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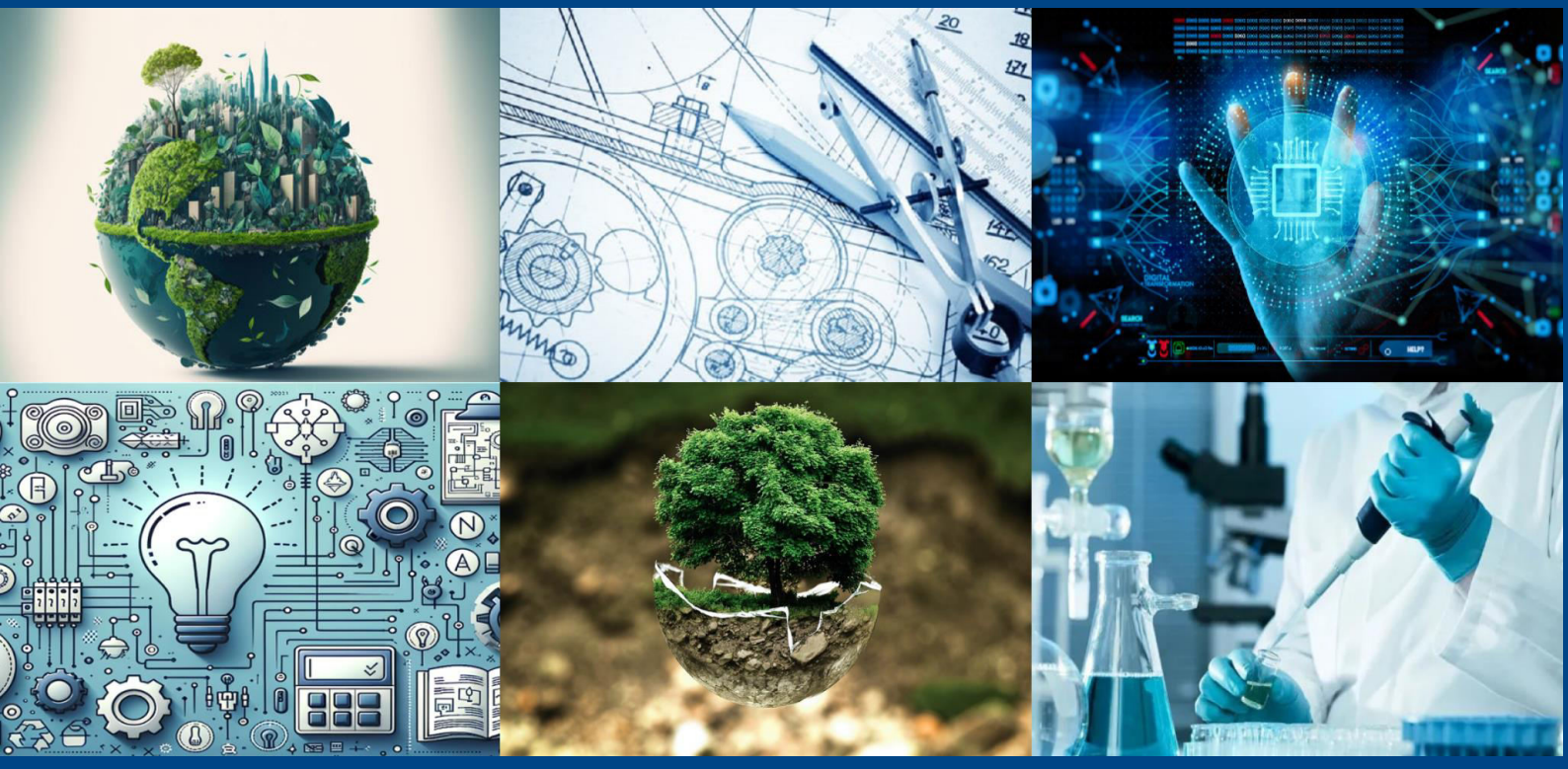

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IntelliCheck: An AI-Powered Program Evaluation and Automated Feedback System for Programming Education

Norberto Cuarez Jr, Engr.Franklin Ganancias, DIT, Engr.Nelyne Lourdes Y. Plaza, PCPE, Ph.D, Joel S. Gracias,MSCS, Felgine Dagohoy, and Dumagtoy Angelica.

