What do students think about during live lectures?

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***Abstract*—Classroom interactivity is today considered to be one of the most important preconditions for successful lecturing. It is also often considered to be the main drawback of learning from lecture captures. In this article, the issue of live lecture and lecture capture interactivity is addressed from the aspect of students' question posing. During several lectures, students were asked to write down all the questions that occurred to them, but for any reason they would not pose them out loud. As the result, more than 250 questions were acquired during 18 hours of lecturing. Acquired questions were used to gain insight into quantity and types of questions that occur to students during a lecture, to try to increase lecture interactivity by answering relevant questions on the next lecture, and to analyze students' concentration during the course of the lecture. The potential of using acquired questions in order to generate additional lecture content for *rich lecture captures* used by Pyramidia tool, thereby increasing captured lectures' interactivity, was also investigated.**

Keywords-students' questions; lecture interactivity; lecture captures; rich lecture captures; frequently asked questions (FAQ); Pyramidia

I. INTRODUCTION

Lecture interactivity, one of the key components of successful lecturing [1], [2], has various definitions and aspects [3], yet is most commonly defined simply as the interaction between the teacher and students in the classroom [4]. Questions posed by students to the lecturer present one aspect of this interaction and an extensive amount of the literature has been dealing with the importance and roles of those questions in both teaching and learning processes [5].

If a student poses a question it certainly indicates that he or she has been thinking about the presented material and has encountered a gap in actively trying to relate the newly presented material to the already acquired knowledge [5]. Aside from activating prior knowledge, posing questions also enables students to check if they understood the presented material correctly, being a simple method of self-assessment [6]. Questioning as a mental operation is also important for being one of the underlying processes supporting critical thinking, creative thinking and problem solving [7].

Questions that students pose can be beneficial for their lecturer as well. Based on them, the lecturer can diagnose students' conceptual understanding of the presented material [8] or its lack and misconceptions [9], and then act accordingly.

Additionally, since questions that students pose to themselves or to the teacher during a lecture are valuable for their learning in the real classroom settings, they should also be considered as valuable material for e-learning tools. Pyramidia [10], [11] is an e-learning tool developed at the University of Zagreb, Faculty of Electrical Engineering and Computing, based on the concept of *rich lecture captures*. The basic idea behind this concept is to enrich lecture captures (video of the lecturer and video of his computer's desktop) with additional material like a quiz designed to assess student's understanding of any part of the lecture, links to additional contents related to the topics of the lecture, and questions that students frequently ask (*FAQ*). All of those additional lecture materials can be uniquely associated and presented together with any of the slides in the lecturer's presentation. Since the lecturer does not necessary has to have right perception of what might be troubling students and how to create mentioned additional lecture content, questions of students during live lectures might be a good way of dealing with this issue.

Still, although students' question posing can be beneficial to both sides of the educational process, this form of interaction is often missing from the real classroom settings since students rarely actively participate in classroom discussions and don't pose questions requesting lecturer's additional explanations. Results reported in the literature [12] suggest students in classrooms pose as little as 0.1 question per student per hour or even less [13], but in one-to-one tutoring this number can reach even 120 questions per student per hour. Fear of teacher's and other students' reactions is often identified as the main reason causing this effect, followed by insecurity in the significance of a question a student would like to pose and lack of support for question posing from teacher's side (for example not enough time during the lecture is devoted to dealing with students' questions) [13].

II. WHAT AND WHY

Since students' questions carry a lot of useful information, yet for identified reasons students most often keep them for themselves, an approach was taken, where students were asked to write down all the questions that have occurred to them during a period of nine lectures regardless of the topic of a

question. It was expected that in this case, students' decision to write a question would not be obstructed by any of the three previously identified reasons.

Using this approach several goals were hoped to be achieved:

1. Obtain statistical information about quantity and types of students' questions during a lecture in real classroom settings.
2. Obtain information about timing during the lecture when specific categories of questions occur to students.
3. Test the effectiveness of this method of acquiring students' questions.
4. Analyze the potential of using acquired questions as additional lecture content for Pyramidia rich lecture captures.

III. EXPERIMENT

Signals and systems is a 4th semester base course taught at the University of Zagreb, Faculty of Electrical Engineering and Computing. Main objectives of the Signals and systems course are to introduce the concepts of signals and systems, and to apply those concepts in real-world situations in the fields of computer science, electrical engineering and telecommunications. There are 600 to 800 students enrolled in this course each year. Students are divided into several groups each taught by a different professor. All lectures, lectured by one of them, were captured using Pyramidia software and published online during the academic year 2009/2010. Published lectures consisted of two synchronized video files (video of the lecturer and video of lecturer's computer's desktop) and navigational system (video slider and navigation through lecture slides), yet without any additional lecture contents like links to materials with additional or more detailed explanations, or frequently asked questions related to lecture slides.

