Introducing Students to Web Engineering Topics by Teaching Web Augmentation

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Abstract

Web augmentation has gained prominence as a promising approach to elevate the user experience by tailoring web content to meet diverse user needs and preferences. It offers the potential to enhance accessibility and personalization, making web experiences more engaging and inclusive. This research study examines the use of web augmentation in the context of web engineering education and its influence on student motivation. The study investigates how the integration of web augmentation techniques motivates students and enhances their learning experience. A questionnaire was administered to gather data on student perceptions and motivation levels following their exposure to web augmentation in the web engineering subject.

The findings reveal that the implementation of web augmentation in the web engineering subject has positively motivated students. Students express a strong preference for web augmentation as a learning tool, citing increased engagement and a more interactive learning environment. The findings support the adoption of web augmentation techniques as a valuable pedagogical tool, enhancing the learning experience and fostering student engagement. This study contributes to the field by addressing the gap in related work that focuses on the use of web augmentation specifically in educational settings.

Keywords: Web engineering, web augmentation, education.

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1 Introduction

Web augmentation (WA) has emerged as a promising technique to enhance the user experience and make web content more accessible and personalized for different user needs and preferences [2]. Bouvin [6] defined WA as "a tool that through integration with a Web browser, an HTTP proxy or a Web server adds content or controls not contained within the Web pages themselves to the effect of allowing structure to be added to the Web page directly or indirectly, or to navigate such structure. The purpose of such a tool is to help users organize, associate, or structure information found on the Web. This activity may be done by a single user or in collaboration with others". WA tools have the capability to modify web pages by inserting new content and adding new style or behavior to the web page. This modification can be achieved through various means, such as the use of a special proxy at the web server or by modifying the web pages displayed in the web browser [6]. According to Díaz, Arellano, and Azanza [11], WA can be likened to augmented reality in the physical world. WA involves layering relevant content, layout, and navigation over the existing web content to personalize the user experience.

With the vast amount of information available on the web, it can be challenging for users to find relevant and meaningful content [1]. WA techniques can help overcome this challenge by providing users with personalized content and a more efficient browsing experience. In the field of web engineering (WE), WA is becoming increasingly important, as it can improve web accessibility, usability, and security.

WE is a comprehensive approach that encompasses all stages of the development of web-based systems, beginning with conception and development, and continuing through implementation, performance evaluation, and ongoing maintenance. The creation and deployment of web-based systems involve multiple iterative steps. In order to keep the information current and satisfy user requirements, most web-based systems undergo continuous evolution [13]. Despite some software developers and software engineering professionals perceiving WE as a clone of software engineering, the two are distinct fields, despite both involving programming and software development. Although WE adopts and integrates many software engineering principles, it also incorporates numerous new methodologies, approaches, guidelines, techniques, and tools tailored to meet the specific demands of web-based systems [13].

WA can benefit WE in various ways. First, it can improve the accessibility of web content for users with different abilities and disabilities. WA techniques such as text-to-speech conversion, image and video descriptions, and keyboard navigation can help make web content more accessible for users with visual, auditory, and motor impairments [15]. Second, WA can enhance the usability of web applications by providing users with a more personalized and efficient browsing experience. For example, personalized recommendations and search results can help users find relevant content more quickly and easily [11, 22]. Third, WA can increase the security and usefulness of web applications by providing additional layers of protection. Techniques such as content filtering or ad-blocking, removing unnecessary content, can help protect users from harmful content and websites [10, 12].

While WA offers many benefits for WE, it also poses various challenges. One of the main challenges is ensuring that the augmented content is accurate and relevant to the user's needs. The effectiveness of WA techniques depends on the accuracy of the data used to customize the content. Therefore, it is essential to use reliable sources and algorithms to ensure the quality and accuracy of the augmented content. Another challenge is maintaining the security of the augmented content. As WA involves the use of third-party tools and services, it can potentially introduce security vulnerabilities. Therefore, it is crucial to ensure that WA tools and services are secure and trustworthy [4].

In this context, this paper presents the experience of using WA in the WE course in the computer science degree for vocational training students. This experience has been carried out with 22 students in a face-to-face manner with first year students during the 2022/23 academic year. The reception of this experience has been measured by answering the following research questions.

- RQ1: What are the key motivating factors of using WA perceived by students as triggers for their engagement in learning WE concepts?
- RQ2: How do students value the use of WA in the WE course?

The rest of this document is structured as follows: Section 2 presents related work on WA in education in other settings. Section 3 presents the case study of this work, including the motivation and implementation of the initiative. Section 4 describes the results obtained in the experience answering the research questions posed. Section 5 shows the discussion related to this work. Finally, Section 6 presents the conclusions and future lines of action.

2 Related Work

WA, a technology that enriches web applications with additional content and interactive features, has been widely explored in various fields [1,2,5,11,12, 14,22]. However, there is a lack of research specifically focusing on the use of WA in the context of WE education. This section provides an overview of the existing literature on WA in education and highlights the need for research in the specific domain of WE.

