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Article

African American Students' Academic and Web Programming Self-Efficacy, Learning Performance, and Perceptions towards Computer Programming in Web Design Courses

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Abstract: Computer programming has been included in computer literacy education in many countries in the last decade. This study examined the effects of gender and the prior programming experience of computer programming on academic and web programming self-efficacy and learning performance in the web design course among African American students, as well as their perceptions towards computer programming. This study's 14-week web design course taught African American students multiple web programming languages, including HTML, CSS, and JavaScript, in order. A one-group pretest–posttest design was adopted in the experiment. The quantitative method was primarily used in data analysis. This study revealed that African American students' academic and web programming self-efficacy significantly increased after the web design course. Most of the African American students' perceptions of computer programming became positive after attending the web design course. This study also found that male African American students had a significantly higher level of web programming self-efficacy than female students before the web design course. Interestingly, this difference disappeared after the course. Additionally, both gender and prior experience in computer programming did not significantly affect students' learning performance in the web design course. The findings of this study not only contribute to the understanding of the feasibility of teaching multiple programming languages in web programming courses for African American students, they also provide evidence of the positive influence of web programming on African American students' perceptions of computer programming.

Keywords: self-efficacy; academic self-efficacy; web programming self-efficacy; African American students; computer programming

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1. Introduction

Rapid technical advancements in information and communication technology have led to an increase in the need for graduates with strong computer skills in knowledge-based economies all over the globe. Additionally, market research reveals that investment in software-related sectors is rising substantially relative to investment in hardware-related industries, which shows the importance of learning computer programming [1]. In the last ten years, computer programming has been included in the teaching of computer literacy in many nations, and it is now regarded as one of the key elements of 21st century skills [2,3]. Many countries have included computer programming instruction into their curricula to foster students' problem-solving, logical reasoning, computational, and algorithmic thinking abilities [4]. Several studies in the literature highlight the lack of education in computer programming despite this trend and the need for human resources with high competence and abilities in computer programming [5–9]. Therefore, how to improve student outcomes and experience in learning computer programming has become an important topic in the fields of STEM (science, technology, engineering, and mathematics).

Students may learn ideas connected to mathematics and informatics via programming education, and they can hone abilities like critical thinking, problem-solving, creativity, and algorithmic thinking [10–12]. However, pupils find understanding and learning about programming challenging [13–15]. The process of producing code is challenging due to the complexity of programming languages and tools, low student self-efficacy, and poor infrastructure [16]. It has been shown that these students' perceptions of computer programming complexity causes a decline in their performance, self-efficacy, and involvement in computer programming activities [17].

Success in the learning process is affected by several variables. Self-efficacy is seen as being more significant than other factors in determining how well people are learning [18]. Bandura defined perceived self-efficacy as "...people's judgments of their capabilities to organize and execute courses of action required to attain designated types of performances" [19] (p. 391). During an activity, a person's self-efficacy will affect how much effort they put forth, how they deal with challenges, and how resilient they are [20]. In many learning domains or activities, it has tight ties to learning experience, learning techniques, learning attitudes, and learning performance [21]. Numerous scholars have investigated the connection between self-efficacy, academic achievement, and demographic factors in several professions [22]. People with strong self-efficacy often show perseverance, strategic planning talent, and high levels of intrinsic motivation and performance [23–25]. A greater association between self-efficacy and programming courses has also been indicated by comparable research [26]. Learners who have high self-efficacy perform better in computer programming [27]. On the other hand, it was discovered that students with low levels of self-efficacy for computer programming, and who considered it challenging even at the start of a course, were more likely to fail [17,28,29].

Previous studies have reported on the effects of gender differences and prior experience in computer programming on self-efficacy, but their results are mixed, and it remains unclear whether these effects change after a sequence of programming courses. Furthermore, Scholz, Doña, Sud, and Schwarzer (2002) [30] have identified that cultural differences in self-efficacy exist and play a role in the determination of academic self-efficacy. Previous studies also have presented that learning different computer programming languages can lead to different self-efficacy results. Web programming is a popular computer programming area among various types of programming languages due to the rapid development of Internet technology. However, to our knowledge, no research examines the influences of a web programming course, including multiple programming languages, on African American students' self-efficacy. Therefore, this study aims to not only investigate the effects of a web programming course combining HTML (Hyper-Text Markup Language), CSS (Cascading Style Sheets), and JavaScript on African American students' self-efficacy, but also to confirm if gender and prior experience provide short-term and long-term advantages in web programming courses or if the advantage fades. Additionally, this study investigates whether the students' perceptions of computer programming change after a web programming course.

