

Research Article

Assessment of Knowledge, Attitude and Practice in Web Programming using PHP among BSIT Students in Bicol University

Jayvee Christopher N. Vibar

Bicol University, Legazpi City, Philippines

Correspondence should be addressed to *Corresponding Author: jcnvibar@bicol-u.edu.ph

ABSTRACT

PHP: Hypertext Preprocessor (PHP) is one of the top server-side scripting languages used worldwide; taking 78.3% of the server-side programming language. It has become the de-facto for web programming not just in the Philippines but around the globe. Programming skills are vital to academics and professionals. It empowers the ability to analyze, manipulate, create and support this digital landscape as a way of solving complex problems. This quantitative research investigates the competencies of the Bicol University College of Science, Bachelor of Science in Information Technology (BSIT) in terms of their self-assessed familiarity with PHP of fifty-one (51) BSIT students. The researcher made use of Likert scale in Student's Demographic, Attitude towards Web Programming and Practice in Web Programming to measure the PHP Programming familiarity of the students. Analyzed data revealed an average level of familiarity of 3.16 indicating moderate competency in PHP programming. Gender distribution was balanced with 27 male and 24 female respondents and an average level of programming attitude of 2.75 indicating a fair level of time devoted to PHP practices. Additionally, 43 out of 44 students reported experience in developing PHP applications. Confidence was highest for locally hosted environments but declined for cloud-hosted applications. There is a high-level of hands-on experience in terms of building PHP projects which shows that majority of the students have created web applications. Further, this highlights potential curriculum gaps in hands-on PHP projects and advanced programming topics and recommends the need for curriculum enhancement and exposure to cloud-hosted applications to better equip students with the necessary skills for real-world web development challenges.

Keywords: Web Programming; Programming Attitude; Programming Practice; PHP Hypertext Preprocessor Skills; Philippines.

1. INTRODUCTION

Great software products have emerged in today's digital age. Similarly, technology has propelled the proliferation of state-of-the-art software applications that connect people and also have become the driving factor for many computing devices around the world. PHP: Hypertext Preprocessor (PHP) is one of the top server-side scripting languages used worldwide; taking 78.3% of the server-side programming language (Ludo Fourrage, 2024). It has become the de-facto for web programming not just in the Philippines but around the globe. As programming skills are vital to academics and professionals, it has large and active community of web developers (Lincopinis et al., 2023) and has an excellent cross-platform compatibility for various computing platform capable of Model View Controller (MVC) design pattern (Zhuang, 2024). It empowers the ability to analyze, manipulate, create and support this digital landscape as a way of solving complex problems. Moreover, it promotes ease in developing web projects that promotes Rapid Application Development (RAD) as the development framework especially for Linux Apache Mysql and PHP (LAMP) (Costea, 2008).

The Knowledge, Attitude, and Practice (KAP) Framework is a fundamental tool that has played a significant role in understanding and influencing human behavior in a wide range of fields particularly in the fields of public health (Zarei et al., 2024) however, Artificial Intelligence (AI) a branch of computer science suggests that in the medical field AI has to be integrated within the curriculum of the students (Al-Qerem et al., 2023). Furthermore, knowledge in programming is composed of the following steps: (1) acquisition of knowledge. (2) learning of design skills. and (3) development of problem-solving skills (McGill & Volet, 1997) Likewise, in this paper, KAP is applied as the framework for assessing students' familiarity in PHP programming which is akin to the knowledge, behavior and attitudes assessment which promote programming engagement and has a positive impact in

computer knowledge (Sun et al., 2021) (Levine & Donitsa-Schmidt, 1998). Moreover, it provides structured approach for investigating the determinants of behavior change and for designing targeted interventions (Imam et al., 2023).

