An Analysis of the Costs and Benefits of Autocomplete in IDEs

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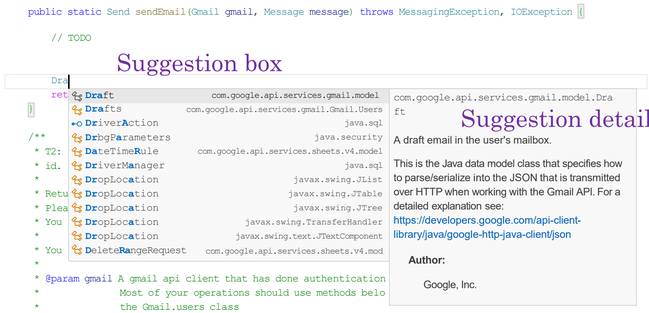
Does Autocomplete help?

Autocomplete Example:



Impact of Autocomplete:

Possible advantages	Possible disadvantages
• Filling remaining characters	• Distracting from current tasks
• No need to remember name	• Context-unrelated suggestions may be misleading
• Exploring more terminology	• No need to memorize
• Suggestion details is perfect	• Shortened information prevents people from learning
• Offering a more direct way of accessing information	• High information density

Our Hypotheses:

TYPING EFFORT — **Autocomplete reduces the number of keystrokes required to complete tasks.**

PRODUCTIVITY — **Programmers who use autocomplete complete more programming tasks**

LEARNABILITY — **Using autocomplete inhibits API learning.**

REDUCE READING TIME — **Autocomplete reduces the time spent in reading documentation.**

Method:

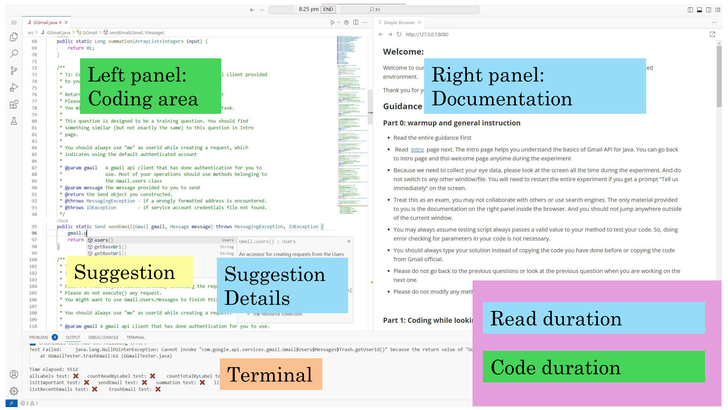
Experiment design:

- 2 hours, between-subjects study
- Web-based VSCode + Eye tracker

Procedure:

- Part 0: General instructions (15 minutes). Read the introduction page.
- Part 1: Coding (110 minutes). Finish 10 tasks in increasing difficulty while having access to relevant documentation
- Part 2: Quiz (no time limit). Finish a quiz relevant to Gmail API
- Part 3: Post-study survey (no time limit). Finish a post-study survey

Materials:



Quiz *(abbreviated)*

Start of Block: Quiz

Quiz Welcome There are 24 questions in this question set. You are required to finish them in order (from beginning to end).

…(truncated)

Q0 Fill in your participant number

(Understanding):

Q8_4pt 8. (Multiple choice, 2 pts) What does toProcess contain? <TypeName> toProcess = gmail.users().messages().trash("me", id);

- The message id to be removed.
- The thread id be removed.
- The content of the message is to be removed.
- Address of the email account of the authenticated user.

…(truncated)

Q20_4pt 20. (Multiple choice, 2 pts) Select the functionality that Gmail API does not provide:

- You can get the recent 10 emails that are sent to a specific email address.
- You can control the number of results you want in each `.list()` execution
- By using `gmail.users().labels().get("me", "SENT")` method, I can get the email id of each email in the inbox
- gmail.users().messages().list("me").execute().getMessages() method provides access to the raw data of each email

(Memorizing):

Q1 1. (Single choice) Which method of Gmail.Users.Messages should you use if you want to get ids of the recent emails from the inbox?

- Get
- list
- send
- Insert
- Modify

(Exploring):

Q16_6pt 16. (Multiple choice, 3 pts) Select the content each Label class directly provides, which means you can get the information without executing any additional commands using .execute().

- Color
- A list of recent thread ids belong to this label
- Type
- Total number of messages that has been marked as read
- A list of recent messages belong to this label
- Name

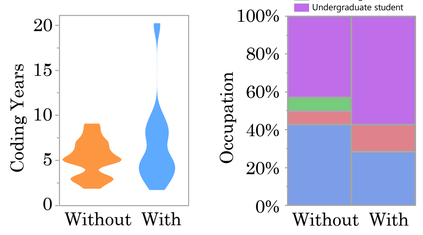
Q17 17. (Single choice) Select the graph that could best represent the structure of the payload of a Message.