This experiment covered a period of nine lectures, each lasting two times forty-five minutes. On each lecture, students were encouraged to ask questions out loud or to write them on survey papers that were collected at the end of each lecture. The questions could be about the current lecture or anything that students were thinking about. Beside questions, students were also instructed to write the time when the question occurred to them. At the beginning of each new lecture, the lecturer answered all relevant questions related to the last lecture.

IV. RESULTS AND DISCUSSION

A. Categories of acquired questions

As the result of the experiment, 257 student questions were acquired. Three examples of student questions and comments from the first lecture are listed in the Table 1. Questions were then divided into groups of related ones resulting in the following 10 categories:

- Lecture – questions about current lesson, formulas, explanations, figures and graphs.
- Suggestions about lectures – how to teach more interestingly, suggestions about design of the slides.
- Exam and course organization – what teacher is the best and what and how to study for the exam.
- Motivation – why students need to learn the material that is being lectured.
- Lecturer and assistant teachers – about lecturer and his helpers conducting the experiment.
- General suggestions – about classroom properties and settings.
- Survey – questions about this survey.
- Learning – questions about learning material for other courses.
- Break – when will the teacher make a break in the lecture?
- Random – thoughts about football, lunch, sleeping, jokes, etc.

The exact question counts and their statistics are presented in the Table 2.

TABLE 1. EXAMPLES OF STUDENT QUESTIONS

Time	Question	Category
08:38	What is the cause of the Gibbs phenomenon?	Lecture
08:40	Why these slides don't have history facts to make them more interesting?	Suggestions about lectures
09:50	Why does the professor not use crayons?	General suggestions

B. Question posing statistics

The total number of acquired questions (257) collected over nine two-hour lectures makes an average of 14.28 questions per hour of lecture. The average for questions related to the lecture itself (question categories: lecture, suggestions about lectures, exam and course organization and motivation) equals 8.16 per hour of lecture, which is still significantly higher than the usual number of questions students pose during a lecture.

If expressed as the number of questions an average student has posed per hour of a lecture during the measuring period, those rates drop to 0.31 for overall question rate, and 0.17 for the rate of questions related to the lecture. The last rate of 0.17 suggests a 70% increase over the reported rate at which

students pose questions out loud during a lecture in real classroom settings [12]. Yet, if only the results of the students who actually participated and submitted a survey are taken into account, their question rate per hour of lecture rises to 0.99 for all questions and 0.57 for questions regarding the lecture. Detailed statistics for each of the lectures can be found in the Table 2.

C. The decrease of question posing rate

Surveys' results also indicate that students were very motivated to write their questions first time when the survey was introduced to them, with an average of 2.54 questions per survey and 74% of students participating. However, both the number of submitted surveys and number of question per survey were decreasing on every further lecture. The only exception was the 6th lecture, when the students were again additionally encouraged by the lecturer to write their questions through a motivational speech.

Several reasons were identified to explain this issue:

- Delayed response and lack of reward. Since students were not offered a direct reward for submitting surveys, and doing that did on the other hand require some effort on their side they soon lost motivation to do so, which was confirmed by their survey comments. And although anonymity encouraged students to write more questions than they would usually pose out loud, indicated both in number and types of acquired questions, the delayed lecturer's response to those questions occurring at the next lecture did not encourage them enough to continue filling surveys with their questions.
- Decrease in the number of students who attend lectures and lack of continuous studying throughout the semester. Since students mostly do not study on a regular basis, their lack of knowledge prevents them from being able to follow a lecture for which they often decide not to attend it at all. Otherwise, even if they do attend a lecture, they do not pay close attention to the lecturer or their insufficient knowledge prevents them from being able to formulate a question.
- Issues with simultaneous question writing and lecture listening activities. Some students complained that they did not manage to write down questions and listen to the lecturer at the same time. This complaint is found to be justified and confirmed in the literature [14], [15].
- Need for practice. The material to be learned in frames of Signals and systems is quite challenging and difficult to comprehend without further practice. There are many formulas and mathematical proofs included in the course material, thus students need more time to think about them. This also means students could have more questions at home, when they study, than at the lecture, which was confirmed in some of the students' comments.