The significance of this study uncovers the level of programming skills among students and other programming aspects such as debugging, tracing, problem comprehension and ultimately the thinking process of solving a particular problem. As application of programming skill is geared toward students' future career, the study can be an eye opener to those aspiring web programming enthusiasts (Ramiro Z. Dela Cruz, 2020). Additionally, it could contribute to an effective way of teaching and enhancing learning methodologies in information technology. It is worth nothing that (McCracken et al., 2001) assessed the programming skills of first-year computer science students at four universities in the United States, Canada, and Europe. It suggested that to improve and develop the programming skills of the students, educators should use more authentic programming tasks, provide more scaffolding and support for students during the programming task, and use a variety of assessment methods. Indeed, computer programming is complicated and brings challenging tasks to students (Kadar et al., 2021). In addition, a proposed theory of instruction for introductory programming skills that is based on four distinct skills that novices learn incrementally: tracing, writing syntax, comprehending templates, and writing code with templates (Benjamin Xie, 2019). While it explored the use of concept maps as an assessment tool for teaching computer programming, and for assessing students' understanding of computer programming concepts (Keppens & Hay, 2008). However, it is difficult to develop a scoring rubric that accurately measures the quality of a concept map, and can be time-consuming for students to create. Although there are limitations, still the authors argued that concept maps can provide a holistic view of students' understanding of computer programming concepts, and they can be used to identify areas where students need additional support.

This paper models a systematic approach to investigate and assess the programming proficiencies of Bicol University (BU) students, particularly Bachelor of Science in Information Technology (BSIT). By conducting a systematic approach to analyze the level of programming skills that underpins the KAP framework, the results of the research project will elaborate in detail the intricacies of teaching programming that align the needs of aspiring students. Furthermore, the output of this research project could be used to bridge the gap between academic instruction and real-world application. Finally, this research establishes a model of delivering a new and tailored approach of educating the upcoming information technology students of BU. This quantitative research investigates the competencies of the students in terms of their self-assessed familiarity with PHP of fifty-one (51) BSIT students.

Based on the CHED Memorandum Order (CMO) No. 25 series of 2015 outlining guidelines and standards for various aspects of higher education, it provides a foundational framework for integrating programming education into higher education curricula. This research study is significant in developing relevant and up-to-date curricula that meet the needs of industries and global competitiveness. By incorporating programming skills using the KAP framework, BU can design courses that not only impart technical knowledge but also focus on fostering positive attitudes towards programming and providing ample opportunities for practical application. Additionally, by integrating the KAP framework into programming education, BU can establish benchmarks for assessing the effectiveness of their programs in terms of knowledge acquisition, attitude development, and practical application of programming skills. This ensures that graduates are well-prepared to meet the demands of the workforce and contribute to global competitiveness.

Given these conditions, the study aims to address the following research question: What is the level of knowledge, attitude, and practice (KAP) of BSIT students at Bicol University regarding PHP programming? This research is expected to introduce insights that can bridge the gap between academic instruction and real-world application. Furthermore, contributing to a better understanding of how to enhance the programming education for future students not just in Bicol University but in other State Universities and Colleges (SUC) or in private colleges as well.

2. MATERIALS AND METHODS

This study used descriptive research design to examine the present state of programming familiarity, attitudes, and practices of the students in BSIT program about PHP programming; the goal is to describe them in terms of KAP. The methodology ensures that the research objectives are met in a systematic and rigorous process.

2.1. Research Design

A descriptive research design was used for this study to examine the current state of KAP of the BSIT students in the area of web programming. Descriptive research is appropriate for this study since it focuses on providing a detailed status of the participants in the familiarity with PHP programming, their attitude towards learning this environment and so with the practices involving PHP projects. In this approach, the researcher collects quantifiable information, information on students competencies

and behavior in specific area (Saunders et al., 2009) .

The KAP framework was used as a guiding model for understanding student behavior in programming. This model breaks down the research variable into three categories namely:

1. Knowledge – Understanding of the concepts and technical aspects of PHP programming.
2. Attitude – Students' perception, interest, and belief toward programming.
3. Practice – Extend in which the students actively engage in programming activities, such as debugging, coding, tracing, and using PHP in practical or real-world applications.

2.2. Sources of Data

The research focused on the BSIT students of Bicol University, located in Legazpi City, Philippines. The selection of participants was done using convenient sampling. This non-probability sampling method was used due to logistical considerations and the ease of access for the students. While it may introduce some selection bias, the research is still targeted to ensure that there is enough sample representing these broad set of students. Moreover, the sample size was calculated using a 95% confidence level and a margin of error of ± 9 . The calculation yielded a necessary sample size of 51, guaranteeing moderate statistical power. Although not exhaustive, this sample size gives the study to gather a significant amount of data for analyzing the trends in programming familiarity within the university.