2. Literature Review

2.1. Self-Efficacy

The most significant variables influencing learning achievement are typically self-efficacy perception and attitude [18,31,32]. Self-efficacy is a crucial psychological concept that affects how people choose the activities they engage in, how much effort they will put forth when performing a task, and how long they will persevere in the face of challenges they face while trying to complete that task [33]. Self-efficacy affects students' performance and decision making since it is a personal conviction in one's capacity to execute tasks [34]. One of the trustworthy markers that accurately forecasts a person's performance and helps them complete tasks successfully is self-efficacy [13,35]. Students with high self-efficacy are more likely than those with low self-efficacy to accept difficult assignments, increase motivation, encourage individuals to set higher objectives, put out more effort, and demonstrate greater resilience and tenacity [13,36,37]. Bandura (2006) [38] and Weigand and Stockham (2000) [39] also stress that the explanatory and predictive ability of a self-efficacy measure that is not task-specific would be constrained. Several self-efficacy measures were created to assess student efficacy in subjects (including general academic accomplishment, mathematics, programming, etc.) [40–42].

2.2. Academic Self-Efficacy

Academic self-efficacy (ASE) refers to students' attitudes and views about their potential for academic success and their confidence in their ability to perform academic tasks, effectively assimilate knowledge, and participate in academic activities [43–46]. ASE is the epitome of self-efficacy in the area of education and influences effort, tenacity, and perseverance, which in turn influences performance [47–49]. Students with low self-efficacy are more likely to avoid, postpone, or completely give up on their work [43,45,50]. When faced with difficult challenges, however, people with high levels of self-efficacy are more inclined to rely on their resources and abilities. They are also more likely to be patient while working through the issue at hand, exert more effort, and stick with it for longer [33,45,51]. According to previous research, ASE is favorably correlated with academic success [52–56]. Numerous studies have shown that students' learning, motivation, and academic performance are significantly impacted by their level of ASE [51,57–61].

Fenollar, Román, and Cuestas (2007) performed research on students' academic performance as an integrative conceptual framework and empirical analysis at the University of Murcia, which contrasts the aforementioned perspective that self-efficacy is connected with student academic success [53]. According to the findings of structural equation modeling, there was no connection between students' academic achievement and self-efficacy. Similarly, Strelnieks (2003) investigated the connection between minority students' academic performance, domain-specific self-concepts, and self-efficacy [62]. The study discovered that some outside variables, such as a student's gender and socioeconomic background, affected whether self-efficacy may affect academic achievement. The findings showed that self-efficacy could only accurately predict girls' academic success, while failing to predict that of males. Additionally, Kolo, Jaafar, and Ahmad (2017) found that self-efficacy could only accurately predict the academic achievement of students from better socioeconomic backgrounds; it could not accurately predict this for students from lower socioeconomic backgrounds [63]. According to the examination of various ASE studies, self-efficacy seems to have varying predictive potential for various people [62].

2.3. Programming Self-Efficacy

Beliefs in one domain may or may not influence beliefs in another. Therefore, self-efficacy varies depending on the context [64]. Students' programming abilities, as well as their decision making and actions in the classroom, are profoundly impacted by their sense of self-efficacy [65–67]. Students' confidence in their own abilities to complete programming assignments is what Gorson and O'Rourke (2020) called "programming self-efficacy" (PSE) [34]. Students' programming accomplishment and PSE are the most significant variables to study since they provide crucial insights into the growth of programming abilities [67]. According to several studies, learning results were favorably impacted and considerably influenced by students' attitudes or ideas about programming and their PSE [68,69]. According to Hongwarittorn and Krairit (2010), a lack of confidence in one's programming abilities hinders the spread of computer science education [70]. Using exploratory factor analysis, Rama-lingam and Wiedenbeck (1998) reported four self-efficacy variables and discovered substantial changes in students' self-efficacy levels after the coding course [27]. Tsai et al. (2019) examined the effect that alterations to a programming course had on students' perceptions of their own abilities and found no statistically significant differences [67].

2.4. Effects of Prior Experience on Academic and Programming Self-Efficacy

According to Ramalingam et al. (2004), previous experience impacts computer programming self-efficacy, and self-efficacy affects course achievement [40]. In other words, confidence in one's own abilities serves as a mediator between past performance and future outcomes [71]. Student self-efficacy and performance were shown to be greater among those who had received coding courses or training compared to those who had not [72–74]. Mazman and Altun (2013) looked at students' assessments of their own programming abilities and found that those with more experience were more likely to rate themselves as competent in computer programming [75]. According to the analysis of Cigdem and Yildirim (2014), previous computer knowledge and programming course experience were the only significant predictors of PSE in the visual programming course [76]. Students who take more computer programming classes may feel more confident in their abilities as programmers. Research shows that students with previous expertise in computer programming outperform those without by more than 5% on assignments and examinations [76]. However, different research indicated that, towards the conclusion of the programming course, the gap in participants' evaluations of their self-efficacy narrowed between the inexperienced and the experienced groups [15].

