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LEARNING WEB DEVELOPMENT USING GITHUB COPILOT IN AND OUTSIDE ACADEMIA: A BLESSING OR A CURSE?

Gabriel Oliver Mesaroš

Pančevo, Serbia

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ABSTRACT

This article investigates the usage of GitHub Copilot, an artificial intelligence-powered coding assistant owned by Microsoft and GitHub, in the process of learning and teaching web development both in formal academic, and informal settings. We dive into the idea behind utilizing GitHub Copilot and highlight its most common and relevant use cases which can be used to learn Web Development. Drawing from existing scientific literature and online statements from software professionals, we present an overview of the current situation with artificial intelligence-assisted programming tools such as GitHub Copilot and its impact and irrelevance on Web Development education especially for the early learning stages. Professionals both in and outside academia agree that usage of artificial intelligence Pair Programming tools such as GitHub Copilot is neither recommended nor essential when learning or teaching Web Development.

KEY WORDS

AI pair programming, GitHub Copilot, Web Development, VS Code

CLASSIFICATION

ACM: I.2.2, I.2.6

JEL: O33

*Corresponding author, η: gabrielmesaros013@gmail.com; -; -

RATIONALE FOR USING GITHUB COPILOT

INTERACTIVE PROGRAMMING LEARNING AND DEVELOPMENT ENVIRONMENT

Copilot provides real-time code suggestions and generation in the user's IDE of choice (in ones that support the feature) [1], such as VS Code, fostering an interactive development and learning environment where learners can experiment and learn by doing whilst also being able to ask for clarification and explanation via the Copilot Chat feature. It is enticing and informative in a tangible manner, Figure 1.

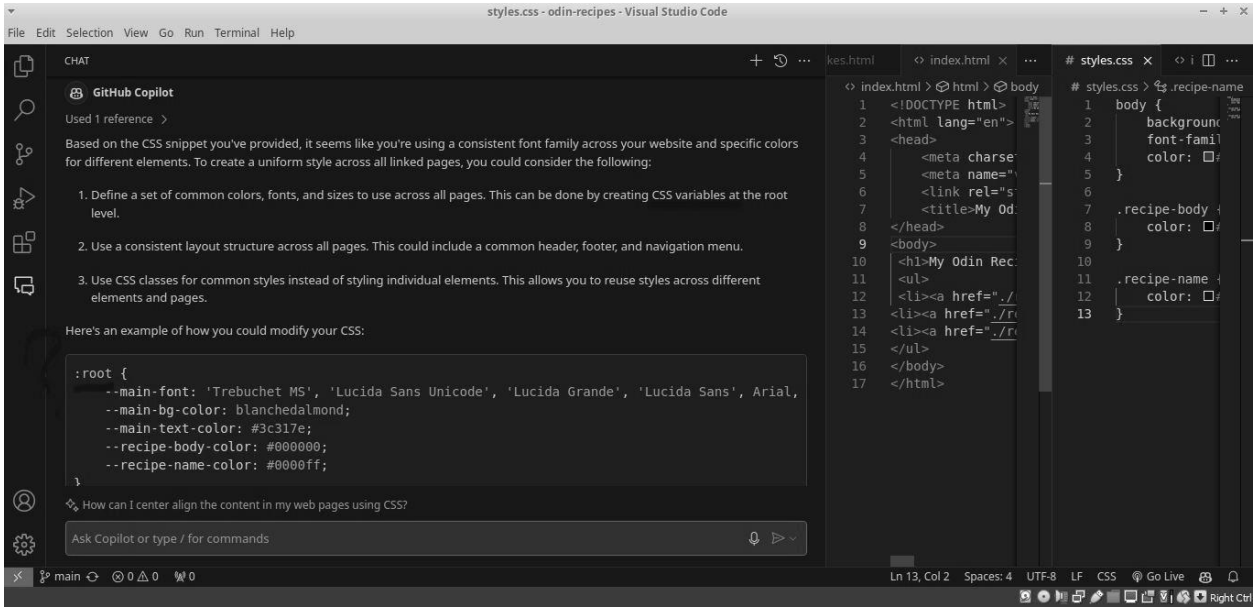

Figure 1. GitHub Copilot development suggestions.

EFFICIENCY AND EFFECTIVENESS IN WRITING CODE

Copilot accelerates the coding process by suggesting relatively accurate and relevant code snippets according to your file contents, directory structure, and coding patterns, allowing learners to focus on problem-solving and understanding core concepts with the right approach to coding [2, 3].

ADAPTABILITY TO DIFFERENT SKILL AND KNOWLEDGE LEVELS

Copilot adapts to the learner's proficiency level, offering suggestions ranging from basic to advanced, thereby catering to a wide range of learners and their skill sets [2; p.4]. This can be harnessed both in and outside academia when developing the web and teaching web development.