Department of Computer Studies, North Eastern Mindanao State University – Cantilan Campus, Cantilan, Surigao del Sur, Philippines

Email: nornorcuarez@gmail.com

ABSTRACT: The rapid advancement of artificial intelligence in educational technology has transformed the way programming courses are taught and evaluated. Traditional programming assessment methods often rely on manual checking and delayed instructor feedback, resulting in inefficient evaluation processes and reduced opportunities for iterative learning among students. This study developed and evaluated IntelliCheck, an AI-powered program evaluation and automated feedback system designed to enhance programming education through real-time code analysis and intelligent feedback generation. The system was developed using the Agile Software Development Model to support iterative refinement and continuous stakeholder collaboration. IntelliCheck integrates automated code evaluation, syntax validation, logic analysis, and Q-learning-based feedback mechanisms to provide students with personalized suggestions for improving their programming solutions. The study was conducted at North Eastern Mindanao State University with 172 respondents composed of 162 students and 10 Computer Science instructors. Evaluation of the developed system was based on the ISO/IEC 25010 software quality standards, specifically Functional Suitability, Reliability, Usability, Performance Efficiency, Maintainability, Security, Compatibility, and Portability. Results revealed an overall mean score of 4.55 interpreted as Excellent, indicating a high level of acceptability among users. Functional Suitability and Performance Efficiency both achieved the highest mean of 4.59, demonstrating the system's capability to provide accurate and efficient automated evaluation. The findings confirm that IntelliCheck significantly improves programming assessment workflows, supports self-regulated learning, and reduces instructor workload through intelligent and real-time feedback mechanisms.

KEYWORDS: Artificial Intelligence, Automated Code Evaluation, Q-Learning, Programming Education, ISO/IEC 25010, Intelligent Feedback System

I. INTRODUCTION

Programming education plays a critical role in developing analytical, logical, and computational thinking skills among students in Computer Science and Information Technology programs. However, traditional approaches to evaluating programming assignments remain heavily dependent on manual assessment procedures, which often consume significant instructor time and delay the delivery of meaningful feedback. In many higher education institutions, especially in developing academic environments, instructors encounter challenges in assessing large volumes of programming submissions while simultaneously maintaining accuracy, consistency, and timely evaluation.

The increasing demand for digital learning environments and intelligent educational technologies has accelerated the integration of artificial intelligence into programming instruction. Recent advancements in automated assessment systems demonstrate that AI-powered evaluation tools can provide immediate diagnostic feedback, improve learning engagement, and support self-regulated learning practices among students. Modern intelligent systems are no longer limited to syntax checking alone; instead, they incorporate logic analysis, semantic evaluation, and adaptive feedback generation mechanisms that simulate instructor-guided mentoring.

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In the Philippine academic context, higher education institutions continue to experience challenges associated with delayed grading processes, limited feedback quality, and insufficient diagnostic evaluation tools for novice programmers. Existing learning management systems often lack the capability to provide comprehensive code analysis and personalized recommendations for improving programming logic and efficiency. Consequently, students may struggle to identify their mistakes independently, leading to reduced learning effectiveness and increased instructor workload.

To address these issues, this study developed IntelliCheck, an AI-powered program evaluation and automated feedback system designed to assist both students and instructors in programming education. The system integrates automated code submission, syntax validation, logic analysis, real-time evaluation, and Q-learning-based feedback generation to create an intelligent academic support environment. Through the implementation of Agile development methodologies and ISO/IEC 25010 quality standards, IntelliCheck aims to improve the efficiency, reliability, and usability of programming assessment processes within academic institutions.

II. REVIEW OF RELATED LITERATURE AND STUDIES

The reviewed literature and studies emphasized the growing importance of artificial intelligence and automated assessment systems in modern programming education. Both foreign and local researchers highlighted that AI-powered platforms significantly improve the efficiency of programming evaluation through real-time feedback, automated code analysis, and adaptive learning support. Studies revealed that intelligent systems help students enhance problem-solving skills, reduce coding errors, and improve learning engagement while minimizing instructor workload. Additionally, researchers noted that machine learning and automated diagnostic feedback systems contribute to more accurate, consistent, and scalable programming assessment processes. Local studies further identified the limitations of traditional manual grading systems in Philippine higher education institutions, particularly the delayed feedback process and lack of intelligent evaluation tools. Overall, the reviewed literature and studies strongly support the development of IntelliCheck as an AI-powered program evaluation and automated feedback system capable of modernizing programming education and improving both instructional efficiency and student learning outcomes.

