things with words. Oxford University Press, 1962.

[2] Beuster, L., Elkina, M., Fortenbacher, A.; Kappe, L., Merceron, A., Pursian, A., Schwarzrock, S., Wenzlaff, B. 2013. Learning Analytics und Visualisierung mit dem LeMo Tool. In Proceedings of the 11. e-Learning Fachtagung Informatik DeLFI 2013, A. Breiter, C. Rensing (Eds), Bremen (Germany), September 09-11 2013, Gesellschaft für Informatik Publisher, 245-250.

[3] Cobo, G., Garcia, D., Santamaria, E., Moran, J.A., Melenchon, J., Monzo, C. 2012. Using agglomerative hierarchical clustering to model learner participation profiles in online discussion forums. In (Dawson, S., Haythornthwaite, C. Hrsg.): Proceedings of the 2nd International Conference on Learning Analytics and Knowledge. (Vancouver, Canada, April 29 – May 2, 2012). ACM, 248-251. DOI=http://doi.acm.org/10.1145/2330601.2330660.

[4] Coursera. https://www.coursera.org/ last accessed Oct. 12, 2013.

[5] Dyckhoff, A.L.; Lukarov, V.; Muslim, A.; Chatti, M.A.; Schroeder, U. 2013. Supporting Action Research with Learning Analytics. In (Suthers, D.; Verbert, K.; Duval, E.; Ocoa, X. Eds.): Proceedings of the 3th International Conference on Learning Analytics and Knowledge. (Leuven, Belgium, April 8 – 12, 2013). ACM, 220-229. DOI=http://doi.acm.org/10.1145/2460296.2460340.

[6] Ezen-Can, A., Boyer, K.E. 2013. Unsupervised Classification of Student Dialog Acts with Query-Likelihood Clustering. In (D'Mello, S. K., Calvo, R. A., and Olney, A. (eds.)): Proceedings of the 6th International Conference on Educational Data Mining. (Memphis, TN, USA, July 6 - 9, 2013), EDM 2013, 20-27. http://www.educationaldatamining.org/EDM2013/papers/rn_paper_06.pdf

[7] Grünwald, F., Mazanbarani, E., Meinel, C., Teusner, R., Totschnig, M., Willems, C. 2013. openHPI: Soziales und Praktisches Lernen im Kontext eines MOOC. In Proceedings of the 11. e-Learning Fachtagung Informatik DeLFI 2013 , A. Breiter, C. Rensing (Eds), Bremen (Germany), September 09-11 2013, Gesellschaft für Informatik Publisher, 143-154.

[8] Khan, T.M.; Clear, F.; Sajadi. S. S. 2012. The relationship between educational performance and online access routines: the analysis of students' access to an online discussion forum. In (Dawson, S., Haythornthwaite, C. Eds.): Proceedings of the 2nd International Conference on Learning Analytics and Knowledge. (Vancouver, Canada, April 29 – May 2, 2012). ACM, 226-229. DOI=http://doi.acm.org/10.1145/2330601.2330655.

[9] Kizilcec, R.F.; Piech, C.; Schneider, E. 2013. Deconstructing Disengagement: Analyzing Learner Subpopulation in Massive Open Online Courses. In (Suthers, D.; Verbert, K.; Duval, E.; Ocoa, X. Eds.): Proceedings of the 3th International Conference on Learning Analytics and Knowledge. (Leuven, Belgium, April 8 – 12, 2013). ACM, 170-179. DOI=http://doi.acm.org/10.1145/2460293.2460330.

[10] Kim, J.; Li, J.; Kim. T. 2010. Towards Identifying Unresolved Discussions in Student Online Forums. In (Tetreault, J., Burstein, J., Leacock, C. Hrsg.): Proceedings of the NAACL HLT 5th Wokshop on Innovative Use of NLP for Building Educational Applications. (Los Angeles, CA, USA, June 2010). Association for Computational Linguistics, 84 -91.

[11] Litman, D.; Forbes-Riley, K. 2006. Correlations between dialog acts and learning in spoken tutoring languages. Natural Language Engineering 12 (2) 161-176, Cambridge University Press. DOI=10.1017/S1351324906004165

[12] Lopez, M. I., Romero, R., Ventura, V., Luna, J.M. 2012. Classification via clustering for predicting final marks starting from the student participation in Forums. In (Yacef, K., Zaïane, O., Hershkovitz, H., Yudelson, M., and Stamper, J. Hrsg.): Proceedings of the 5th International Conference on Educational Data Mining. (Chania, Greece, June15-21). EDM'12. http://www.educationaldatamining.org/EDM2012/, 148-151.

[13] Martinez, A.; Dimitriadis, Y.; Gomez-Sanchez, E.; Rubia-Avi, B.; Jorrin-Abellan, I.; J. A. Marcos, J.A. 2006. Studying participation networks in collaboration using mixed methods, International Journal of Computer-Supported Collaborative Learning, 1, pp. 383-408.

[14] Paredes, W. C., Chunk, K. S. K. 2012. Modeling Learning & Performance: A Social Network Perspective. In (Dawson, S., Haythornthwaite, C. Hrsg.): Proceedings of the 2nd International Conference on Learning Analytics and Knowledge. (Vancouver, Canada, April 29 – May 2, 2012). ACM, 34-42. DOI=http://doi.acm.org/10.1145/2330601.2330617.

[15] Rus, V., Moldovan, C., Niraula, N. and Graesser, A.C. 2012. Automated Discovery of Speech Act Categories in Educational Games. In (Yacef, K., Zaïane, O., Hershkovitz, H., Yudelson, M., and Stamper, J. Hrsg.): Proceedings of the 5th International Conference on Educational Data Mining. (Chania, Greece, June15-21). EDM'12. http://www.educationaldatamining.org/EDM2012/, 25-32.

[16] Teo, H.J; Johri, A. 2013. Experts Learn More (than newcomers): An Exploratory Study of Argumentation in an Online Help Forum. In To See the World and a Grain of Sand: Learning across Levels of Space, Time, and Scale: CSCL 2013 Conference Proceedings Volume 1 — Full Papers & Symposia. Rummel, N., Kapur, M., Nathan, M., & Puntambekar, S. (Eds.). International Society of the Learning Sciences, 470 - 477.

[17] Weinberger, A.; Fischer, F. 2006. A framework to analyze argumentative knowledge construction in computer-supported collaborative learning. Computers and Education, 46(1), 71-95.