
Invention Activities in Biology 112: changing the way first year biology students approach problem solving.

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Biology 112 Activities

- In an effort to promote problem solving, teamwork, and creative thinking, two types of weekly tutorial activities were designed to accompany Biology 112: ***Invention Activities*** and ***Structured Problem Solving Activities***.
 - Invention activities are based on the work of Daniel Schwartz, Stanford University.
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Biology 112 Activities

Invention Activities (IA)	Structure Problem Solving Activities (SPSA)
<ul style="list-style-type: none">■ Present the students with fictitious problems that do not appear to be related to biology, but analogous to problems that living cells must overcome.■ Have more than one possible solution.■ The related lecture material has not yet been covered but is introduced in the lectures following the activity.■ Goal: to prime the students to learn the related lecture material.	<ul style="list-style-type: none">■ Present the students with problem sets that are clearly related to lecture material.■ Have one correct solution.■ The related lecture material has already been recently covered (or is currently being covered) in class.■ Goal: to reinforce the lecture material by requiring the students to apply knowledge from class to tackle biological problems.

Biology 112 Activities

- The activities have been tried both outside of lecture and during lecture.
 - Out-of-lecture format:
 - In January 2009, Biology 112 students were invited to volunteer to participate, although they did not know which type of activity group they would be joining.
 - During-lecture format:
 - In the September 2009 and January 2010 semesters, a combination of invention and structured problem solving activities were used in large lecture settings (six sections in total with 240-280 students in each).
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The Out-of-Lecture Activity Format

- The activities use a 50 minute format:
 - Students work on the given problem for about 30 minutes in fixed groups (three or four students per group).
 - A facilitator is always present to provide aid.
 - For the structure problem solving activities, aid is given by answering questions and clarifying material.
 - For the invention activities, aid is given by providing guidance and giving feedback to the students without providing a “solution” to the problem.
 - Each group is required to present their work in two ways:
 - The group writes out the complete solution on large flipchart paper.
 - SPSA students record all information in workbooks.
 - IA students are required to each provide a written paragraph summarizing their group’s invention.
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The Out-of-Lecture Activity Format

- The format, continued:
 - Each group must carry out a mini-presentation to the other activity groups.
 - SPSA students present their group's solution (or part of the solution depending on the time remaining).
 - IA students present their group's invention.
 - In the final 10 minutes the facilitator provides explanation (SPSA) or relates the problem to upcoming lecture material (IA).
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The During-Lecture Activity Format