Authors	Year	Key Findings
Becker et al.	2023	Automated code analysis systems improve programming learning and coding standards.
Kasneci et al.	2023	AI educational systems provide adaptive mentoring and intelligent feedback.
MacNeil et al.	2022	AI-generated hints improve student engagement and persistence in programming tasks.
Chen & Wang	2024	Hybrid AI evaluation systems provide accurate semantic and logic analysis.
Hernandez	2022	Manual grading delays negatively affect iterative programming learning.
Mendoza & Reyes	2025	Philippine HEIs require AI-powered educational technologies for programming assessment.
Tabora	2023	Automated grading systems reduce instructor workload and improve evaluation efficiency.
Corpuz et al.	2025	Students preferred intelligent AI-generated feedback over direct solution-based systems.

Global literature highlights the growing importance of artificial intelligence in programming education and automated assessment systems. According to recent studies, intelligent evaluation platforms have evolved from basic syntax verification tools into advanced learning systems capable of semantic reasoning and adaptive feedback generation. Automated assessment technologies incorporating static code analysis and machine learning algorithms help novice programmers understand coding standards, logic structures, and best programming practices more effectively.

Studies conducted internationally emphasized that AI-powered educational systems improve student persistence and learning outcomes by providing immediate and personalized feedback. Hybrid evaluation systems combining Abstract Syntax Trees (AST), machine learning, and Large Language Models demonstrated higher diagnostic accuracy compared to traditional rule-based approaches. Furthermore, intelligent scaffolding techniques enable students to engage more deeply with problem-solving processes by offering contextual guidance instead of direct solutions.

Local literature also revealed the need for educational modernization within Philippine higher education institutions. Researchers identified significant limitations in manual grading systems, including delayed feedback delivery, instructor burnout, and inadequate support for iterative programming learning. Existing local systems often focus on administrative

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automation while lacking intelligent diagnostic capabilities necessary for evaluating computational logic and programming quality.

Several studies further emphasized the importance of integrating AI-driven feedback systems into programming curricula to enhance student learning experiences and reduce instructional workload. Researchers found that automated evaluation tools positively influence student performance, improve engagement, and encourage independent learning behaviors. Additionally, the incorporation of plagiarism detection, structured feedback mechanisms, and real-time code analysis was identified as essential for supporting modern programming education in local academic environments.

Collectively, these studies validated the pedagogical and technical foundations of IntelliCheck by establishing the importance of AI-driven assessment systems in improving code evaluation efficiency, supporting self-regulated learning, and addressing the limitations of traditional manual grading methods.

III. METHODOLOGY

This study utilized the Agile Software Development Model in developing IntelliCheck. Agile was selected because it supports iterative development, continuous feedback, rapid prototyping, and adaptive system enhancement. The methodology enabled the researchers to continuously refine the system based on stakeholder evaluation and testing results.

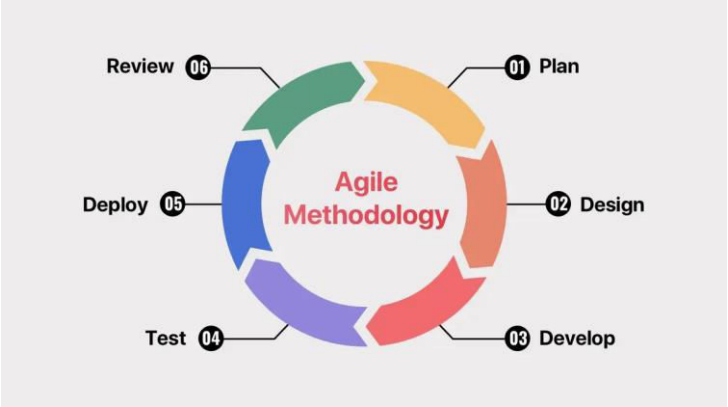

Figure 3.0 Agile Model

The development process included the following phases:
Planning Phase
The planning stage identified the required system functionalities, including automated code evaluation, assignment management, syntax validation, and AI-based feedback generation. Development tasks were organized into iterative sprints to facilitate continuous improvement.