2.3. Data Collection

A Likert scale-based questionnaire was used as the primary tool for collecting data from the students within the university. A meticulously designed survey questionnaire was created, including established scales and elements that are pertinent to the research aims. The scale comprises statements pertaining to various programming familiarity measures, such as how often do they practice. Participants were instructed to assess the frequency of each statement using a five-point Likert scale, where 1 represents “strongly disagree”, 2 represents “disagree”, 3 represents “neutral”, 4 represents “agree”, and 5 represents “strongly agree”. A pilot test was conducted on the survey instrument with a limited number of participants. The feedback obtained from the pilot study was utilized to enhance and complete the questionnaire.

The questionnaire that was covered are the following key areas:

- **Knowledge:** These are related to students' familiarity with PHP e.g. syntax, function usage, and common web development activities.
- **Attitude:** Questions related to students' confidence in programming, about their interest in pursuing web development career, and their perception of the usefulness of PHP in web development.
- **Practice:** It focuses on students' engagement in programming tasks, frequency of PHP-related exercises, and participation in practical or real-world development projects.

Furthermore, the participants were given explicit guidance regarding the study's objectives, the Likert scale response structure, and guarantees of privacy. The data collection period extends over one semester, ensuring an ample quantity of responses. Chosen individuals were contacted via email and on-campus distribution, and were extended an invitation to take part in the survey using paper questionnaire. Likewise, we acquired informed consent from every individual.

2.4. Data Analysis and Synthesis

After the data was collected, the responses were analyzed using descriptive statistics, to identify trends and patterns in students' knowledge, attitude, and practices in PHP programming. It includes the mean scores for each Likert-scale item, were computed to provide a summary of the student's familiarity and engagement with PHP programming.

2.5. Ethical Considerations

During the process of data collection, informed consent was obtained from the participants thus imposing ethical protocols in this research process. Additionally, due to the fact that the subject matter that is going to be researched includes private information from the students, all of the data that was acquired was handled with the highest confidentiality. The findings and outcomes of this research study were anonymized, and no associations of the respondents, such as their names. Thus, no information was provided about the respondents.

3. RESULTS AND DISCUSSIONS

3.1. Demographic Information of the Respondents

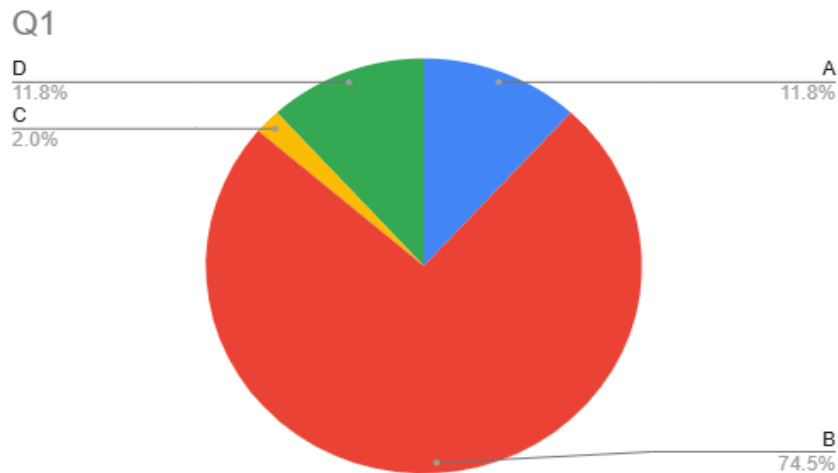
There were 27 male and 24 female respondents which indicate that the gender distribution was balanced. The age distribution was predominantly 21 to 23 years of age.