In the context of digital textbooks, augmented content has been found to promote interactive and immersive learning experiences. By transforming static content into dynamic and multimedia-rich resources, augmented textbooks can facilitate deeper understanding and knowledge retention among students [18]. For example, Kalir's contribution discusses the utilization of open web annotation for collaborative learning in online communities, focusing on the case study of hypothesis [17]. It examines six collaborative learning practices enabled by hypothesis, including multimodal expression, context connections, and contribution to open educational resources. The study concludes by presenting research questions regarding OWA's impact on formal and informal learning environments, the growth of open educational resources and practices, and the use of open data for learning analytics. Chen [8] introduces a web-based collaborative reading annotation system with gamification mechanisms to enhance students' annotation behaviors and reading comprehension. The research involved 55 fifth-grade students, using a quasi-experimental design to compare the effects of the web-based collaborative reading annotation system with and without gamification on annotation behaviors, collaborative interaction, reading comprehension performance, and immersion experience.

WA has also been explored to support collaborative learning and knowledge construction. By augmenting web environments with collaborative features like annotation tools, discussion boards, and shared workspaces, students can engage in meaningful interactions, foster collaboration, and co-construct knowledge. Chan and Pow [7] examined the impact of a social annotation on collaborative inquiry-based learning among university students. The tool allowed students to bookmark, annotate, discuss, and collaborate on information sources for their assignments. Although students perceived the tool as useful and effective and there were no significant improvements in their marks.

However, despite this research on WA in education, there is a dearth of studies specifically investigating its application in the domain of WE

education. The unique nature of WE, which encompasses the design, development, and maintenance of web applications, warrants research to explore how WA can be integrated effectively into the WE curriculum.

Therefore, this study aims to fill the research gap by investigating how students value the use of WA in a WE course. By exploring students' perspectives and perceptions, the study intends to shed light on the potential benefits and challenges of incorporating WA in WE education and provide valuable insights for curriculum development and instructional practices in this domain.

3 Case Study

WE is an essential subject in the computer science vocational training program, especially for those interested in pursuing a career in web development. The 2022/23 academic year would be a critical time for students in this program to gain skills and knowledge in WE. The program consists of three parts: HTML, CSS, and JavaScript. Notepad++ is used to perform all the class activities.

The first part of the program is HTML, which is the foundation of web development. Students learned how to structure web pages using HTML tags and elements. They study basic structure of an HTML page, character style, indentation and text alignment, headlines or headings, paragraphs, lists, separation lines, links, images, maps, tables, frames, and forms. The focus of the course was on creating semantically correct HTML code that is accessible to all users.

The second part of the program is CSS, which stands for Cascading Style Sheets. This course focuses on the design and layout of web pages using CSS. Students learn how to use CSS to create responsive and visually appealing web pages. The course covers topics such as selectors, properties, and values, as well as responsive design techniques (selectors, syntax, units, box model (margins, padding, borders), visual format model, visual format model details, visual effects, generated content, automatic numbering and lists, colors and background, fonts, text, tables and user interface).

The third and last part of the program is JavaScript, which is the programming language used to create dynamic and interactive web pages. In this course, students learn how to use JavaScript to create animations, form validation, and other interactive features (syntax, data types, operators, conditional statements, loops, functions, arrays, events, DOM manipulation, local storage and debugging). The course uses the WA technique, which involves adding

Table 1 Subject distribution per week and lesson

Month	September			October					November				December			January			
Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Lesson	HTML					CSS							JavaScript						

new functionality to existing web pages without changing their original code. Table 1 shows the distribution of the subject every week.

One challenge that the program may face is low student motivation and lack of effort. Students who do not work may struggle to keep up with the pace of the program and may not fully understand the concepts taught. To address this issue, it is essential to create a learning environment that fosters motivation and engagement.

In the field of web development, HTML and CSS are considered the building blocks of a web page. They provide the foundation for web design and layout. For this reason, HTML and CSS are often taught in a traditional way, with an emphasis on syntax and structure. However, the same approach is not always effective when teaching JavaScript. Because JavaScript is a programming language, it requires a more interactive and dynamic approach to learning. That is why, in the WE program, JavaScript concepts have been explained using WA techniques.

WA is a technique that involves adding new content, style and functionality to an existing web page without changing its original code [2]. This approach is different from traditional web development, where developers would create a new web page from scratch to add new features or functionality. With WA, the focus is on enhancing the user experience by providing new and interactive elements on the page.

The use of WA techniques in teaching JavaScript provides several advantages. Firstly, it allows students to experiment with JavaScript in a practical context. Students can work on existing web pages and see the results of their work in real-time. This approach makes it easier for students to see the impact of their work and understand how JavaScript can be used to create interactive web pages.

Secondly, WA techniques make learning more engaging and interactive. Students can work on a project where they can apply the concepts they have learned in class. This project creates a sense of ownership and responsibility for their learning, which can motivate them to work harder and achieve better results. Also, the project provides an opportunity for students to practice collaboration and teamwork, which are important skills for web development professionals.

Finally, WA techniques help bridge the gap between theory and practice. Many students may find it challenging to apply the concepts they have learned in class to real-world scenarios. By using WA, students can work on existing web pages and see how the concepts they have learned can be applied in practice. This approach can help students develop a deeper understanding of JavaScript concepts and prepare them for real-world web development projects.

At the end of the WE course, students are expected to develop a project that creates a WA tool. The project provides an opportunity for students to demonstrate their knowledge and skills in WA and JavaScript. The project consists of developing a Chrome browser extension in groups of 3–4 students that adds new functionality, removes content and changes CSS to an existing web page that they created with HTML and CSS at the end of the second semester.

The project should demonstrate the student's ability to use JavaScript to add new functionality to a web page. The project should also demonstrate the student's ability to work collaboratively and communicate effectively with others. The project should be well-documented, easy to use, and free from errors and bugs.