- The format used in lecture with large groups of students is the same as the out-of-lecture format, with the following key differences:
 - The students work in groups of 2-3 that are not fixed for the semester.
 - The groups do not use flip-chart paper, but rather write their solution on a legal-sized worksheet that is handed in before the presentations.
 - Only a small selection of the solutions are presented to the class, either by facilitators themselves (after randomly choosing some from the class) or by any group that volunteers to present their ideas.
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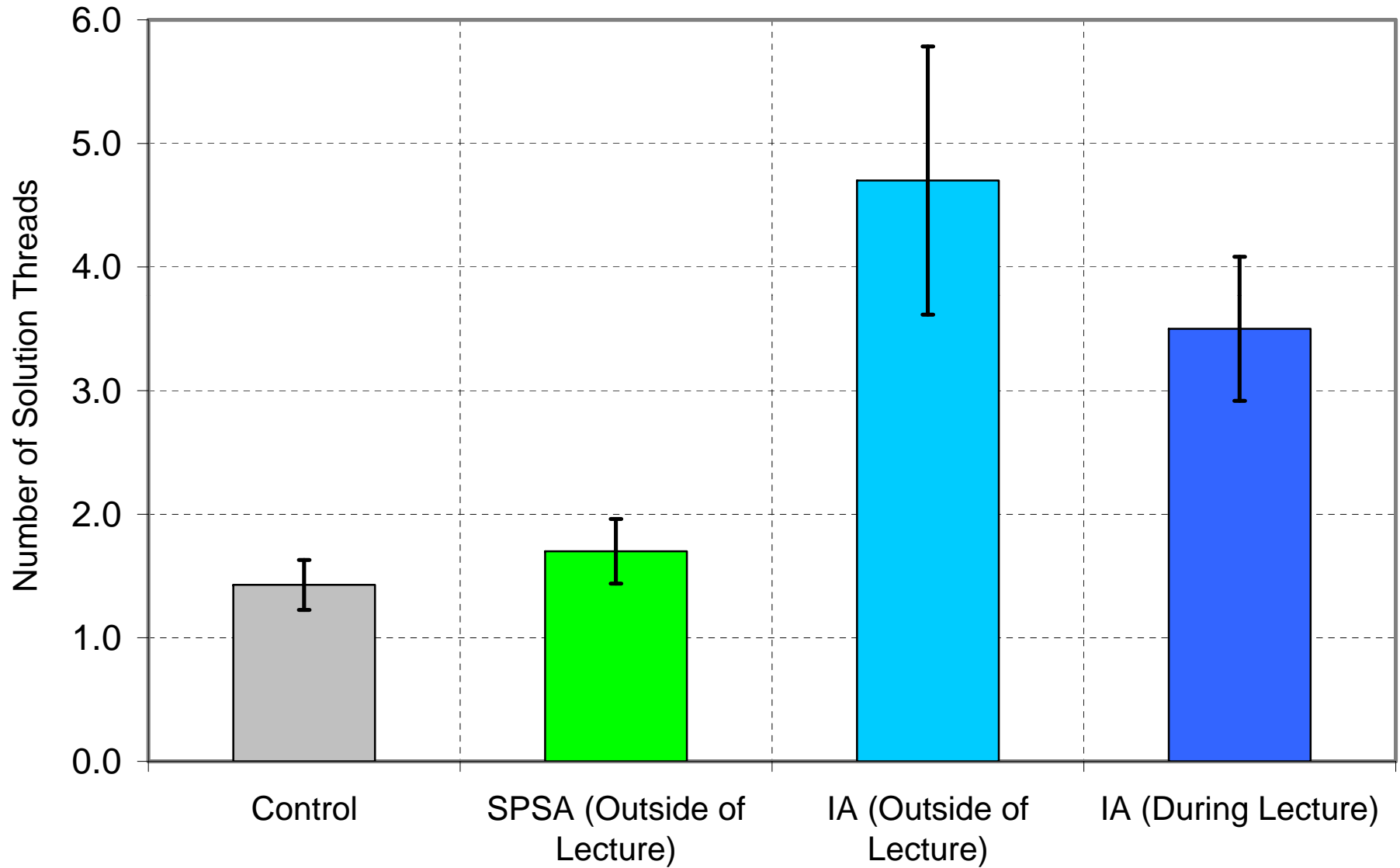
Assessing the Effects of the Activities