Design Phase
The design phase established the system architecture, technological stack, and database structure. The system utilized web-based technologies integrated with machine learning models for logic assessment and automated evaluation.

Development Phase
During development, the researchers implemented the core modules of IntelliCheck, including:

- User authentication
- Assignment management
- Code submission
- Real-time feedback generation
- Evaluation analytics
- Progress tracking

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Testing Phase

Comprehensive testing procedures were conducted to evaluate system functionality, performance efficiency, usability, reliability, and security. Machine learning feedback mechanisms were also validated for consistency and accuracy.

Deployment and Maintenance

The system was deployed within the academic environment of North Eastern Mindanao State University and continuously monitored for improvements and maintenance updates.

SYSTEM FEATURES AND ARCHITECTURE

IntelliCheck provides an intelligent evaluation environment for both students and instructors through a secure role-based architecture.

Student Features

- User registration and authentication
- Assignment selection and submission
- Automated code evaluation
- AI-generated technical feedback
- Progress monitoring and analytics
- Historical submission tracking

Instructor Features

- Assignment and rubric management
- Test case configuration
- Student performance analytics
- Real-time monitoring dashboard
- Additional feedback generation
- Class performance insights

The system incorporates Q-learning algorithms to generate adaptive feedback. Through reinforcement learning principles, the system continuously improves its evaluation capability by analyzing user interactions and code correction behaviors.

The Q-learning concept utilized in IntelliCheck is represented by:

where:

- represents the quality of a feedback action,
- is the learning rate,
- is the immediate reward,
- is the discount factor,
- and is the maximum expected future reward.

This approach enables IntelliCheck to adapt feedback recommendations according to varying student coding behaviors and logic structures.

IV. RESULTS AND DISCUSSION

The system evaluation involved 172 respondents composed of 162 students and 10 Computer Science instructors from North Eastern Mindanao State University.

Table 1. Respondents of the Study

Respondents	Frequency
Students	162
Computer Science Instructors	10
Total	**172**

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The developed system was evaluated using ISO/IEC 25010 quality standards.

Table 2. ISO/IEC 25010 Evaluation Results

Quality Characteristic	Mean	Interpretation
Functional Suitability	4.59	Excellent
Reliability	4.55	Excellent
Usability	4.49	Excellent
Performance Efficiency	4.59	Excellent
Maintainability	4.56	Excellent
Security	4.58	Excellent
Compatibility	4.56	Excellent
Portability	4.50	Excellent
Overall Mean	**4.55**	**Excellent**

The evaluation results demonstrate that IntelliCheck successfully satisfies both functional and non-functional software quality requirements. Functional Suitability and Performance Efficiency achieved the highest ratings, indicating that the system effectively evaluates programming submissions while maintaining efficient processing speed and responsiveness. The Reliability evaluation confirmed that the system consistently provides stable performance during simultaneous code submissions and securely stores academic records. Usability results also indicate that students and instructors can easily navigate the platform with minimal technical difficulty. Furthermore, the Maintainability and Compatibility scores demonstrate that the system architecture supports scalability, future enhancement, and deployment across various devices and operating environments. The Security evaluation validates the effectiveness of the authentication and authorization mechanisms implemented within the platform. Overall, the findings confirm that IntelliCheck is a reliable and efficient intelligent assessment system capable of supporting programming education within higher education institutions.

V. CONCLUSION

This study successfully developed and evaluated IntelliCheck, an AI-powered program evaluation and automated feedback system designed to improve programming education through intelligent assessment and real-time feedback generation. By integrating automated code evaluation, syntax analysis, logic assessment, and Q-learning-based adaptive feedback mechanisms, the system effectively addressed the limitations of traditional manual grading processes commonly experienced in programming courses. Evaluation results based on ISO/IEC 25010 standards revealed that the system achieved an overall mean score of 4.55, interpreted as Excellent, indicating a high level of user acceptability among both students and instructors. The findings further demonstrated that IntelliCheck improves instructional efficiency, enhances student learning experiences, and supports self-regulated programming practice through immediate and actionable feedback. The study concludes that AI-driven assessment systems such as IntelliCheck can significantly contribute to modernizing programming education by reducing instructor workload, improving feedback delivery, and fostering more effective coding skill development. Future enhancements may include expanded programming language support, advanced plagiarism detection, deeper semantic analysis, and cloud-based deployment for wider institutional adoption.

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