According to previous studies [15,77], students' self-efficacy in their programming abilities grows as they acquire expertise. Students in computer education areas had their sense of self-efficacy and background knowledge assessed by Mazman and Altun (2013) [77]. They discovered that both the inexperienced and the experienced students' assessments of their own ability to write computer programs improved dramatically after taking the course, with the inexperienced students benefiting more than anybody else in their study [15]. Additionally, Türker and Pala (2020) found that students' confidence in their own abilities (i.e., self-efficacy) and the depth and breadth of their prior knowledge both significantly predicted their performance in the course [15]. However, previous research [78] conducted on engineering students at a Nigerian institution indicated that prior experience with computer programming did not affect their proficiency with Java. Alvarado, Lee, and Gillespie (2014) found that only men, but not women, benefited significantly from past experience in terms of performance [1].

2.5. Effects of Gender on Academic and Programming Self-Efficacy

The self-efficacies of men and women have been observed to vary significantly in several studies [27,77,79]. Previous research found that boys seem to have better STEM experiences than girls [80–82]. Women are more likely than men to rate their own programming skills as poor and to feel that they need a lot of practice to become proficient [83,84]. Allaire-Duquette et al. (2022) conducted a 2 h introductory programming workshop on robotics in a science museum and found that boys reported higher self-efficacy beliefs related to their programming skills than girls did prior to the workshop [85]. According to a different study [13], males reported greater levels of self-efficacy in Java programming than females did, and students majoring in computer engineering had the highest levels of self-efficacy of any engineering subfield. Tsai et al. (2019) observed that, while controlling for prior programming experience, males tended to score higher on the algorithm and debug aspects of programming self-efficacy [77]. However, there was no gender difference in areas of reasoning, self-regulation, or teamwork.

Knowledge of computer programming has the potential to reduce the gap in self-efficacy between different genders. Even if both females' and males' self-efficacy views grow following participation in the computer programming workshops, Allaire-Duquette et al. (2022) indicated that gender disparities in self-efficacy for programming were first discovered to be reduced and then even eliminated [85]. Similarly, Gunbatar, and Karalar (2018) discovered that, while boys started the mBlock programming course with a better sense of self-efficacy than girls, the gender gap was bridged by the conclusion of the semester [86]. Teaching middle school children to code using mBlock did not significantly change students' evaluations of their own programming abilities based on gender [86]. Self-efficacy in C++ programming did not vary significantly between males and females, but after three months of training, males scored considerably higher than females [27]. Using the 32-item PSE scale, Korkmaz and Al-tun (2014) reported on research that looked at participants' perceptions of their own ability to write programs in C++ [87]. Computer engineering students were shown to have greater levels of self-efficacy than electrical and electronics engineering students, although there was no difference between male and female levels of self-efficacy [88]. Further research by Korkmaz and Altun (2014) looked at the C++ programming self-efficacy of 378 engineering students and found no significant variation between the genders [87]. There were no variations in ASE between the genders among students, as reported by Choi (2005) [89]. However, other research showed that women often have greater levels of ASE than men [90,91].

2.6. Relationships between Self-Efficacy and Learning Performance

The concept of self-efficacy has been widely acknowledged to have a close association with overall academic achievement and specific skill-learning performance. Numerous prior studies have consistently indicated a strong correlation between learners' academic self-efficacy and their academic performance [92–95]. These findings showed that higher levels of academic self-efficacy were associated with improved academic performance and could contribute to academic success [27,96]. Ramalingam and Wiedenbeck (1998) proposed that self-efficacy plays a crucial role in the success of programming learning. Ramalingam, LaBelle, and Wiedenbeck (2004) discovered that students' self-efficacy in computer programming had a positive impact on their performance [40]. Another study showed that programming self-efficacy was positively correlated with course grades in an introductory programming course [20]. However, it is important to note that some studies have reported no significant relationship between academic self-efficacy and academic performance [97–99]. This discrepancy was attributed to factors such as the operationalization of academic self-efficacy and cultural differences [95].

2.7. Research Questions

Although many researchers emphasized the importance of self-efficacy in the learning process, the influences of self-efficacy could be varying depending on different settings (e.g., disciplines, tools, methods, cultures, etc.) [30,95]. As of now, there is no research focusing on a web programming course encompassing multiple programming languages. Additionally, self-efficacy studies of computer programming learning among minority students, including the exploration of gender and prior experience, are very limited. With the rapid development of Internet technology and the promotions of diversity in STEM areas, it is crucial to fill the above research gaps. Thus, this study focuses on investigating the effects of web programming courses, gender, and prior experience of computer programming on African American students' academic and web programming self-efficacy, learning performance, and perceptions of computer programming. The research questions include the following:

RQ1: What are the effects of the web design course on academic self-efficacy and web programming self-efficacy among African American students?
RQ2: Do African American students' academic self-efficacy, web programming self-efficacy, and learning performance differ in terms of gender and their prior experience of computer programming?
RQ3: Do gender and prior experience of computer programming affect the changes in African American students' academic self-efficacy and web programming self-efficacy?
RQ4: What is the relationship between academic self-efficacy, web programming self-efficacy, and learning performance among African American students?
RQ5: After participating in the web design course, what are African American students' perceptions towards computer programming?