- Ten IA students, ten SPSA students, and seven control students (volunteers that were not placed into an activity) from the January 2009 semester were interviewed to test their problem solving skills.
 - Nine students from the January 2010 semester were also interviewed.
 - During the interview, student were asked to suggest a solution to biological problem based on a system they had not seen in class and which they had no way of knowing what the “correct” solution would be.
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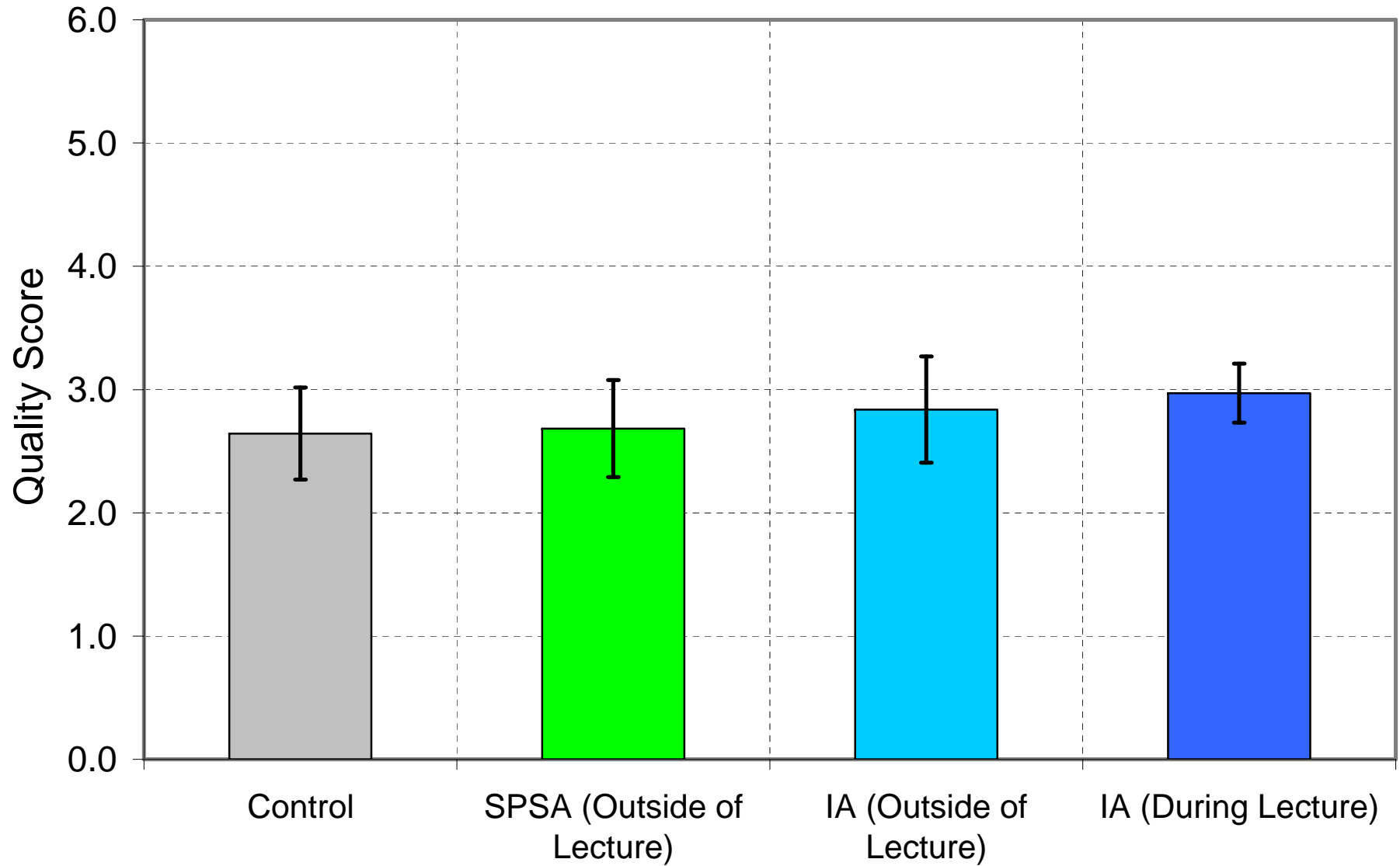
Assessing the Effects of the Activities