3.2. Knowledge towards Web Programming in PHP

3.2.1. Q1: Which of the following best describes the purpose of using prepared statements in PHP?

Firstly, the students' response revealed that there is a strong understanding of the primary use of prepared statements in PHP as shown in Figure 1. These can be seen that out of 51 respondents, 38 students (74.5%) have correctly identified Option B which is to "Prevent SQL injection and ensure secure database interactions" as the correct answer. This result indicates that the majority of them recognize the importance of secure coding practice, particularly when working with MySQL and PHP, that is when preventing vulnerabilities like SQL injection is involved. Secondly, 6 students (11.8%) selected Option A which is "To execute multiple SQL queries simultaneously" - is incorrect, they might have been confused with the role of prepared statements. Thirdly, 6 students (11.8%) chose Option D which is "To automatically generate SQL queries based on user input." Again, it can be said that there is a misunderstanding of the distinction between prepared statements and other forms of dynamic query. Finally, only 1 student (2%) chose Option C which is "To format the output of SQL queries for display in HTML" which indicate that most of the students did not confuse of the purpose of prepared statements with formatting tasks. This can be said that while there is a vast majority of students who demonstrated a solid understanding of the security advantage of prepared statements, there is a small portion of the respondents who exhibited some misunderstanding or misconception, suggesting further clarification in area of security in database and PHP.

Figure 1. Response to the purpose of using prepared statements in PHP.

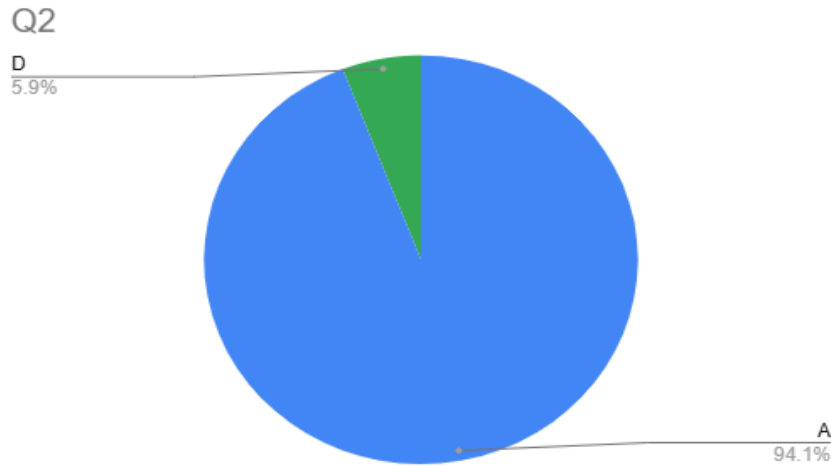


3.2.2. Q2: What does the `isset()` function in PHP do?

It can be seen in Figure 2 that the students' demonstrated a strong overall comprehension of the `isset()` function of PHP. Since, out of 51 respondents, there is an overwhelming 48 students (94.1%) that correctly choose Option A "Checks if a variable is initialized and not null.". This means that there is a high percentage that students have a solid understanding of the basic functionality of the `isset()` function, which is commonly used to check if the existence of a value in PHP script. There are however a small percentage of the respondents who chose incorrect answers. 3 students (5.9%) selected Option D which is "Validates if a variable contains a specific value.". Which is an indicator that there are some confusion `isset()` and other PHP functions like `in_array()` or direct conditional checks, that are used to validate value. None of them selected Option B "Verifies if a variable is a string," or Option C "Determines the size of an array" which shows that there is clarity among the students that `isset()` is not related to any of these operations. To summarize, the majority of students clearly understand the purpose of `isset()` PHP function,

with only a small number needing to review the function's role in checking variable initialization and null values. This shows a high level proficiency of the basic syntax and functionality of PHP among students.

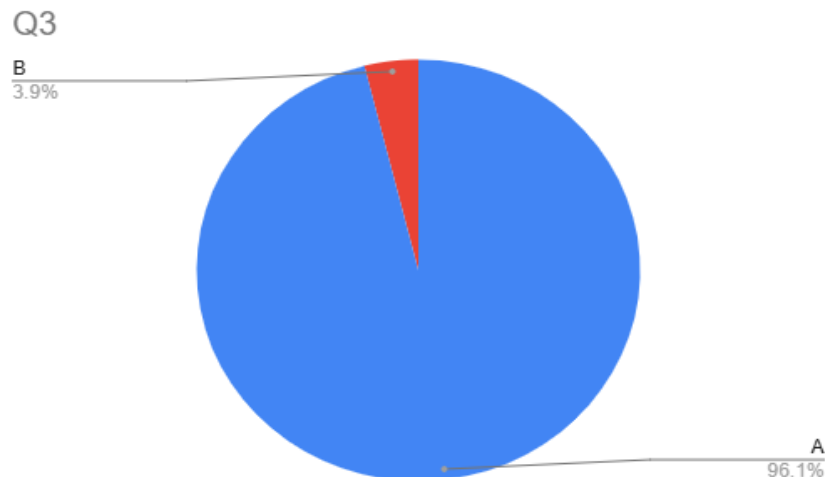
Figure 2. Response to the isset function in PHP.