3. Materials and Methods

3.1. Sample

The participants were the undergraduate students enrolled in the Web Design course. The course was an undergraduate-level course offered through the Computer Graphics Technology program from an eastern HBCU (Historically Black Colleges and Universities) university in the United States. The valid sample consisted of 32 participants. All of them were junior undergraduate students of Computer Graphics Technology and had similar academic backgrounds and course-taking records. Overall, the participants included 53.1% and 46.9% male and female students, respectively. These students ranged in age from 20 to 23. More than 80% of them were between 20–21 years old. All of the students are Black/African American. Regarding the participants' self-reported prior computer programming experience, 56.3% of students did not have programming experience, and 43.8% reported they had some basic or simple programming language knowledge (see Table 1).

Table 1. Demographic characteristics table.

		Total	
		n	**%**
Gender			
	Male	17	53.1
	Female	15	46.9
Marital Status			
	Married	0	0
	Single	32	100.0
Age			
	20	13	40.625
	21	14	43.75
	22	4	12.5
	23	1	3.125
Ethnicity			
	White/Caucasian	0	0
	Black/African American	32	100
	Hispanic/Latino	0	0
	Asian	0	0
	Others	0	0
Prior Experience of Computer Programming			
	Level 0: No experience.	18	56.25
	Level 1: Knowing a few basic or simple programming languages or syntax.	14	43.75
	Level 2: Knowing the majority of basic or simple programming languages or syntax, as well as a few complex programming languages.	0	0
	Level 3: Knowing both the basic and complex programming languages.	0	0

3.2. Procedure

The experiment was a one-group pretest–posttest design and conducted in a 14-week-long web design course that included 11 learning units designed based on the step-by-step functions of constructing a website and three weeks of lab time (see Figure 1). This course was conducted remotely via Zoom. In this course, the lectures were delivered using PowerPoint slides with animations, and the practices of web programming (i.e., HTML, CSS, and JavaScript) were demonstrated using the Adobe Dreamweaver CC version 20 software. The in-class interactions and activities were achieved through microphones, online whiteboards, chat windows, and breakout rooms. In the first class, the goals and objectives of this web design course were introduced to the students. They understood that their final task was to create their own websites through web programming by the end of the course. Next, the instructor provided three-week lessons for the students to learn how to style their website using CSS. After that, five-week lessons were provided for the students to learn how to structure their website using HTML. Then, three-week lessons were given for the students to learn how to develop the user interface interactions using JavaScript. In the final three weeks, the students applied what they had learned to design and develop their own website.

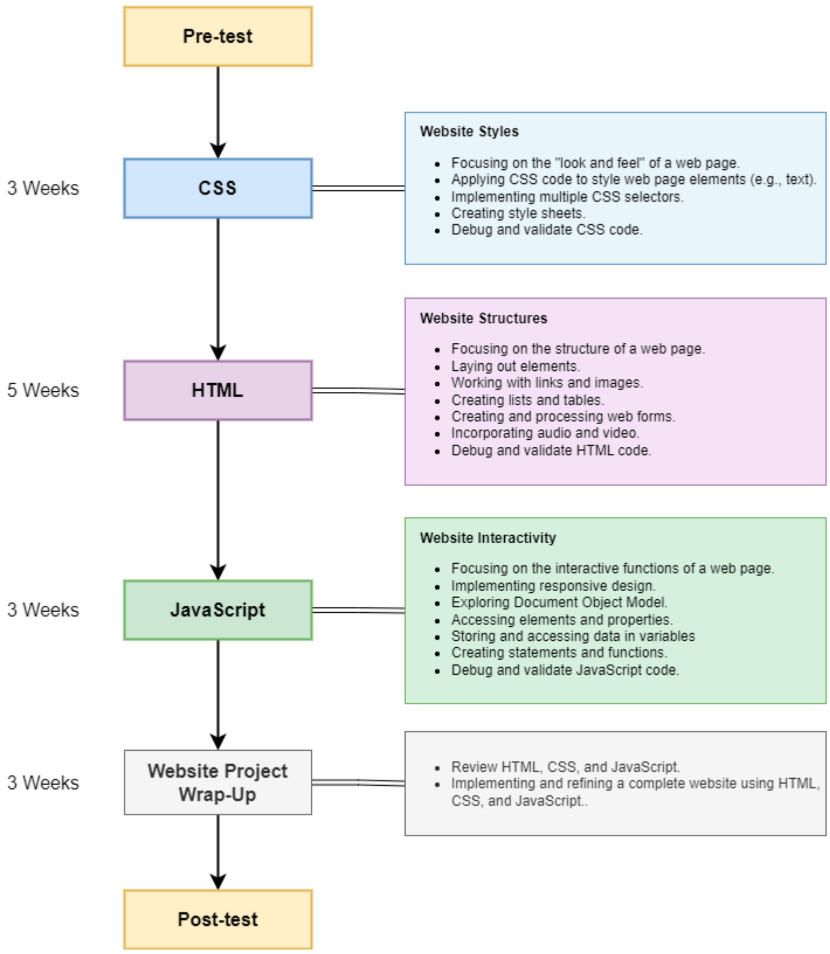

Figure 1. Experimental procedure and plans of course content of web programming.