COMMON AND RELEVANT USE CASES OF GITHUB COPILOT

CODE COMPLETION AND AUTO-GENERATION

Copilot assists in writing boilerplate code, reducing repetitive tasks and allowing learners to focus on creative problem-solving [2; p.4]. This saves both time and energy for more creative aspects and problem-solving segments of programming.

EXPLANATORY AND INSTRUCTIONAL FEEDBACK

With the Chat feature, GitHub Copilot can answer user queries regarding the reasoning and usage of a certain programming technique or approach, Figure 2.

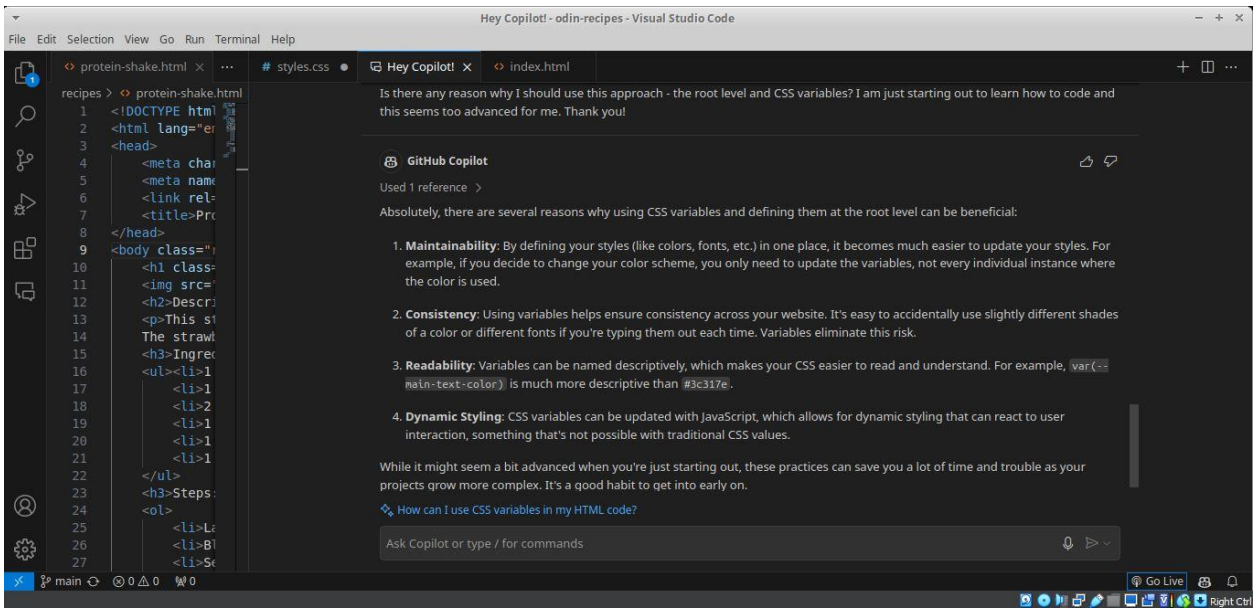

Figure 2. GitHub Copilot chat coding rationale.

Table 1. Benefits of using Copilot for Development – RQ5 Results (adapted from [2]).

Benefit	Example	Count	%
Useful code generation	*I find myself writing a lot of tests, and Copilot is excellent at helping with writing repetitive tests* (GitHub #9282)	24	49.0%
Faster development	*I really enjoy using it , it reduce programming time* (GitHub #17382)	8	16.3%
Better code quality	*it's faster and simpler to your solution* (SO #68418725)	5	10.2%
Good adaptation to users' code patterns	*GitHub copilot adapt to your coding practices* (SO #69740880)	3	6.1%
Better user experience	*Since copilot works totally different compared to all the other products out there, it is a lot more fun to use and does not annoy me like some other AI systems* (GitHub #7254)	3	6.1%
Powerful code interpretation and conversion functions	*Does Copilot have the code explanation feature or something similar? It does! some active members were given beta access.* (GitHub #38089)	2	4.1%
Frequent updates to provide more features	*Keep in mind that there are updates to the plugin very frequently, so there's still hope* (SO #70428218)	1	2.0%
Free for students	*If you are a student you can sign up for the GitHub Student Pack, which gives a lot of benefits, one being copilot for free* (GitHub #31494)	1	2.0%
Strong integration capability	*GitHub is supporting more editors* (GitHub #6858)	1	2.0%
Ease of study and use	*when using this plugin, can study at a relatively low cost* (GitHub #8028)	1	2.0%

CHALLENGES AND CONSIDERATIONS OF EDUCATIONAL USAGE

OVER-RELIANCE ON ARTIFICIAL INTELLIGENCE SUGGESTIONS IN LEARNING

The risk of over-reliance on GitHub Copilot for learning and development goals is obvious and serious. Doing so may hinder the development of problem-solving and critical thinking skills [4, 5].