TABLE II. COUNTS OF EACH QUESTION TYPE PER CATEGORY AND PER LECTURE

Lecture index		1.	2.	3.	4.	5.	6.	7.	8.	9.
Number of students in the classroom		85	48	67	49	36	39	30	35	32
Number of the filled surveys		63	21	10	9	6	11	2	5	3
Questions related to the lecture	Lecture	72	6	5	3	1	12	1	3	2
	Suggestions about lectures	14	10	2	1	3	2	0	0	0
	Exam and organization	6	0	0	0	0	0	0	0	0
	Motivation	4	0	0	0	0	0	0	0	0
Questions related to the lecture (total)		96	16	7	4	4	14	1	3	2
Average number of questions related to the lecture per student		1.13	0.33	0.11	0.08	0.11	0.36	0.03	0.09	0.09
Average number of questions related to the lecture per survey		1.52	0.76	0.70	0.44	0.67	1.27	0.50	0.60	0.67
Questions unrelated to the lecture	Lecturer and assistant teachers	15	3	1	1	0	3	1	1	0
	General suggestions	3	1	0	1	0	0	0	0	0
	Survey	8	2	1	1	1	0	0	0	0
	Learning	5	1	1	0	0	0	0	0	0
	Break	8	5	1	0	1	0	0	0	0
	Random	25	12	2	3	0	1	0	1	1
Questions unrelated to the lecture (total)		64	24	6	6	2	4	1	2	1
Average number of questions unrelated to the lecture per student		0.75	0.50	0.09	0.12	0.06	0.10	0.03	0.06	0.03
Average number of questions unrelated to the lecture per survey		1.02	1.14	0.60	0.67	0.33	0.36	0.50	0.40	0.33
Average number of questions per student		1.76	0.83	0.19	0.2	0.16	0.46	0.07	0.14	0.09
Average number of questions per survey		2.54	1.90	1.30	1.11	1.00	1.64	1.00	1.00	1.00

D. Time analysis

Another point of interest in this research was the time analysis of students' questions. Although students were asked to write the time when each of the questions occurred to them on the survey, only a limited number of them really did this, resulting in 150 questions (60%) including their occurrence time. A time graph of the lecture including number of

questions occurring at each minute of a lecture is presented at the Figure 1. The results, although obtained from a very small sample of students' questions, suggest a relatively constant rate of questions related to the content of the lecture (question categories: lecture, suggestions about lectures, exam and course organization and motivation) throughout the whole lecture and a lower rate of questions unrelated to the lecture content (question categories: lecturer and assistant teachers, general suggestions, survey, learning, break, random) increasing around 25 minutes after the beginning of the lecture and after the break between two hours of lecture. This increase in number of questions unrelated to the lecture material indicates a loss of students' concentration and moving the focus of their thoughts away from the lecture. Those results are in accordance with the results of related research reporting a drop in students' attention occurring 10 to 30 minutes after the lecture has begun due to its passive nature [16], [17]. Intervals 0-15 and 60-75 of the lecture refer to breaks before and during the lecture and therefore don't contain questions.

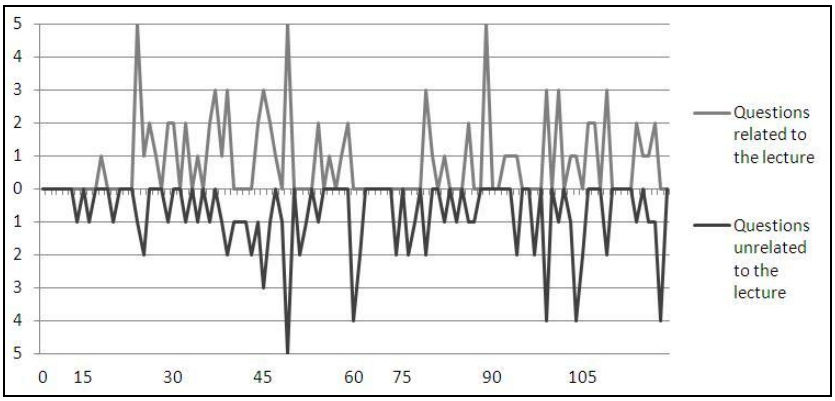

Figure 1. Students' questions during the course of the lecture

E. Applicability of questions as Pyramidia additional lecture content

Out of all the acquired questions, those related to the lecture content and those related to students' motivation were considered for use as additional lecture contents in Pyramidia lecture captures of the Signals and systems course. Categories where acquired questions are intended to be used are links and frequently asked questions. For each of 26 identified students' questions related to misunderstanding of general concepts that were expected to be a part of students' prior knowledge links to materials explaining them will be provided in Pyramidia, and associated with the presentation slide during which they occurred. Also, for each of 84 identified students' questions related to a very specific part of the lecture or lecture slide, the question and its answer will be provided in Pyramidia FAQ section. Those materials are now to be added to previously recorded Pyramidia lecture captures.