3.3. Instruments

Several surveys were used in this study. The first one was the background survey, which included the participants' information on gender, age, race, and previous experience of computer programming. Another one was the academic self-efficacy (ASE) survey, including a total of eight questions (7-point Likert scale). This survey was adopted from one subscale (Self-Efficacy for Learning and Performance) from the Motivated Strategies for Learning Questionnaire (MSLQ) [100]. The value of Cronbach's alpha of ASE in this study was 0.945. Additionally, the web programming self-efficacy (WPSE) survey consisting of 16 questions (6-point Likert scale) was used to investigate students' self-efficacy in web programming. This survey was adapted from the Computer Programming Self-Efficacy Scale (CPSES) including five sub-scales: Logical Thinking, Cooperation, Algorithm, Control, and Debug [77]. The value of Cronbach's alpha of WPSE in this study was 0.972. The learning performance of computer programming was from the grades of the students' final website project. Finally, two open-ended questions were applied to examine participants' opinions and perceptions regarding computer programming after the web design course. The two questions included "Do your perceptions of computer programming change after participating in the course?" and "Do you think that computer programming is an important skill?".

3.4. Data Collection and Analysis

Data were collected using online surveys through Qualtrics. The online surveys were, respectively, provided to the students at the beginning of the semester and at the end of the semester. At the beginning of the course, the students were asked to complete the pre-test of the background survey, ASE survey, and WPSE survey. They were also asked to complete the posttest, including the ASE survey, WPSE survey, and the open-ended questions after they completed the 14-week web design course. Data were analyzed using a quantitative approach through SPSS 28. Quantitative approaches included descriptive analysis, paired *t*-tests, independent *t*-tests, one-way ANOVAs, and correlation analyses.

4. Results

4.1. RQ1: What Are the Effects of the Web Design Course on Academic Self-Efficacy and Web Programming Self-Efficacy among African American Students?

A paired-sample t-test was conducted to compare web programming self-efficacy and academic self-efficacy reported by the students before and after the web design course (see Table 2). The results showed that there were significant differences in academic self-efficacy [$t(31) = 3.670$, $p < 0.001$, $d = 0.649$], Logical Thinking [$t(31) = -7.953$, $p < 0.001$, $d = 1.406$], Cooperation [$t(31) = -5.813$, $p < 0.001$, $d = 1.028$], Algorithm [$t(31) = -6.205$, $p < 0.001$, $d = 1.097$], Control [$t(31) = -8.872$, $p < 0.001$, $d = 1.568$], Debug [$t(31) = -6.814$, $p < 0.001$, $d = 1.205$] and overall web programming self-efficacy [$t(31) = -8.735$, $p < 0.001$, $d = 1.544$].

Table 2. Results of paired samples test.

Variables	Pretest		Posttest		*t*	df	*p*
	M	*SD*	*M*	*SD*			
Academic Self-Efficacy	6.223	0.764	5.512	1.068	3.670	31	<0.001
Web Programming Self-Efficacy	2.854	1.249	4.613	0.785	−8.735	31	<0.001
Logical Thinking	3.073	1.322	4.917	0.803	−7.953	31	<0.001
Cooperation	3.364	1.299	4.657	0.862	−5.813	31	<0.001
Algorithm	2.656	1.364	4.187	0.950	−6.205	31	<0.001
Control	2.573	1.472	4.864	0.900	−8.872	31	<0.001
Debug	2.708	1.468	4.479	0.923	−6.814	31	<0.001

4.2. RQ2: Do African American Students' Academic Self-Efficacy, Web Programming Self-Efficacy, and Learning Performance Differ in Terms of Gender and Their Prior Experience of Computer Programming?

Independent *t*-tests were performed to answer research question two (RQ2). The results revealed that gender had a significant influence on web programming self-efficacy [$t(30) = 2.441$, $p < 0.05$, $d = 0.865$] but there was no significant difference in academic self-efficacy [$t(30) = -0.589$, $p = 0.56$, $d = 0.209$] before the course (see Table 3). Before the course, the male students showed significantly higher levels of web programming self-efficacy ($M = 3.324$) than female students ($M = 2.321$). Prior experience of computer programming showed no significant effect on academic self-efficacy and web programming self-efficacy either before or after the course (see Table 3). Additionally, both gender [$t(30) = -0.539$, $p = 0.594$, $d = 0.191$] and prior experience of computer programming [$t(30) = 0.572$, $p = 0.572$, $d = 0.068$] did not significantly affect student learning performance in the web design course (see Tables 3 and 4).

Table 3. Results of paired samples tests for academic and web programming self-efficacy and learning performance in terms of gender.