Learners are not encouraged to practice asking questions to actual mentors, seniors or peers and have no way of understanding the larger context behind certain code and programming solutions without having anyone or anything to immediately guide and assist them to understand what the artificial intelligence (AI) feature outputs [3, 4].

Furthermore, if one takes an autodidactic approach, unlike books or professional discussion forums, code completion and generation tools do not offer a systematic overview of the subject matter and cannot offer highly credible insight into the reasons and core principles behind certain programming approaches and techniques.

The example illustrated in Figure 2 adds to this as the concept of CSS variables suggested by the pair programming tool, while not being the latest feature of CSS [6], is not explicitly mentioned in undergraduate-level Web Development courses for BSc Informatics programs [7] and can create additional challenges that the learner must tackle first in order to utilize the presented code suggestion to the fullest.

ASSESSING THE QUALITY AND ACCURACY OF CODE SUGGESTIONS

Copilot's suggestions are not reliably accurate, optimal, nor commonly anticipated (Figure 3) and a beginner developer is in no way prepared to fully analyze the quality and accuracy of code suggestions given by the AI tool [3; p.25].

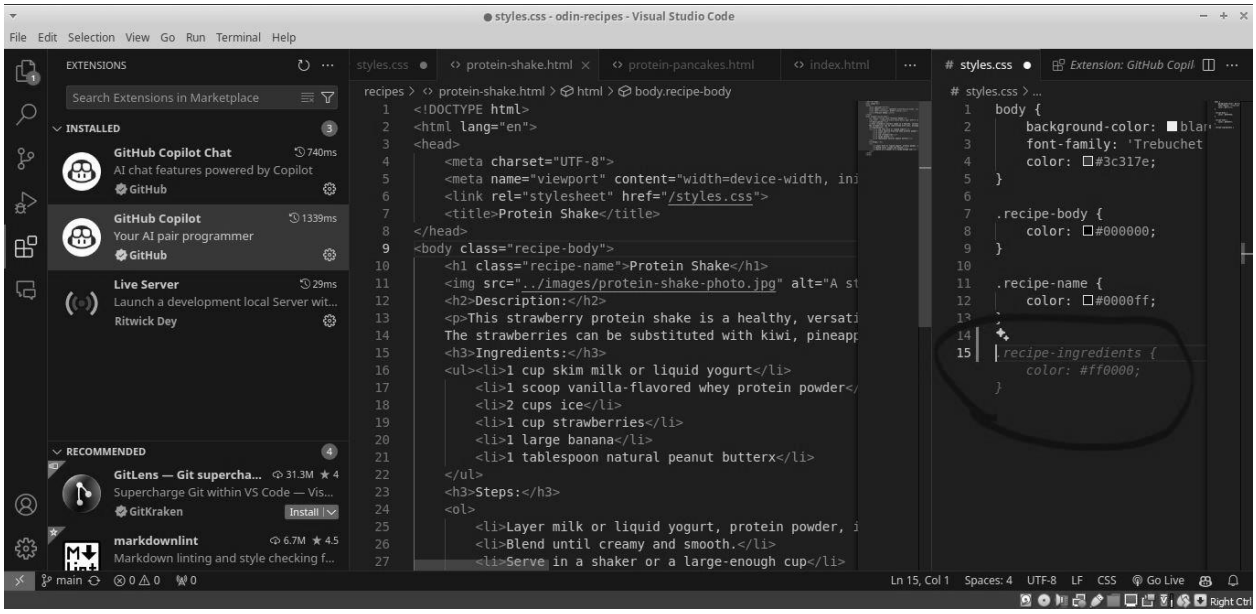

Figure 3. GitHub Copilot code completion/suggestions.

Implementing the code completion suggestion shown in Figure 3 would result in a stark coloring discrepancy between different page elements which may not be something the usual developer or user expects to encounter and which is shown and highlighted in Figure 4.