The students demonstrated a diverse range of skills and expertise in their projects, showcasing their ability to employ various WA techniques. First and foremost, they excelled in accessibility enhancement, implementing features like adaptable font sizes, and adaptable color text and background to ensure web content is more accessible to users with disabilities. Additionally, they harnessed the power of personalization by developing systems that tailor website content based on individual user preferences, providing a more customized browsing experience. Moreover, their prowess in data extraction and scraping was evident as they efficiently collected and organized data from websites for analysis and adapt information. In terms of content augmentation, the students enhanced web content with multimedia elements, such as images and videos, creating more engaging and informative web experiences. They also focused on user experience improvement, reducing intrusive elements. Lastly, they skillfully integrated social media features, enabling social sharing and interaction, which fosters greater user engagement and community-building. Collectively, these students showcased their proficiency in utilizing these WA techniques to enhance web accessibility, usability, and user satisfaction.

The project about WA was successful due to various reasons. Firstly, the students were able to apply the theoretical concepts of JavaScript that

they learned during the course to practical use. They were able to use their creativity and programming skills to develop a useful tool that can enhance the web browsing experience for users.

Secondly, the project allowed the students to work in groups, fostering teamwork and collaboration skills. The project required brainstorming, planning, designing, and coding, which were done in teams. The group discussions and exchange of ideas helped in the development of the tool and made the project more engaging.

Thirdly, the project provided an opportunity for the students to showcase their learning. The WA tool developed by the students was not only useful but also innovative. It demonstrated the potential of JavaScript and the importance of WA in enhancing the web browsing experience.

Overall, the success of the project was evident from the satisfaction of the students and the positive feedback from their peers and instructors. The project allowed the students to apply their skills, learn new concepts, and work collaboratively. It also gave them a sense of achievement and motivation to continue exploring and developing their programming skills. To measure this evidence, a questionnaire was provided to students, which will be shown in Section 4.

4 Results

The participants in this study were predominantly young, with ages ranging from 18 to 20. The gender distribution among the participants showed that 4 out of 22 were female, indicating a slight gender imbalance. In terms of programming knowledge, the majority of the participants had very basic programming knowledge, which was a key consideration for designing the pedagogic strategy. The study drew students from Arrasate-Mondragon and nearby towns, providing a regional context for the sample. Notably, 17 out of 22 participants reported having at least one browser extension installed, underlining their familiarity with browser extensions, a relevant factor for the study's focus on teaching WA techniques. This demographic information is critical for understanding the characteristics of the participants and how they may have influenced the study's outcomes.

The Students' Motivation Towards Science Learning (SMTSL) is a tool commonly used to evaluate students' motivation and learning strategies in a science subject [21]. In the context of a WE subject, the SMTSL can provide valuable insights into students' motivation and strategies for learning about

web development and design. The questionnaire has been adapted to WE, like other researchers have adapted the questionnaire to their topics [9, 16, 19].

The SMTSL typically includes questions that assess students' motivation for learning, their use of various learning strategies, and their perceptions of the learning environment. Some of the specific dimensions assessed in the SMTSL include active learning strategies, performance goals, achievement goal and self-efficacy.

An evaluation using the SMTSL in a WE subject might yield several key results. For example, it might reveal that students in the course are highly motivated to learn about web development and design, perhaps due to the increasing importance of these skills in the workforce. This could be reflected in high scores on the SMTSL questionnaire.

The evaluation might also reveal that students are using a variety of learning strategies to master the material in the course. Some students might rely heavily on cognitive strategies, such as elaboration and organization, to better understand the technical aspects of web development. Others might focus more on metacognitive strategies, such as self-monitoring and self-reflection, to track their progress and adjust their learning approach as needed.

In addition, the SMTSL might reveal that students in the WE subject have high self-efficacy for learning about web development and design. This could be a result of the practical, hands-on nature of the subject matter, which may give students a greater sense of control and confidence in their ability to master the material.

Overall, an evaluation using the SMTSL in a WE subject can provide valuable insights into students' motivation, learning strategies, and perceptions of the learning environment. This information can be used to identify areas where students may need additional support or resources, as well as to inform the design of future courses and instructional materials. By using tools like the SMTSL to better understand students' motivations and learning strategies, educators can help to create a more effective and engaging learning experience for all students. Furthermore, the questionnaire evaluates students' perception of using the WA technique.

This questionnaire was carried out at the end of the course, on the last day of class and the day before taking the final exam, anonymously. All students answered the questionnaire. The objective was that the students would not bias their opinion regarding the results of the exam. The questionnaire was presented in Google Forms format, and the students had all the time they needed to complete it.

4.1 RQ1: What are the Key Motivating Factors of Using WA Perceived by Students as Triggers for Their Engagement in Learning WE Concepts?

Measuring motivation in WE students after using WA is crucial for assessing the impact of the teaching approach, identifying at-risk students, and informing future research. It can also help us determine whether WA can be an effective tool for improving students' motivation and engagement in WE courses.

Cronbach's alpha describes the extent to which all items in a test measure the same concept, and is therefore related to the inter-relatedness of the items within the test [20]. In our case, Cronbach's alpha value is 0.91 for the results of Tables 2, 3, 4, 5, 6 and 7. A value of 0.9 or higher indicates an excellent result [20].