Those images are just showing the structure and relationship between Message and MessagePart. It is not intended to show the inheritance relationships.

…(truncated)

Participants:

- 32 Participants
  - ≥ One year of Java experience.
  - No experience with Gmail API for Java.
  - $50 compensation



Coding experience vs. autocomplete usage (p≈0.63).

Occupation vs. autocomplete usage (p≈0.63).

Post-study survey *(abbreviated)*

In what situations did you prefer to disable autocomplete in general? Why?

Is English the first language you learned in your childhood?

- No
- Yes

what age did you first start coding?

For the following autocomplete components, provide how useful you feel in general.

	Not at all useful	Slightly useful	Moderately useful	Very useful	Extremely useful
Variables					

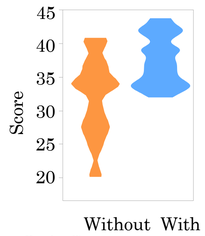
Do you think autocomplete affects the process of learning APIs in general? If so, in what way?

Q2.1 What is your current title?

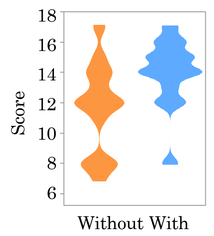
- Undergraduate student (1)
- Master student (2)
- PhD student (3)
- Software engineer (4)
- Other, please specify below (5)

Result:

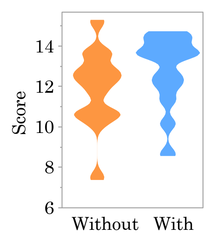
Using autocomplete inhibits API learning. No, it promotes learning



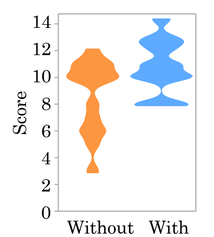
Quiz Score vs autocomplete usage (p≈0.0079, N=28, d≈1.1).



Understanding questions score vs autocomplete usage (p≈0.024).



Memorizing questions score vs autocomplete usage (p≈0.20, d=0.50).



Exploration questions score vs autocomplete usage (p≈0.021, d=0.93).

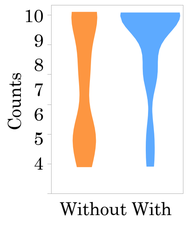
Table 2. Beliefs about how autocomplete influences learning

Inhibits Learning	No effect	Promotes Learning	Unsure
5 (16%)	3 (9.4%)	19 (59%)	3 (9.4%)

- Helpful: learn and apply the right method, reducing time spent in reading documentation, learning the type of each variable.
- Not helpful: understand APIs extensively and inhibiting thinking.

Completed more tasks?

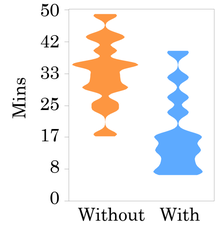
Shorter time
Not more tasks



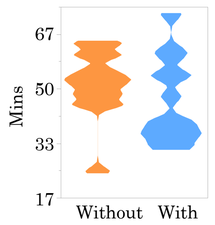
Completion time versus autocomplete usage: ($p < 0.0001$) across conditions with $R^2 \approx 0.54$, and the autocomplete group is 8.2% faster than the group without autocomplete.

Finished tasks vs autocomplete (p≈0.11, N=28)

Reduced time in reading documentation. Yes

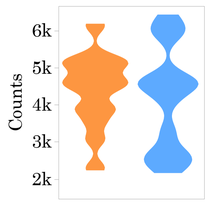


Reading duration (min.) vs. autocomplete usage (p≈0.00012, N=27, d≈1.76)

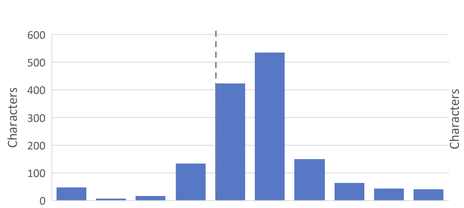


Coding duration (min.) vs. autocomplete usage (p≈0.22, N=27, d≈0.48)

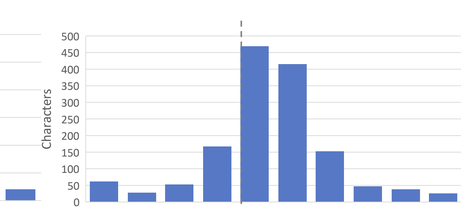
Reduced the number of keystrokes? No significant result observed



Keystrokes vs. autocomplete usage (p≈0.65, N=28, d=0.18)



Autocomplete reduced keystrokes in 1254 sessions (86%)



Autocomplete reduced time in 1147 sessions (79%)

Conclusion:

The primary benefit of autocomplete is in providing information, not in reducing time spent typing.

- Autocomplete reduces the time needed to finish tasks.
- Autocomplete doesn't significantly reduce typing effort.
- Autocomplete helps programmers learn new materials faster while reducing the amount of reading effort.

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