Variables	Male		Female		*t*	df	*p*
	M	*SD*	*M*	*SD*			
Before the class							
Academic Self-Efficacy	6.147	0.858	6.308	0.661	−0.589	30	0.560
Web Programming Self-Efficacy	3.324	1.353	2.321	0.889	2.441	30	0.021 *
Logical Thinking	3.627	1.409	2.445	0.897	2.787	30	0.009 *
Cooperation	3.882	1.312	2.778	1.036	2.616	30	0.014 *
Algorithm	3.097	1.504	2.156	1.015	2.045	30	0.050
Control	2.980	1.669	2.111	1.089	1.717	30	0.096
Debug	3.156	1.612	2.200	1.133	1.916	30	0.065
After the class							
Academic Self-Efficacy	5.618	0.938	5.392	1.222	0.591	30	0.559
Web Programming Self-Efficacy	4.721	0.832	4.492	0.737	0.819	30	0.419
Logical Thinking	4.981	0.828	4.845	0.795	0.472	30	0.640
Cooperation	4.765	0.919	4.534	0.805	0.751	30	0.459
Algorithm	4.215	0.993	4.155	0.933	0.177	30	0.861
Control	5.058	0.953	4.645	0.811	1.312	30	0.199
Debug	4.588	0.961	4.355	0.895	0.708	30	0.484
Learning Performance	80.541	12.519	83.303	16.424	−0.539	30	0.594

Note. * $p < 0.05$.

Table 4. Results of paired samples tests for academic and web programming self-efficacy and learning performance in terms of prior experience of computer programming.

Variables	No Experience		Experienced		*t*	df	*p*
	M	*SD*	*M*	*SD*			
Before the class							
Academic Self-Efficacy	6.153	0.911	6.313	0.541	−0.580	30	0.566
Web Programming Self-Efficacy	2.625	1.239	3.147	1.244	−1.181	30	0.247
Logical Thinking	2.778	1.328	3.452	1.258	−1.457	30	0.155
Cooperation	3.333	1.313	3.405	1.328	−0.154	30	0.879
Algorithm	2.556	1.368	2.785	1.400	−0.466	30	0.645
Control	2.241	1.477	3.000	1.402	−1.475	30	0.151
Debug	2.333	1.469	3.191	1.369	−1.688	30	0.102
After the class							
Academic Self-Efficacy	5.424	1.029	5.625	1.146	−0.523	30	0.605
Web Programming Self-Efficacy	4.646	0.772	4.571	0.829	0.262	30	0.795
Logical Thinking	5.000	0.704	4.810	0.930	0.658	30	0.515
Cooperation	4.556	0.855	4.786	0.884	−0.742	30	0.464
Algorithm	4.351	0.953	3.976	0.938	1.113	30	0.275
Control	4.907	0.892	4.809	0.940	0.301	30	0.766
Debug	4.518	0.951	4.428	0.919	0.271	30	0.788
Learning Performance	82.266	12.689	81.283	16.640	0.190	30	0.851

4.3. RQ3: Do Gender and Prior Experience of Computer Programming Affect the Changes in African American Students' Academic Self-Efficacy and Web Programming Self-Efficacy after the Web Design Course?

One-way ANOVAs were used to compare the levels of changes in web programming self-efficacy and academic self-efficacy in terms of gender and the prior experience of computer programming, respectively. The results revealed that there were no significant differences between male and female students on the levels of the changes in academic self-efficacy [$F(1, 30) = 0.995$, $p = 0.327$, $\eta^2 = 0.032$] and web programming self-efficacy [$F(1, 30) = 4.033$, $p = 0.054$, $\eta^2 = 0.119$] (see Table 5). Regarding the prior experience of computer programming, the results showed that students' prior experience of computer programming did not significantly affect the levels of changes in academic self-efficacy

[$F(1, 30) = 0.011$, $p = 0.917$, $\eta^2 = 0.032$] and web programming self-efficacy [$F(1, 30) = 2.246$, $p = 0.144$, $\eta^2 = 0.07$] (see Table 6).

Table 5. Results of one-way ANOVAs for the changes in academic and web programming self-efficacy in terms of gender.

Variables	Male		Female		*F*	*df*	*p*
	M	*SD*	*M*	*SD*			
Academic Self-Efficacy	−0.529	0.927	−0.917	1.262	0.995	1	0.327
Web Programming Self-Efficacy	1.397	1.051	2.171	1.128	4.033	1	0.054
Logical Thinking	1.354	1.289	2.400	1.135	5.869	1	0.022 *
Cooperation	0.883	1.098	1.756	1.299	4.243	1	0.048 *
Algorithm	1.118	1.184	1.999	1.507	3.419	1	0.074
Control	2.078	1.557	2.533	1.356	0.767	1	0.388
Debug	1.432	1.526	2.155	1.351	1.989	1	0.169

Note. * $p < 0.05$.

Table 6. Results of one-way ANOVAs for the changes in academic and web programming self-efficacy in terms of prior experience of computer programming.