We will now measure the results of the SMTSL questionnaire for each of its domains: self-efficacy, active learning strategies, science learning value, performance goal, achievement goal and learning environment stimulation.

4.1.1 Self-efficacy

Self-efficacy refers to the belief that students have in their ability to perform well in WE learning tasks. This includes their confidence in their own skills and knowledge.

Table 2 Results of the Students' Motivation Towards Science Learning, self-efficacy (strongly disagree, SD; disagree, D; neither agree nor disagree, N; agree, A; strongly agree, SA)

	Frequencies					
Questions	SD	D	N	A	SA	p-value
Q1: Whether web engineering is difficult or easy, I am sure that I can understand it.	0	3	7	10	2	0.44
Q2: I am not confident about understanding difficult web engineering concepts.	0	4	6	8	4	0.06
Q3: I am sure that I can do well on web engineering tests.	0	0	3	7	12	0.08
Q4: No matter how much effort I put in, I cannot learn web engineering.	2	4	4	6	6	0.27
Q5: When web engineering activities are too difficult, I give up or only do the easy parts.	0	3	7	6	6	0.27
Q6: During web engineering activities, I prefer to ask other people for the answer rather than think for myself.	0	3	7	6	6	0.6
Q7: When I find the web engineering content difficult, I do not try to learn it.	3	5	5	5	4	0.16

Looking at the results of Table 2, we can see that the majority of participants (between 60% and 80%) responded positively to questions Q1, Q2, Q3, Q5, and Q6, indicating that they have a positive attitude towards their ability to understand and perform well in WE tasks. However, a substantial minority (between 20% and 40%) responded negatively to these questions, indicating that they have some doubts or difficulties in understanding and performing well in this field.

Question Q4 received a more evenly distributed response, with no strong agreement or disagreement across the sample. This suggests that the majority of participants do not believe that learning WE is impossible, but some may encounter difficulties that require more effort or different approaches.

Question Q7 received a mixed response, with roughly half of the participants indicating that they lack confidence in understanding difficult WE concepts, while the other half responded positively. This suggests that some participants might perceive WE as challenging and require more support or resources to improve their understanding of complex concepts.

In terms of the p-values, no questions have values below the significance level of 0.05, indicating that there might not be a significant difference in responses between participants for these questions. However, Q2 and Q3 have been close to the limit.

Overall, the results suggest that while the majority of participants have a positive attitude towards WE through WA, some may require additional support or resources to improve their confidence and understanding of complex concepts. It might be beneficial to identify the specific areas that participants find challenging and provide targeted interventions or resources to help them overcome these difficulties.

4.1.2 Active learning strategies

Active learning strategies refer to the various strategies that students use to construct new knowledge based on their previous understanding. This can include methods such as experimenting, analyzing data, and working collaboratively with others.

Looking at the results (see Table 3), we can observe that the majority of participants (between 50% and 70%) responded positively to questions Q8, Q9, Q10, Q11, Q12, Q13, Q14, and Q15. This indicates that they engage in active learning strategies, such as attempting to understand new concepts, connecting them to previous experiences, seeking relevant resources for clarification, discussing with lecturers or students, making connections between learned concepts, investigating their mistakes, and trying to learn concepts

Table 3 Results of the Students' Motivation Towards Science Learning, active learning strategies (strongly disagree, SD; disagree, D; neither agree nor disagree, N; agree, A; strongly agree, SA)

	Frequencies					
Questions	SD	D	N	A	SA	p-value
Q8: When learning new web engineering concepts, I attempt to understand them.	0	4	6	8	4	0.3
Q9: When learning new web engineering concepts, I connect them to my previous experiences.	0	0	9	11	2	0.06
Q10: When I do not understand a web engineering concept, I find relevant resources that will help me.	0	0	5	12	5	0.07
Q11: When I do not understand a web engineering concept, I would discuss with the lecturer or other students to clarify my understanding.	0	3	5	11	3	0.14
Q12: During the learning processes, I attempt to make connections between the concepts that I learn.	1	3	9	6	3	0.13
Q13: When I make a mistake, I try to find out why.	0	2	6	12	2	0.09
Q14: When I meet web engineering concepts that I do not understand, I still try to learn them.	0	5	8	7	2	0.07
Q15: When new web engineering concepts that I have learned conflict with my previous understanding, I try to understand why.	0	0	7	13	2	0.26

even when they are difficult to understand. These results suggest a generally proactive and motivated approach to learning WE.

However, a minority of participants (between 0% and 30%) responded negatively to some of these questions, indicating that they may not consistently engage in these active learning behaviors. It is important to note that these percentages vary across the questions, indicating that participants' attitudes and behaviors may differ depending on the specific aspect of learning to be addressed.

In terms of the p-values, only questions Q9, Q10, Q13, and Q14 had values close to the significance level of 0.05. This suggests that there might be significant differences in responses among participants for these questions.

Overall, the results indicate that the majority of participants demonstrate positive attitudes and behaviors when learning new WE concepts with WA. However, there is a portion of participants who may not consistently engage in these active learning strategies. It may be beneficial to provide additional support, resources, or guidance to help all participants develop and reinforce effective learning approaches. Additionally, addressing the specific areas where participants struggle, as identified by the questions with significant differences, can help tailor interventions to their needs.