- The transcripts of the interviews were analyzed to measure four parameters:
 - Number of solution threads.
 - Quality of the solution threads (using a six-point rubric).
 - Time taken before the first solution thread is produced.
 - Average time spent on each solution thread.
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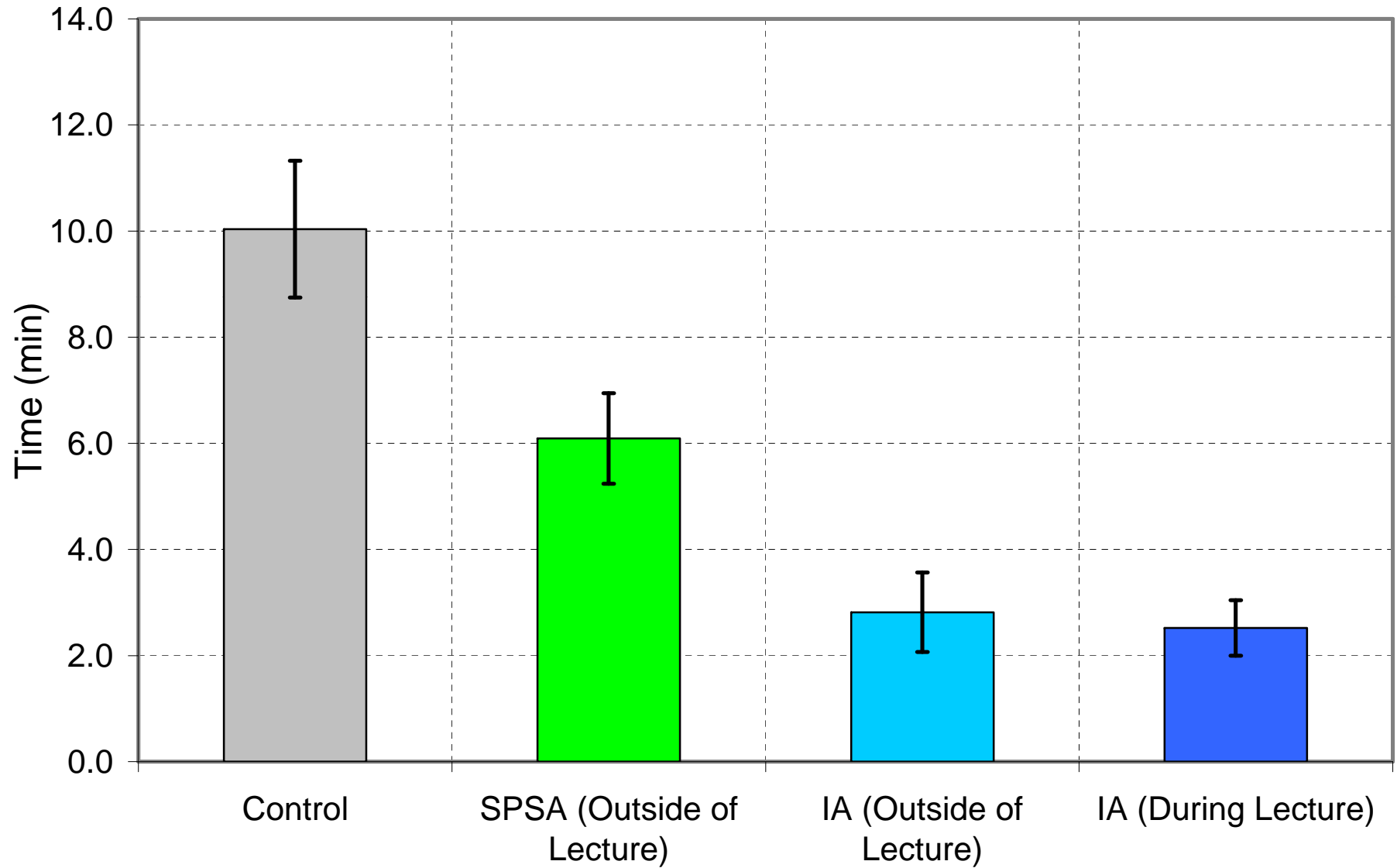
Average Number of Solution Threads (Fluency)