Variables	No Experience		Experienced		*F*	*df*	*p*
	M	*SD*	*M*	*SD*			
Academic Self-Efficacy	−0.729	1.235	−0.688	0.933	0.011	1	0.917
Web Programming Self-Efficacy	2.021	0.881	1.424	1.367	2.246	1	0.144
Logical Thinking	2.222	1.144	1.358	1.393	3.720	1	0.063
Cooperation	1.223	1.154	1.381	1.420	0.120	1	0.732
Algorithm	1.796	1.309	1.191	1.478	1.503	1	0.230
Control	2.667	1.232	1.809	1.631	2.876	1	0.100
Debug	2.186	1.127	1.237	1.717	3.548	1	0.069

4.4. RQ4: What Is the Relationship between Academic Self-Efficacy, Web Programming Self-Efficacy, and Learning Performance among African American Students?

Pearson's correlation was performed to examine the relationships between academic self-efficacy and web programming self-efficacy after the course. The results showed that web programming self-efficacy was significantly and positively related to academic self-efficacy ($r = 0.762$, $p < 0.001$). However, the learning performance was not significantly related to academic self-efficacy ($r = 0.337$, $p = 0.059$) and web programming self-efficacy ($r = 0.186$, $p = 0.309$) (see Table 7).

Table 7. Correlations among variables.

		Academic Self-Efficacy	Web Programming Self-Efficacy	Learning Performance
Academic Self-Efficacy	Pearson Correlation	1	0.762 **	0.337
Web Programming Self-Efficacy	Pearson Correlation	0.762 **	1	0.186
Learning Performance	Pearson Correlation	0.337	0.186	1

Note. ** $p < 0.01$.

4.5. RQ5: After Participating in the Web Design Course, What Are African American Students' Perceptions towards Computer Programming?

There were 24 out of 32 African American students who clearly indicated that their perceptions of computer programming had completely changed and the computer programming was not as difficult as they thought before they took the web design course. The representative responses from these students are shown below. However, there were 3 out of 32 African American students whose perceptions did not change after the course. There was 1 out of 32 African American students who clearly pointed out coding was still difficult for them. The remaining four African American students did not answer the questions.

Change in Perceptions:

> Student 6: "*At first I thought, coding was a lot more difficult than it ended up being. Now I have a pretty good grasp on the concept.*"
>
> Student 11: "*I did not think I was able to code in the beginning, I thought it would be too hard. But now I know it is not that hard.*"
>
> Student 21: "*I thought it was more complex than it really is.*"
>
> Student 22: "*My perceptions are changed greatly because of this course. Coding is very simple and forward to me now.*"

Interesting and Fun:

> Student 1: "*I thought coding was boring at first, but now I find it more interesting.*"
>
> Student 16: "*At first I thought it was going to be difficult but it was a lot of fun to do.*"
>
> Student 28: "*I did not know I would enjoy coding as much as I do now.*"
>
> Student 32: "*It's fun and makes me want to do more!*"

Increased Confidence:

> Student 31: "*My perception of coding/programming has changed after taking this course. I do not feel nervous about the idea of coding anymore.*"

Additionally, there were 28 out of 32 African American students who agreed that computer programming is a very important skill to possess. The selected responses are listed below. Nevertheless, the remaining four African American students did not completely consider computer programming as an essential skill. For example, one student indicated that "It may not be important to every student, but it definitely be useful to almost anybody". Another student said that "I don't think so due to the tools such as wix [Wix] that will do all the coding for you".

> Student 4: "*I think coding is an important skill because If you're ever going to work for a company or have your own company then having the ability to promote yourself or others is a needed skill.*"
>
> Student 6: "*I think coding is a very important skill, especially since the world is going into a sort of tech boom at the moment. It is a good basic skill to possess.*"
>
> Student 7: "*. . . , coding/programming enhances your critical thinking and problem-solving skills by making you figure out what is wrong. With coding/programming, you must debug the code in order to move on. So, this forces one to find a solution to the problem.*"
>
> Student 8: "*I think as a graphic designer it is important to know as many ways to digitally create things as possible.*"
>
> Student 11: "*. . . in coding/programming you need to plan out every step so your website looks how you want it to. In the real world, you need to plan out all the steps you must take to reach your goal.*"
>
> Student 27: "*. . . it enhances your ability to think, especially when thinking about what code would be best for the creation of you design.*"
>
> Student 30: "*. . . it allows them to create there [their] own solutions to problems.*"

5. Discussion, Conclusions, and Limitations

Through pre- and posttests, the results showed that the African American students' academic self-efficacy and web programming self-efficacy significantly increased after participating in the web design course. Most African American students with no or less computer programming experience thought learning web programming was boring and difficult before they took the web design course [101]. This may imply that the stereotypes of unfamiliar or unknown computer programming knowledge still exist among African American students, which may lower their learning motivation. However, through the gradual progress of learning computer programming concepts using different programming languages (from simple to complex ones), African American students' perceptions of computer programming can apparently be positively changed. This kind of computer programming course design can help decrease African American students' nervousness or fear of learning computer programming, increase their interest and enjoyment in learning computer programming, and enhance their perceptions of the importance of computer programming skills in the world.