Table 4 Results of the Students' Motivation Towards Science Learning, web engineering learning value (strongly disagree, SD; disagree, D; neither agree nor disagree, N; agree, A; strongly agree, SA)

	Frequencies					
Questions	SD	D	N	A	SA	p-value
Q16: I think that learning web engineering is important because I can use it in my daily life.	0	1	9	9	3	0.31
Q17: I think that learning web engineering is important because it stimulates my thinking.	0	3	4	10	5	0.43
Q18: In web engineering, I think that it is important to learn to solve problems.	0	2	3	14	3	0.17
Q19: In web engineering, I think it is important to participate in inquiry activities.	0	2	6	13	1	0.42
Q20: It is important to have the opportunity to satisfy my own curiosity when learning web engineering.	0	2	8	10	2	0.22

4.1.3 Web engineering learning value

WE learning value relates to the importance of WE learning for students. It helps them acquire problem-solving skills, experience inquiry-based learning, stimulate their own thinking, and understand the relevance of WE in their job.

Examining the results of Table 4, we observe that the majority of participants (ranging from 50% to 75%) responded positively to questions Q16, Q17, Q18, Q19, and Q20, indicating that they perceive learning WE as important. Participants generally agreed that learning WE is essential because it can be applied in their daily work lives (Q16), stimulates their thinking (Q17), emphasizes problem-solving skills (Q18), involves participation in inquiry activities (Q19), and allows the opportunity to satisfy personal curiosity (Q20).

However, a smaller proportion of participants (around 5% to 15%) responded negatively to some of these questions, suggesting that they may not fully recognize the significance of learning WE in these aspects.

Regarding the p-values, none of the questions had values below the significance level of 0.05, indicating that there were no statistically significant differences in responses among participants for these questions. This implies that the perceptions of the participants regarding the importance of learning WE in these specific areas were relatively consistent.

In summary, the results suggest that a majority of participants acknowledge the importance of learning WE in their daily lives, as a cognitive stimulant, for problem-solving skills, participation in inquiry activities, and satisfying personal curiosity. However, a subset of participants expressed

a less positive attitude towards these aspects. It may be beneficial to further explore the reasons behind these varying perceptions and address any concerns or misconceptions that participants may have. Additionally, emphasizing the practical applications and benefits of WE with WA in various contexts can help foster a stronger appreciation for its importance among all participants.

4.1.4 Performance goal

A performance goal is the motivation that drives students to compete with others and seek attention from lecturers in WE learning. This may include a desire to outperform their peers or gain recognition for their accomplishments.

Upon examining the results (see Table 5), we can observe that the majority of participants (ranging from 60% to 80%) responded positively to questions Q21, Q22, Q23, and Q24. This suggests that they primarily participate in the WE subject to obtain a good grade, outperform other students, impress others with their intelligence, or seek attention from the lecturer.

On the other hand, a smaller proportion of participants (around 10% to 15%) responded negatively to these questions, indicating that they may not have some degree of extrinsic motivation or external recognition as a factor influencing their participation in the WE subject.

Analyzing the p-values, none of the questions had values below the significance level of 0.05. This implies that there were no statistically significant differences in responses among participants for these questions. Therefore, the perceptions regarding motivations for participation in the WE subject using WA were relatively consistent among the participants.

Table 5 Results of the Students' Motivation Towards Science Learning, performance goal (strongly disagree, SD; disagree, D; neither agree nor disagree, N; agree, A; strongly agree, SA)

	Frequencies					
Questions	SD	D	N	A	SA	p-value
Q21: I participate in a web engineering subject to get a good grade.	0	2	4	14	2	0.19
Q22: I participate in a web engineering subject to perform better than other students.	1	2	6	11	2	0.19
Q23: I participate in a web engineering subject so that other students think that I'm smart.	0	2	3	16	1	0.42
Q24: I participate in a web engineering subject so that the lecturer pays attention to me.	0	3	3	14	2	0.31

In summary, the results suggest that the majority of participants participate in the WE subject primarily for obtaining good grades, outperforming others, impressing their peers with their intelligence, or seeking attention from the lecturer. This indicates a more intrinsic or genuine interest in the subject matter. However, a subset of participants may not have some extrinsic motivations. It is important to foster intrinsic motivation and emphasize the value of learning for its own sake rather than external rewards. Promoting a positive and supportive learning environment that focuses on personal growth, collaboration, and curiosity can help further engage students in the WE subject.

4.1.5 Achievement goal

An achievement goal is the sense of satisfaction that students experience as they increase their competence and achievement during WE learning. This may include feelings of pride and accomplishment as they learn and master new concepts.

Analyzing the results (see Table 6), we can observe that the majority of participants (ranging from 50% to 65%) responded positively to questions Q25, Q26, Q27, Q28, and Q29, indicating that they feel most fulfilled during a WE subject when they attain a good score in a test, feel confident about the subject's content, solve difficult problems, have their ideas accepted by the lecturer, and have their ideas accepted by other students. These results suggest that participants find fulfillment in both personal achievements and social validation within the WE subject.