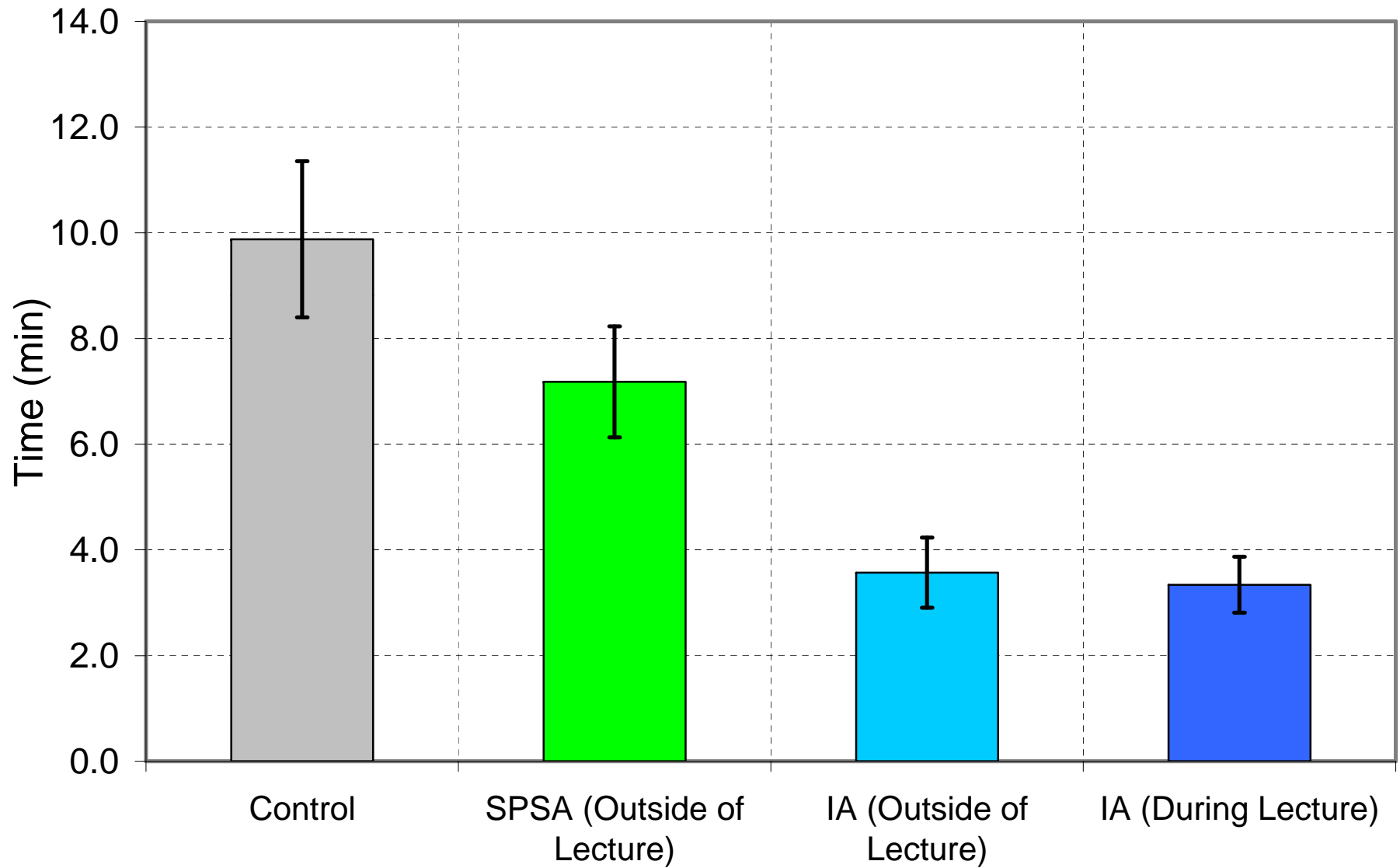
Average Quality of the Solution Threads



Average Time to First Solution Thread



Average Time Spent per Solution Thread



Conclusions

- Students that participate in invention activities generate multiple plausible solutions without any loss in overall solution quality.
 - These students also tackle unfamiliar problems much more quickly than other students.
 - The invention activities seem to have provided the students with experience in generating solutions/hypotheses to problems that have no one correct answer.
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Ongoing Work

- We are continuing to refine the invention activities for use in large lecture hall settings.
 - We are investigating ways of assessing the invention activities, and are developing invention-type questions for use on written exams.
 - We are working with Ido Roll to analyze what type of thought processes are being utilized during the invention activities.
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Acknowledgements

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