3.2.3. Q3: Which of the following is the correct way to start a PHP session?

This question that falls under knowledge was shown in Figure 3. The responses shows that a high level of understanding among the students about how to correctly initiate a session in PHP. Of these 51 respondents, there are 49 students (96.1%) who correctly selected Option A – the correct way to start a PHP session using `session_start()`. This is an overwhelming indicator that almost all of the students are familiar with one of the most fundamental functions in PHP that is crucial for managing user sessions in web applications. There are however, 2 students (3.9%) who chooses Option B, while none of them selected Option C or Option D, indicating that there was minimal confusion regarding this concept. These small number of incorrect responses could reflect a minor misunderstanding or might be a simple error, but the correctness demonstrates a strong grasp of the basic PHP session management across the student population. In summary, the response shown was solid comprehension of how to correctly start a PHP session, with nearly all students demonstrating accurate knowledge which can further reinforce their competency in this essential aspect of web programming.

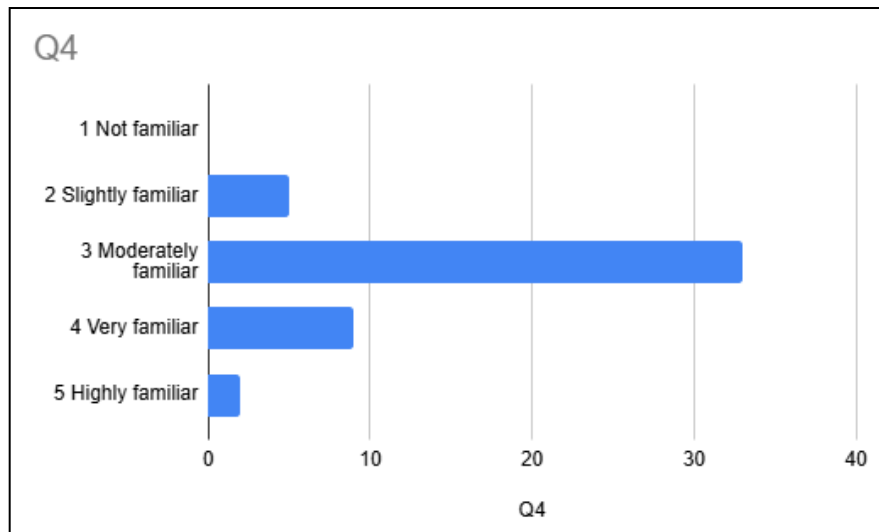
Figure 3. Response to the correct way to start a PHP session



3.2.3. Q4: Rate your familiarity with PHP web application development on a scale of 1 to 5

The question falls under the area of attitude as it asks for a personal perception of students' familiarity in PHP. The response to this question is shown in Figure 4. With the 51 respondents, the majority rated themselves as either Moderately familiar (15 students) or Very familiar (12 students), showing that there is a significant portion of the group has a solid understanding of PHP development. Moreover, 11 students rated themselves as Highly familiar, which can be said that some students feel confident in their PHP skills. However, there were a few of them who rated their familiarity as lower. 5 students rated themselves as Not familiar, and 8 students as Slightly familiar, suggesting that a portion of the respondents feel they need more exposure or practice in PHP web development. Nevertheless, it is worth noting that the mean familiarity rating across the responses was 3.16, which indicates between "Moderately familiar" and "Very familiar". This average suggests that generally students have a moderate level of self-assessed proficiency with PHP. Although, most respondents feel comfortable working with PHP, there remains a small group of students that may benefit from additional learning support to elevate their familiarity with PHP development. In summary, majority of the students have at least had a moderate level of familiarity with PHP, while others have shown higher levels of comfort, there are minority of students responded lower levels of familiarity. These highlight a diversity of skill level within the group. The mean of 3.16 further supports this, it shows an overall moderate proficiency in PHP web development among the students.

Figure 4. Response to the familiarity with PHP web application development.