Table 6 Results of the Students' Motivation Towards Science Learning, achievement goal (strongly disagree, SD; disagree, D; neither agree nor disagree, N; agree, A; strongly agree, SA)

	Frequencies					
Questions	SD	D	N	A	SA	p-value
Q25: During a web engineering subject, I feel most fulfilled when I attain a good score in a test.	1	1	8	9	3	0.43
Q26: I feel most fulfilled when I feel confident about the content in a web engineering subject.	0	3	5	12	2	0.31
Q27: During a web engineering subject, I feel most fulfilled when I am able to solve a difficult problem.	1	2	7	10	2	0.14
Q28: During a web engineering subject, I feel most fulfilled when the lecturer accepts my ideas.	0	0	9	10	3	0.13
Q29: During a web engineering subject, I feel most fulfilled when other students accept my ideas.	0	3	8	9	2	0.43

However, a smaller proportion of participants (around 0% to 15%) responded negatively to some of these questions, suggesting that they may not experience the same level of fulfillment in these aspects.

In terms of the p-values, there are no statistically significant differences in responses.

In summary, the results indicate that the majority of participants experience feelings of fulfillment during a WE subject using WA when they achieve good scores, feel confident, solve difficult problems, have their ideas accepted by the lecturer, and have their ideas accepted by other students. However, a subset of participants may not share the same level of fulfillment in these areas. It is important to consider and support both personal achievements and social interactions to foster a sense of fulfillment and engagement within the WE subject. Additionally, providing opportunities for collaboration, constructive feedback, and recognition can contribute to a positive learning environment where all participants can experience fulfillment in their learning journey.

4.1.6 Learning environment stimulation

Learning environment stimulation refers to the various factors that contribute to the learning environment for students, such as the curriculum, teaching style of instructors, and interactions with peers. These factors can greatly impact students' motivation and engagement in WE learning.

Examining the results of Table 7, we can observe that the majority of participants (ranging from 45% to 75%) responded positively to questions Q30, Q31, Q32, Q33, Q34, and Q35, indicating that they are willing to participate in the WE subject because they find the content exciting and changeable, the lecturer uses a variety of teaching methods, the lecturer does not put a lot of pressure on them, the lecturer pays attention to them, the subject is challenging, and the students are involved in discussions. These results suggest that participants are motivated and engaged by various factors such as the subject's content, teaching methods, lecturer–student interactions, and challenging nature of the subject.

However, a smaller proportion of participants (around 5% to 20%) responded negatively to some of these questions, indicating that they may not share the same level of willingness to participate in these aspects.

Regarding the p-values, questions Q30, Q31, Q32, Q33, and Q35 had values above the significance level of 0.05, indicating no statistically significant differences in responses among participants.

Table 7 Results of the Students' Motivation Towards Science Learning, learning environment stimulation (strongly disagree, SD; disagree, D; neither agree nor disagree, N; agree, A; strongly agree, SA)

	Frequencies					
Questions	SD	D	N	A	SA	p-value
Q30: I am willing to participate in this web engineering subject because the content is exciting and changeable.	0	4	8	6	4	0.43
Q31: I am willing to participate in this web engineering subject because the lecturer uses a variety of teaching methods.	0	2	9	9	2	0.43
Q32: I am willing to participate in this web engineering subject because the lecturer does not put a lot of pressure on me.	0	4	6	8	4	0.07
Q33: I am willing to participate in this web engineering subject because the lecturer pays attention to me.	0	1	4	12	5	0.18
Q34: I am willing to participate in this web engineering subject because it is challenging.	2	0	6	9	5	0.27
Q35: I am willing to participate in this web engineering subject because the students are involved in discussions.	0	3	4	12	3	0.25

In summary, the results indicate that the majority of participants are willing to participate in the WE subject using WA due to factors such as exciting and changeable content, diverse teaching methods, low pressure from the lecturer, lecturer's attention, challenging nature of the subject, and active student discussions. However, a subset of participants may not share the same level of willingness in these aspects. It is important to leverage these motivational factors and create a dynamic and engaging learning environment that incorporates a variety of teaching methods, promotes student–lecturer interactions, fosters challenging tasks, and encourages active student participation through discussions. Additionally, addressing any concerns or barriers to participation expressed by the minority of participants can help enhance their engagement and willingness to participate.

4.1.7 SMTSL questionnaire domains overview

Analyzing the results of the SMTSL questionnaire for each of its domains (see Figure 1), it is noticeable that for self-efficacy, the majority of respondents tend to agree or strongly agree. This suggests that respondents generally have a high level of confidence in their ability to accomplish tasks or meet

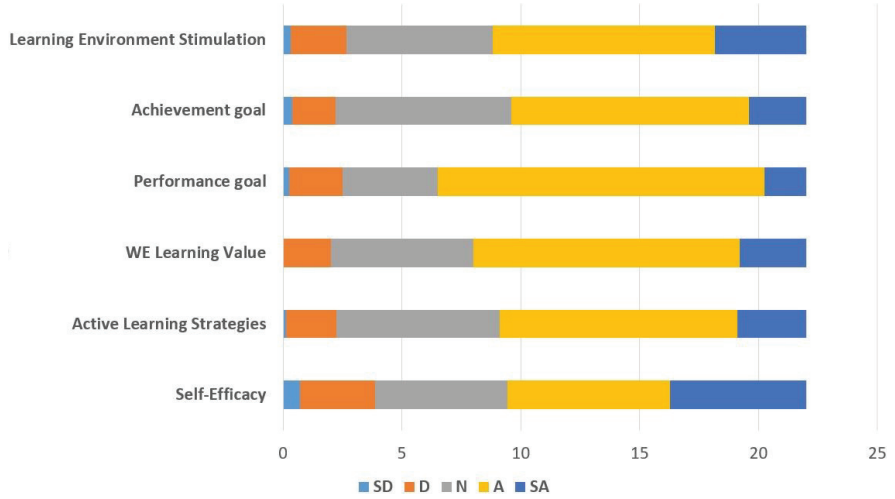

Figure 1 Results of the SMTSL questionnaire (strongly disagree, SD; disagree, D; neither agree nor disagree, N; agree, A; strongly agree, SA).