This study found that African American male students reported significantly higher levels of web programming self-efficacy than female students before participating in the web design course. However, this difference disappeared after the course. The results are aligned with the previous studies proposed by Allaire-Duquette et al. (2022) [85] and Gunbatar and Karalar (2018) [86]. In STEM activities, males were found to show more positive beliefs and experiences and higher motivation than females, which appeared to result in most males reporting higher confidence and perceptions of self-efficacy in learning computer programming [80–82]. However, by attending web programming courses combining diverse programming languages, the difference in academic and programming self-efficacy between males and females was eliminated. This may imply that computer programming courses can provide equal opportunities for learning for both males and females and lead to comparable levels of self-efficacy. Additionally, starting with lower levels of academic and computer programming self-efficacy, females probably tend to actively pay more attention to and put more effort into learning than males, and relatively experience a greater increase in academic and web programming self-efficacy.

Prior experience in computer programming did not lead to significant differences in both academic and web programming self-efficacy, whether before or after the web design course. These results differ from the previous studies [72–74], which found that students with more prior computer programming experience have higher self-efficacy perceptions than those with less prior computer programming experience. The possible explanation for the results is that the types, quality, depth, and memories of prior computer programming experience can differ. For example, if the prior experience of programming languages differs from the web programming languages used in the course, the lack of familiarity with new content might affect students' self-efficacy [102]. Additionally, the prior experience of success in learning computer programming might affect students' perceptions when they self-reported their skills in computer programming. According to Bandura's self-efficacy theory, individual experiences of managing efforts toward performance achievements (i.e., enactive mastery experiences) is the most influential source of evaluating self-efficacy [33,43]. More past success leads to an increase in self-efficacy beliefs, while repeated failures lead to a decrease in self-efficacy beliefs [33]. In this study, self-reported computer programming skills could not fully reflect students' success in the prior experience of computer programming. For instance, a student with high self-reported skill of computer programming might have lower accomplishments in their prior learning experience, which resulted in lower academic and programming self-efficacy. These speculations are aligned with the previous study where self-efficacy was related to successful grades in computer programming courses but not programming experience and the number of years in programming [103]. Moreover, in this study, all of the self-reports from the African American students were in Level 0 or Level 1 of computer programming skills. The difference between these two levels might not be large enough, which leads to non-significant results.

A significantly positive relation was found between academic self-efficacy and web programming self-efficacy, which implies that African American students with higher levels of self-efficacy of understanding the instructional materials and completing the course tasks were more likely to show higher web programming self-efficacy. This finding is aligned with previous research indicating that self-efficacy was positively correlated with programming self-efficacy in an introductory programming course [20]. However, this study found that learning performance was not significantly and positively related to academic self-efficacy and web programming self-efficacy, which is not in line with the previous studies conducted by Kolo (2017) [63], but is in line with the study of Fenollar et al. (2007) [53]. The researchers speculated that students might have inaccurate beliefs or perceptions about their competence in learning computer programming, which leads to overconfidence and less motivation to put more effort into the learning processes [104].

Overall, this study suggests that web programming courses combining multiple programming languages are beneficial to enhance African American students' academic and web programming self-efficacy. According to the findings in this study, we suggest that (a) African American learners' prior experience in computer programming should be taken into account while designing web programming course content; (b) educators should consider incorporating the inclusive learning content to increase female African American learners' web programming self-efficacy; (c) educators should consider adopting various tools or designing activities that can help gradually deliver learning content and concepts of computer programming and decrease African American students' frustrations and fear towards computer programming; (d) educators should consider teaching various web computer programming from simple to complex web computer languages to decrease African American students' barriers to learning and increase their academic and web programming self-efficacy; and (e) beginners or novices can consider starting computer programming with web computer programming languages which include more visualized or graphics outputs and results to enhance the interest in learning computer programming.

There are several limitations in this study. First, because of limited resources and time, the study included a relatively small sample size during the data collection. While the small sample size was conducive to the study's feasibility, it might lead to a potential challenge to reach solid findings and conclusions. Thus, even though there were no statistical violations in the process of data analysis, we suggest that researchers collect larger samples to increase the robustness of the findings. Secondly, because the participants in this study were African America undergraduate students from the Computer Graphics Technology program at an eastern HBCU university, the findings were interpreted within the context of this sample and may not be generalized to other populations with different characteristics or backgrounds. Researchers are encouraged to conduct similar studies with different groups to validate the changes in their self-efficacy and perceptions towards computer programming in the web design courses integrating multiple computer languages. Thirdly, the learning performance in this study was based on the grades of students' final project combining CSS, HTML, and JavaScript. We did not consider that the levels of difficulty in CSS, HTML, and JavaScript might vary. This might result in different influences on student academic and programming self-efficacy. Thus, future studies are encouraged to create grading rubrics to clearly determine student learning performance based on these three different computer languages and to further analyze their specific impact. Finally, we encourage future researchers to examine the relationship between self-efficacy and various factors and their combined effects via regression analysis.

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