3.3. Attitude Toward Web Programming Using PHP

The survey results revealed a diverse range of experiences and attitudes towards web programming among the 51 respondents. As can be seen in Table 1 the belief in the importance of web programming for future careers was relatively low (mean = 2.51), suggesting a disconnect between perceived career relevance and technical skills. Interestingly, most respondents agreed that web technologies are relevant to solving real-world problems (mean = 2.80), with moderate levels of confidence in their ability to learn web programming with sufficient effort (mean = 2.59). Although many students found web programming both challenging and rewarding (mean = 2.57), curiosity about how web applications and websites are built scored moderately (mean = 2.66). A significant portion of respondents expressed a desire to pursue advanced web programming skills (mean = 2.86) and showed an inclination towards hands-on experimentation (mean = 2.86). Moreover, practicing beyond the classroom (mean = 2.78) suggest a solid foundation for further skill development. The results emphasize the importance of aligning web programming curricula with students' personal goals and career aspirations, while providing practical opportunities to reinforce their learning and increase confidence.

Table 1. Resulting mean of Attitude indicators

Indicators	Mean
1. I believe learning web programming is essential for my future career.	2.51
2. Web programming helps me develop logical and problem-solving skills	2.53
3. I believe web technologies are relevant to solving real-world problems.	2.80
4. I feel confident that I can learn web programming if I put in enough effort.	2.59
5. I believe web programming is challenging but rewarding to learn.	2.57
6. I am genuinely curious about how web applications and websites are built.	2.66
7. I enjoy exploring new web programming tools and technologies.	2.76
8. I am interested in pursuing advanced skills in web programming.	2.86
9. I enjoy experimenting with code to create functional web applications.	2.86
10. I find web programming topics and tutorials engaging and exciting.	2.76
11. I am motivated to learn web programming to achieve my personal goals.	2.69
12. I dedicate extra time to practice web programming beyond the classroom.	2.78
13. I engage in real-world projects outside the school to improve my web programming skills	2.88
14. I am determined to overcome challenges in learning web programming.	2.75
15. I feel inspired by successful programmers to enhance my skills in web technologies.	2.69

3.4. Practices towards Web Programming in PHP

3.4.1 Q1: How often do you practice PHP/Web programming?

The majority of the students practice PHP/web programming on a weekly basis (35.29%) as shown in Table 2, followed by those practicing monthly (33.33%). A smaller percentage of students practice daily (7.84%), while 19.61% practice yearly. The distribution shows a relatively regular engagement with PHP, but very few students practice consistently on a daily basis. Also, regarding PHP and MySQL experience, an overwhelming majority of students (84.31%) have created a web application in PHP and MySQL, indicating that they have hands-on experience. Only a small group of students (11.76%) have not created such an application, pointing to a general familiarity with PHP web development in the cohort.

Table 2. Frequency of Programming Practice

Coding Practice	No. of students
Daily	4 students (7.84%)
Weekly	18 students (35.29%)
Monthly	17 students (33.33%)
Yearly	10 students (19.61%)

3.4.2. Q2: Have you ever created a Web application in PHP and Mysql?

The response from the question, “Have you ever created a web application in PHP and MySQL?” is shown in Table 3, the resulting information indicates that there is a significant portion of students have practical experience with these technologies. Out of 51 respondents, 43 students (84.31%) have reported having created a web application using PHP and MySQL, while there are only 6 students (11.76%) stated that they have not. These results highlights that the vast majority of the students have engaged in practical web development projects, which suggests a strong level of real-world practice with both PHP and MySQL. This hands-on experience is essential for building confidence and proficiency in web programming, demonstrating that most respondents are well-equipped for real-world web application development.

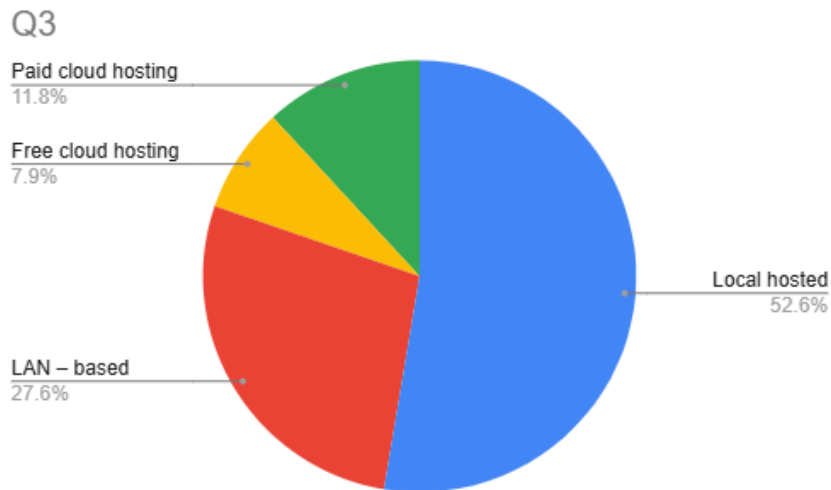
Table 3. Web application in PHP and Mysql