their goals. Most respondents fall within the range of neutral to agree for active learning strategies. This might be considered moderately important by the respondents. The data for WE learning value shows that the majority of respondents fall within the range of agree to strongly agree. This suggests that respondents highly prioritize WE learning, underscoring its significance in the context where students emphasize the importance of WE learning. For performance goal, respondents are spread across disagree to strongly agree. It seems that opinions on the importance of performance goals vary among the respondents. Achievement goals are generally rated between neutral and strongly agree. Respondents tend to agree with the importance of achievement goals, but not as strongly as some other constructs. Finally, the majority of respondents seem to agree or strongly agree with the importance of a stimulating learning environment. This suggests that respondents value a learning environment that is engaging and motivating.

4.2 RQ2: How do Students Value the Use of WA in the WE Course?

This research endeavors to contribute to the existing body of knowledge by shedding light on how students perceive and value the use of WA in the WE course. By exploring students' perspectives, this study aims to provide

valuable insights that can inform educational practices and promote the integration of innovative technologies in WE education, ultimately enriching students' learning experiences and preparing them for the dynamic and evolving field of WE.

Examining the results of Table 8, we can observe the following patterns. In addition, the Cronbach alpha value for Table 8 is 0.95. Values above 0.9 are considered an excellent result [20].

- Familiarity and importance: participants expressed their familiarity with the concept of WA (Q1), with a significant portion (around 75%) feeling they agreed. Furthermore, participants recognized the importance of WA in the field of WE (Q2), with a majority (over 85%) indicating agreement or strong agreement.
- Technical aspects and comfort level: participants found the technical aspects of WA easy to understand (Q3), with the majority (over 95%) indicating agreement or strong agreement. Most participants felt comfortable using WA techniques in their web development projects (Q4), with around 90% indicating agreement or strong agreement.
- Confidence and motivation: participants expressed moderate confidence in their ability to implement WA techniques correctly (Q5), with the majority agreeing. Additionally, participants believed that WA could enhance their learning experience (Q6) and motivate them to learn WE (Q8), with around 80–85% indicating agreement or strong agreement.
- Learning and application: participants believed that WA could help them understand complex WE concepts (Q7), learn at their own pace (Q9), and practice what they've learned (Q10), with a majority indicating agreement or strong agreement.
- Future use and effectiveness: participants showed interest in learning more about WA techniques (Q11) and expressed willingness to use them in future web development projects (Q12), with over 75–80% indicating agreement or strong agreement. Participants believed that WA techniques could improve the user experience of web applications (Q13) and their own problem-solving abilities (Q17), with a majority indicating agreement or strong agreement (65–70%). Moreover, participants claim that WA can help them overcome any learning barriers or challenges they may face in WE (over 90%).
- Confidence and value: participants expressed excellent levels of confidence in evaluating the effectiveness of WA techniques (Q14) and their own ability to apply them in real-world projects (Q15), with a significant

Table 8 Results of the web augmentation survey (strongly disagree, SD; disagree, D; neither agree nor disagree, N; agree, A; strongly agree, SA)

	Frequencies					
Questions	SD	D	N	A	SA	p-value
Q1: How familiar are you with the concept of web augmentation in the web engineering subject?	1	2	2	11	6	0.14
Q2: How important do you believe web augmentation is in the field of web engineering?	0	1	2	11	8	0.12
Q3: How easy is it for you to understand the technical aspects of web augmentation in the web engineering subject?	0	1	0	9	12	0.14
Q4: How comfortable are you with using web augmentation techniques in your web development projects?	0	0	2	13	7	0.26
Q5: How confident are you in your ability to implement web augmentation techniques correctly?	1	3	4	8	6	0,15
Q6: I believe that web augmentation can enhance my learning experience in web engineering.	2	0	1	11	8	0.44
Q7: I think that web augmentation can help me better understand complex web engineering concepts.	0	2	4	8	8	0.26
Q8: I feel more motivated to learn web engineering when using web augmentation techniques.	0	1	3	9	9	0.06
Q9: I believe that web augmentation can help me learn web engineering at my own pace.	1	3	5	6	7	0.27
Q10: I find web augmentation to be a helpful tool for practicing and applying what I've learned in web engineering.	0	0	1	14	7	0.1
Q11: How interested are you in learning more about web augmentation techniques in the web engineering subject?	1	3	1	9	8	0.44
Q12: How likely are you to use web augmentation techniques in your future web development projects?	1	0	3	13	5	0.31
Q13: How effective do you believe web augmentation techniques are in improving the user experience of web applications?	1	1	3	13	4	0.37
Q14: How confident are you in your ability to evaluate the effectiveness of web augmentation techniques?	1	1	4	13	3	0.06

portion of agreement (around 75%). Participants felt more confident in their WE skills when using WA techniques (Q18), with around 70% indicating agreement or strong agreement. In addition, participants generally believed that WA should be taught as a mandatory part of WE

Questions	Frequencies					p-value
	SD	D	N	A	SA	
Q15: I believe that web augmentation can help me prepare for real-world web engineering projects.	0	1	5	5	11	0.18
Q16: I think that web augmentation can help me overcome any learning barriers or challenges I may face in web engineering.	0	0	2	14	6	0.14
Q17: I believe that web augmentation can help me become a better problem-solver in web engineering.	0	3	3	9	7	0.36
Q18: I feel more confident in my web engineering skills when using web augmentation techniques.	0	0	5	12	5	0.32
Q19: I think web augmentation should be taught as a mandatory part of web engineering subjects.	2	1	2	10	7	0.15
Q20: Overall, I think that web augmentation is a valuable technique for learning web engineering	0	3	3	10	6	0.12

subjects (Q19) and considered it a valuable technique for learning WE (Q20), with over 70% indicating agreement or strong agreement.