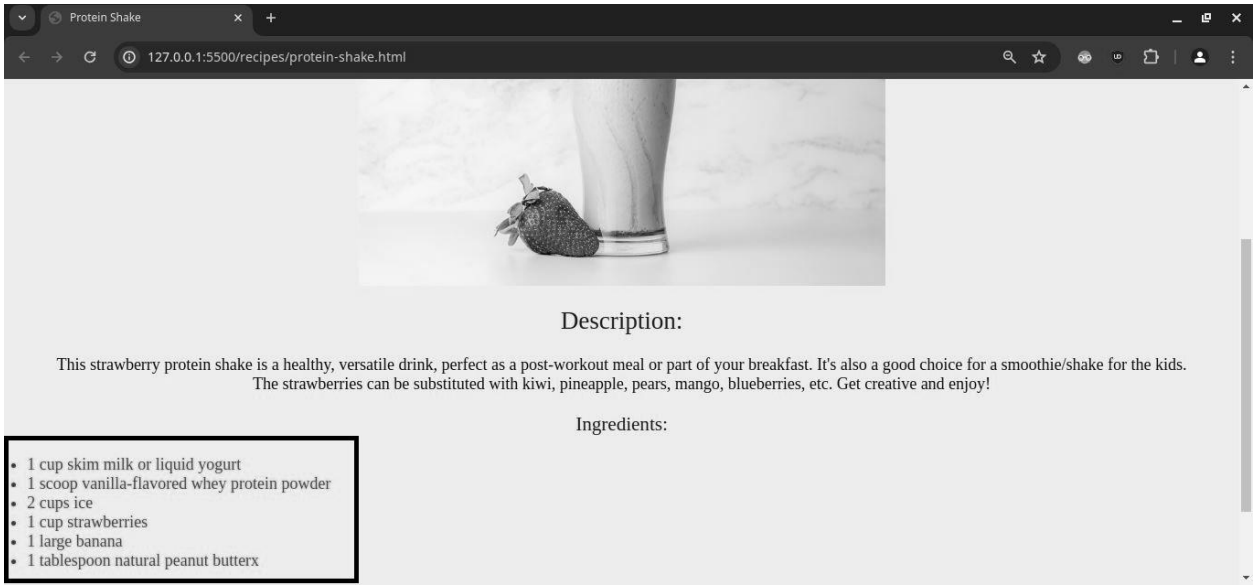

Figure 4. GitHub Copilot code completion implementation result.

The lack of understanding of ethical implications that AI-generated code may bring in professional projects when implemented is another concerning issue requiring its own investigation.

LACK OF DISCOURSE AND COLLABORATIVE OPPORTUNITIES

Using GitHub Copilot individually without having anyone to review code with to potentially improve it leaves one lacking in code review skill development which is essential in both learning Web Development and coding professionally [3, 4].

Table 2. Issues of using Copilot for development – RQ6 Results (adapted from [2]).

Limitation & Challenge	Example	Count	%
Difficulty of integration	*Copilot only works with VSCode, VSCodium is not supported at the moment* (GitHub #14837)	75	28.0%
Difficulty of accessing Copilot	*I cannot connect to the GitHub account and the Copilot server in VSCode, also cannot use the Copilot plugin* (SO #74398521)	47	17.5%
Limitation to code generation	*Copilot is limited to around 1000 characters in the response* (GitHub #15122)	39	14.6%
Poor quality of generated code	*Github Copilot suggest solutions that don't work* (SO #73701039)	31	11.6%
Code privacy threat	*Copilot does collect personal data so just take precaution when working in private repos* (GitHub #7163)	20	7.5%
Unfriendly user experience	*I had the same problem today, an amazing tool with poor user experience* (GitHub #8468)	14	5.2%
High pricing	*it is obvious that no one in South America will pay that price, it is too expensive* (GitHub #24594)	11	4.1%
Difficulty of understanding the generated code	*I really do not understand this enough, and have no idea half of what this code does honestly. It was written by Copilot.* (SO #72282605)	9	3.4%
No edition for organizations	*Currently, Copilot is only available for individual user accounts and organizations aren't able to purchase/manage Copilot for their members just yet* (GitHub #32775)	7	2.7%
Lack of customization	*My question is about setting up shortcuts in Visual Studio Code VSCode for GitHub Copilot Labs.* (SO #73564811)	5	1.9%
Difficulty of subscription	*My copilot subscription suddenly stopped. Tried log out and in. Never have reply on support ticket over 10 days* (GitHub #36190)	3	1.1%
Challenge of not providing outdated suggestions	*making sure that the tool does not provide outdated suggestions would still be a challenge* (SO #72554382)	2	0.7%
Show loading	*I am not sure what is causing this but while editing files within Visual Studio, I am periodically locking up with the following dialog showing* (SO #73682137)	2	0.7%
Hard to configure	*Keep getting "Your Copilot experience is not fully configured, complete your setup" in Visual Studio 2022* (GitHub #19556)	2	0.7%
Need of basic programming knowledge	*It is useless if you do not understand the programming language or the task you want to do* (GitHub #35850)	1	0.4%

CONCLUSION

While GitHub Copilot offers a promising avenue for enhancing and supplementing the learning experience in Web Development by providing intelligent code suggestions, code generation rationale, and fostering an interactive learning environment, it is not considered essential nor is generally recommended by professionals both in and outside academia for learning to develop the Web and teaching Web Development as such to beginners at the moment [4] yet hope is proposed for using it more effectively in formal academic teaching [5]. It is reasonable to assume that certain updates to it could expand its functionality for software development purposes [3; p.25]. which can be extended to educational goals, e.g. automatic post-code generation debugging and code optimization features, but that remains solely dependent on its proprietor.

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