Coding Practice	No. of students
Yes	43 students (84.31%)
No	6 students (11.76%)

3.4.3. Q3: Which of the following Web targets did you implement in a PHP program?

The majority of students (78.43%) have implemented their PHP programs on Local Hosted environments as shown in Figure 5. There is a significant drop when it comes to LAN-based environments (41.18%) and an even more substantial reduction in students who have experience with Cloud-based hosting—either free (11.76%) or paid (17.65%). This suggests that most students are more comfortable developing in local environments, with less exposure to more complex hosting solutions like LAN-based or cloud-hosted environments. Moreover, the majority of students (62.75%) rated their confidence at Level 4 out of 5, indicating a relatively high self-assessed confidence in developing PHP applications. However, only 7.84% rated themselves at the maximum confidence level (Level 5). A significant portion (19.61%) rated themselves at Level 3, indicating some areas for improvement in student confidence. The overall confidence level among students is relatively high, but there is room for further development to increase the proportion of students at the highest confidence levels.

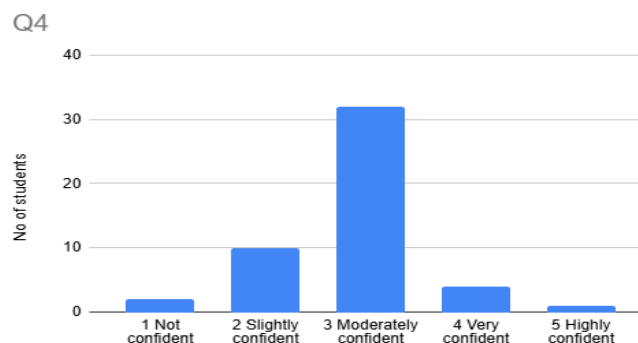
Figure 5. Response to Web target environments



3.4.4. Rate your confidence level in developing PHP Web applications

The result based on this question, "Rate your confidence level in developing PHP web applications," show a range of self-assessed confidence levels among the students. Out of 51 respondents, 2 students (3.92%) rated themselves as "Not confident," and 10 students (19.61%) as "Slightly confident." The majority, 32 students (62.75%), rated themselves as "Moderately confident," indicating that most respondents feel reasonably capable in their PHP development skills, though they recognize room for improvement. Furthermore, 4 students (7.84%) expressed being "Very confident," while only 1 student (1.96%) rated themselves as "Highly confident," reflecting a strong belief in their abilities. The overall mean confidence rating was 2.84, falling between "Slightly confident" and "Moderately confident." This suggests that, on average, students feel capable of developing PHP web applications but may benefit from further experience and practice to enhance more on their confidence levels.

Figure 6. Response to confidence level in PHP web applications



4. CONCLUSION

The survey results reveal a moderate level of familiarity with PHP web programming among students, but highlight a disconnect between their understanding of its relevance to future careers and the actual importance of web programming skills. Despite moderate enthusiasm and curiosity about web programming, students expressed a desire for hands-on experience and advanced skills development. Most students practice PHP programming regularly, with a strong foundation in PHP and MySQL. However, there is a limited exposure to LAN-based and cloud-hosted environments, indicating a need for curriculum enhancements that introduce more complex hosting solutions. Additionally, while confidence in PHP development is relatively high, there is an opportunity to further boost student confidence through more challenging projects and practical opportunities, particularly in real-world hosting scenarios. These findings underscore the importance of aligning curriculum content with both technical skill-building and career relevance to better prepare students for what the industry demands.

ACKNOWLEDGMENT

The author extends sincere appreciation to all individuals and institutions that supported the completion of this study.