Analyzing the p-values, all the questions have values above the significance level of 0.05, indicating no statistically significant differences in responses among participants.

In summary, the results indicate that participants generally recognize the importance of WA in the field of WE and find it relatively easy to understand. They express moderate confidence in their ability to implement these techniques and believe that WA can enhance their learning experience, improve understanding, and help them overcome challenges in WE. Participants also show interest in further exploring and utilizing WA techniques in their future projects. Moreover, there is no variation in confidence levels and perceptions of value among participants.

To promote the effective integration of WA in the WE subject, it is essential to address participants' varying levels of familiarity, provide clear explanations of technical aspects, and offer opportunities for hands-on practice. Moreover, enhancing participants' confidence in evaluating the effectiveness of WA techniques can be beneficial. The results also suggest considering the inclusion of WA as a mandatory part of WE subjects, while highlighting its value and benefits. By addressing these aspects, educators can create a supportive and engaging learning environment that maximizes participants' learning outcomes and motivation in the field of WE.

5 Discussion

The findings of this study shed light on the use of WA in the WE subject and its impact on student motivation and perception. The results indicate that the implementation of WA techniques has effectively motivated students in their learning journey.

One notable aspect is that students have expressed a strong preference for WA as a learning tool. The incorporation of augmented content, customized layouts, and interactive features has enhanced their engagement and overall learning experience. This positive response suggests that WA has the potential to create a more interactive and student-centered learning environment in WE education.

However, it is important to note that there is a gap in the related work when it comes to the use of WA specifically in education. While WA has been explored in various domains, such as mobility or entertainment, its application and impact on educational settings are relatively unexplored. This study fills this gap by focusing on the use of WA in the context of WE education.

One limitation of this study is that the questionnaire was administered after the students' experience with WA. While it provides valuable insights into their motivation and perception post-experience, it would have been beneficial to gather data on their motivation towards the subject before the introduction of WA. This would have allowed for a more comprehensive understanding of how WA influenced their motivation over time.

Additionally, it is worth considering that the questionnaire answers might have been influenced by the timing of the assessment. Asking students about their motivation before an exam, compared to after, could yield different responses. The exam-related stress or success could potentially influence their perceptions and motivations. Future studies could address this by conducting pre- and post-experience assessments to capture any potential variations in motivation and perception.

Another important aspect is the use of anonymous questionnaires to collect student responses. While anonymity is crucial for encouraging candid feedback, it may inadvertently introduce inconvenience for some students. Anonymity can lead to students feeling more comfortable providing feedback on general aspects, but may deter them from raising specific concerns or asking for clarifications. Some students might prefer direct interaction or non-anonymous avenues to address their questions or to seek further guidance. Moreover, anonymous questionnaires may sometimes result in vague

or concise responses. Students may hesitate to elaborate on their thoughts, leading to limited insights into their experiences. To address these concerns, we encouraged students to participate voluntarily and made it clear that non-anonymous channels were available for them to seek clarification or express specific concerns if they considered this was necessary.

Despite these limitations, the results of this study provide valuable insights into the use of WA in WE education. The positive student response and increased motivation suggest that WA has the potential to be an effective pedagogical tool. Further research should focus on expanding the scope of this study, exploring different educational contexts, and investigating the long-term impact of WA on students' motivation, learning outcomes, and skill development.

6 Conclusions and Future Work

This article discusses the use of WA as a technique to enhance the learning experience in WE courses. The authors present their experience of using WA in a WE subject for vocational training students, and measure the reception of this experience.

The article highlights the potential benefits of WA in enhancing the user experience and making web content more accessible and personalized for different user needs and preferences.

The results of the study show that participants were motivated and engaged by various factors such as the subject's content, teaching methods, lecturer–student interactions, and challenging nature of the subject. The majority of participants responded positively to questions, indicating that they are willing to participate in a WE course using WA because they find the content exciting and changeable. Furthermore, the lecturer uses a variety of teaching methods, does not put a lot of pressure on them, pays attention to them, and involves them in discussions.

Overall, this article provides valuable insights into how WA can be used to enhance learning experiences in WE courses. It also highlights important considerations around motivation when learning WE using WA techniques.

In the future, the aim is to use WA in the subject of WE in the computer science degree. These students have more programming knowledge and more skills to develop more advanced WA tools. Mondragon University has carried out a project based learning project in every degree and course for years [3]. This period would be adequate to develop advanced WA tools. Moreover, the inclusion of WA to enhance accessibility and inclusive design

in the human–machine interface subject would be fantastic. Exploring how WA techniques can be used to accommodate students with disabilities and providing alternative formats, sensory enhancements, or assistive features would be excellent.

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Biography

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