F. Overall method effectiveness

In conclusion, although a significant number of questions were acquired using the proposed method, and 43% of those questions were found to be applicable and useful as Pyramidia additional lecture content, the sudden decrease in submitted question rate was an issue that needs to be more successfully handled. The key drawbacks of the method identified to cause the decrease in response rate are the difficulty of maintaining students' motivation, lack of students' continuous studying throughout the semester and problem with simultaneous listening and writing.

V. CONCLUSION

This paper attempted to investigate the diversity of questions that occur to students during a lecture, their types and occurrences over the course of the lecture and acquire as many of them as possible by having the students to write them down. As the result a number of questions that will be used as additional content in Pyramidia lecture captures are acquired and statistically processed, indicating that students really have much more questions than they usually pose out loud during a lecture, that their questions are a valuable material that can be used to enrich lecture captures. Still, as a mean of acquiring those questions, the method presented also showed some significant drawbacks, as the rapid decrease of students' interest to participate in the survey, and should be dealt with in future work.

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REFERENCES

[1] B. Su, C. Bonk, R. Magjuka, X. Liu, and S.-H. Lee, "The importance of interaction in web-based education: A program-level case study of online MBA courses," *Journal of Interactive Online Learning*, vol. 4, no. 1, pp. 1–19, 2005.

[2] V. P. Dennen, A. Aubteen Darabi, and L. J. Smith, "Instructor–Learner Interaction in Online Courses: The relative perceived importance of

particular instructor actions on performance and satisfaction," *Distance Education*, vol. 28, no. 1, pp. 65–79, 2007.

[3] C. Markett, I. A. Sánchez, S. Weber, and B. Tangney, "Using short message service to encourage interactivity in the classroom," *Comput. Educ.*, vol. 46, no. 3, pp. 280–293, April 2006.

[4] R. Kalantari, "Techniques for Classroom Interaction," *International Journal of Language Studies*, vol. 3, no. 4, pp. 425–434, 2009.

[5] C. Chin and J. Osborne, "Students' questions: a potential resource for teaching and learning science," *Studies in Science Education*, vol. 44, no. 1, pp. 1–39, 2008.

[6] P. Black, C. Harrison, C. Lee, B. Marshall, and D. Wiliam, *Working Inside the Black Box: Assessment for Learning in the Classroom*. NFER Nelson, 2004.

[7] S. Cuccio-Schirripa and H. E. Steiner, "Enhancement and Analysis of Science Question Level for Middle School Students," *Journal of Research in Science Teaching*, vol. 37, no. 2, pp. 210–224, 2000.

[8] R. T. White and R. F. Gunstone, *Probing Understanding*. Routledge, 1992.

[9] Y. Hadzigeorgiou, "On problem situations and science learning," *School Science Review*, vol. 81, pp. 43–53, 1999.

[10] P. Pale, I. Miletic, Z. Kostanjcar, H. Pandzic, and B. Jeren, "Development of Pyramidia: an integrative e-learning multimedia tool.," *Journal of Electrical Engineering Education*, pp. 264–279, 2011.

[11] P. Pale, I. Miletic, Z. Kostanjcar, H. Pandzic, and B. Jeren, "Pyramidia - An Integrative E-learning Tool," in *EUROCON, 2007. The International Conference on Computer as a Tool*, 2007, pp. 2459 – 2464.

[12] A. C. Graesser and N. K. Person, "Question Asking during Tutoring," *American Educational Research Journal*, vol. 31, no. 1, p. 104, 1994.

[13] J. T. Dillon, "A Norm against Student Questions," *Clearing House*, vol. 55, no. 3, pp. 136–139, October 1981.

[14] P. N. Johnson-Laird, *The Computer and the Mind: An Introduction to Cognitive Science*. Harvard University Press, 1989.

[15] P. H. Lindsay and D. A. Norman, *Human information processing: An introduction to psychology*. Academic Press, 1977.

[16] J. Stuart and R. J. D. Rutherford, "Medical Student Concentration During Lectures," *The Lancet*, vol. 312, no. 8088, pp. 514–516, Sep. 1978.

[17] M. S. Young, S. Robinson, and P. Alberts, "Students Pay Attention! Combating the Vigilance Decrement to Improve Learning During Lectures," *Active Learning in Higher Education*, vol. 10, no. 1, pp. 41–55, March 2009.