REFERENCES

- [1] Al-Qerem, W., Eberhardt, J., Jarab, A., Al Bawab, A. Q., Hammad, A., Alasmari, F., Alazab, B., Husein, D. A., Alazab, J., & Al-Beool, S. (2023). Exploring knowledge, attitudes, and practices towards artificial intelligence among health professions' students in Jordan. *BMC Medical Informatics and Decision Making*, 23(1). <https://doi.org/10.1186/s12911-023-02403-0>
- [2] Benjamin Xie, D. L. G. L. N. M. J. D. D. D. H. K. A. H. T. L. H. M. L. & A. J. K. (2019). A theory of instruction for introductory programming skills. In *Computer Science Education* (Vol. 29). Routledge.
- [3] Costea, C. (2008). PHP Language used for Faculty Site.
- [4] Imam, E., Tanisha, M., & Info, A. (2023). Role of Social Media in Interpersonal Relationship Among Youth. *International Journal for Modern Trends in Science and Technology*, 2023(08), 11–18. <https://doi.org/10.46501/IJMTST0908003>
- [5] Kadar, R., Abdul Wahab, N., Othman, J., Shamsuddin, M., & Mahlan, S. B. (2021). A Study of Difficulties in Teaching and Learning Programming: A Systematic Literature Review. *International Journal of Academic Research in Progressive Education and Development*, 10(3). <https://doi.org/10.6007/ijarped/v10-i3/11100>
- [6] Keppens, J., & Hay, D. (2008). Concept map assessment for teaching computer programming. *Computer Science Education*, 18(1), 31–42. <https://doi.org/10.1080/08993400701864880>
- [7] Lincopinis, D., Paul Apiag, C. W., Bryan Cadiz, E. S., & Lincopinis, D. R. (2023). A Review on PHP Programming Language. <https://orcid.org/0000-0001-9503-8965>,
- [8] Ludo Fourrage. (2024, June 6). Coding Languages to Learn for the Manila, Philippines Market.
- [9] McCracken, M., Almstrum, V., Diaz, D., Guzdial, M., Hagan, D., Kolikant, Y. B.-D., Laxer, C., Thomas, L., Utting, I., & Wilusz, T. (2001). A multi-national, multi-institutional study of assessment of programming skills of first-year CS students. *ACM SIGCSE Bulletin*, 33(4), 125–180. <https://doi.org/10.1145/572139.572181>
- [10] McGill, T. J., & Volet, S. E. (1997). A conceptual framework for analyzing students' knowledge of programming. *Journal of Research on Computing in Education*, 29(3), 276–297. <https://doi.org/10.1080/08886504.1997.10782199>
- [11] Ramiro Z. Dela Cruz, M. A. D. J. P. M. O. and J. R. C. T. (2020). Proposed Enhancements of Factors that Relate to Student Performance in Basic Computer Programming Course in a Local University in the Philippines. *International Journal of Social Sciences & Educational Studies*, 7(4). <https://doi.org/10.23918/ijsses.v7i4p80>
- [12] Saunders, M., Lewis, P., Thornhill, A., Lewis, S. •, & Thornhill, •. (2009). Research methods for business students fi fth edition. www.pearsoned.co.uk
- [13] Sun, D., Ouyang, F., Li, Y., & Zhu, C. (2021). Comparing learners' knowledge, behaviors, and attitudes between two instructional modes of computer programming in secondary education. *International Journal of STEM Education*, 8(1). <https://doi.org/10.1186/s40594-021-00311-1>
- [14] Zarei, F., Dehghani, A., Ratanasiri, A., Ghaffari, M., Raina, S. K., Halimi, A., Rakhshanderou, S., Isamel, S. A., Amiri, P., Aminafshar, A., & Jarrahi, A. M. (2024). ChecKAP: A Checklist for Reporting a Knowledge, Attitude, and Practice (KAP) Study. *Asian Pacific Journal of Cancer Prevention*, 25(7), 2573–2577. <https://doi.org/10.31557/APJCP.2024.25.7.2573>
- [15] Zhuang, L. (2024). A PHP Framework-Based Web-Based Instruction Platform. *International Journal of Interactive Mobile Technologies*, 18(7), 68–81. <https://doi.org/10.3991/ijim.v18i07.48247>