CHAPTER II

REVIEW OF RELATED LITERATURE

Automatic Assessment of Programming Assignment

The study of computer languages is more crucial in the modern world. Computer science students must possess proficient and effective programming abilities. Mastery in programming can only be achieved through rigorous exercise regimens. The instructor or teacher is confronted with a substantial burden when evaluating programming exercises, especially when the process must be completed manually, as the number of students in the class continues to rise (Gupta, S., Dubey, S.K., 2012).

Creating an automated grading system for programming assignments through the use of a verification program that accepts arbitrary inputs. An imperative characteristic of a program is its ability to execute its designated purpose. Verification of the intended function of a program or program segment is possible with the verification program of the inverse function. In order to assess the intended functionality and performance of a program, a verification program was implemented. The efficacy of this evaluation system in basic programming exercises has been demonstrated through its testing on rudimentary C programming courses, yielding encouraging preliminary results.

The system involves three key participants: the Teacher, the Student, and the System. Initially, the Teacher presents programming problems, which are described to the student along with a hidden verification program. The student, upon visiting the system, attempts to solve these problems. The System evaluates the submissions made by the student. The stochastic information generated by the system, including common errors, program errors, the number of inputs, and the number of execution attempts, is stored in the system's database. This stored information becomes valuable for the

Teacher in assessing both individual student performance and the overall course effectiveness.

Automated program compilation and execution by the automatic assessment system; program evaluation is performed in accordance with a verification program. The implementation of this system occurred in a computer course that emphasized fundamental programming concepts. The class consisted of 90 students, of which 81 turned in their assignments. The evaluation performed by the system unveiled that 20% of the assessed assignments contained compilation errors and 25% contained erroneous programs, whereas the remaining 55% yielded accurate outcomes in accordance with the system's criteria. By streamlining the assessment process, this system efficiently provides exhaustive information regarding programming evaluations with minimal exertion.

Nevertheless, the system imposes specific limitations on students, including the requirement that they develop programs that exclusively accept command line arguments as input and conform the output format to predetermined criteria. In order to optimize usability, forthcoming iterations might contemplate eliminating these limitations. At present, the system lacks complete automation; however, future enhancements are in the works to transform it into an entirely online and automated system that can be accessed remotely through the internet (Gupta, S., Dubey, S.K., 2012).

Designing Programming Exercises with Computer Assisted Instruction

The difficulty of computer programming for beginners has been widely recognized for an extended period of time (Boulay, 1989). Teaching and learning programming are confronted with a multitude of obstacles, as described by Sleeman (1986). In most programming courses, class sizes are quite large, which poses a significant obstacle to delivering effective instruction. Due to the substantial number of

students, closely monitoring their individual learning progress becomes an overwhelming task, resulting in limited opportunities for instructors to engage in meaningful interactions beyond the boundaries of weekly lectures and tutorials. Due to the challenges associated with the instruction and acquisition of computer programming knowledge, there has been considerable interest in investigating the potential of computer-assisted instruction (CAI) technology as an improved approach for introductory programming courses (Anderson & Skwarecki, 1986). The objective of the paper is to present the firsthand encounters utilizing CAI technology to instruct computer programming in the setting of sizable class sizes (Wang, F.L., Wong, T.L., 2008).

Ensuring that students have access to immediate help is essential to the success of computer programming education. However, this stipulation imposes a significant financial burden on certain universities and places considerable strain on available resources. In order to resolve these issues, intelligent computer-assisted instruction technology has been suggested as a more efficient method of instructing introductory computer programming courses (Anderson & Skwarecki, 1986).

The system under discussion permits instructors to configure programming challenges by supplying input and output values that correspond to individual test cases. Following this, students proceed to submit their programs for assessment, whereupon the system executes and compiles the code submitted. The system provides students with feedback by comparing the outputs of their programs to the expected outputs specified by the instructors (Wang, F.L., Wong, T.L., 2008).

Didactic Principles, Models, and E-Learning

The educational process is founded upon pedagogy, which comprises the diverse elements comprising a course, including prerequisites, learning activities, assignments, and learning activities. Pedagogy also encompasses the methods utilized

for teaching and learning. When considering didactic approaches, learning technology can be classified into three categories: pedagogy-driven (supports a wide variety of pedagogies), pedagogy-neutral (does not endorse any particular pedagogy), and pedagogy-standard (upholds a singular pedagogical standard). Numerous modern software tools and technologies utilized in the realm of e-learning are distinguished by their subject-specific nature, catering to particular fields and users, while remaining pedagogically impartial. When no specific learning requirements are specified, these tools lack support for methodical strategies and do not specify methods to interpret learning content and objectives under different conditions.

A multitude of pedagogical models and strategies are in existence, recognizing that learning is not simply the consumption of content. It is deemed inadequate to implement a single pedagogical model or strategy for the purposes of e-learning standardization and research. An example of this would be a specific course that comprises exclusively of activities devoid of explicit learning content, which would pose a difficulty in adapting it to a "pedagogy-neutral" or "pedagogy-standard" framework.

This study presents the BEST1 initiative, which aims to create a virtual learning environment. The BEST architecture prioritizes fundamental principles, such as the notion that learning is a purpose-driven endeavor, in which learners have the ability to establish their own learning objectives, oversee and control their learning progress, learner engagement within a social context, and collaborative learning principles. Tasks and evaluations are both product knowledge-based.

In addition to imparting purely scientific knowledge, the primary objective of modern e-learning courses is to handle vocational training duties. When considering the selection of taught knowledge, its relevance to particular professional duties is the primary criterion. As a result, the development of course learning materials has transitioned from a subject-centric to a broad approach. Significant changes occur

concurrently with the preparation of educators for their evolving role in the teaching and learning process, as well as the requirements for educational forms and methods. Priority is given to individual and collaborative learning activities that require active engagement with educational materials and information. Additionally, the teacher-learner dynamic is modified throughout the learning process.

The significance of universal (methodical) knowledge is increasing in relation to evaluation and future prognostications. Significant shifts occur in educational organization methods and structures, with a particular emphasis on the training of educators to adapt to the changing role of educators in this context. The predominance of individual and group active engagement with learning materials and information results in a paradigm shift in the tasks undertaken by both educators and learners. This shift also affects the nature of their relationship throughout the learning process, with an emphasis on the learner's propensity to develop into a fully empowered subject while collaborating with the educator to solve learning and professional tasks (Theelen, 2022)

Computer Aided Instruction to Teach Concepts in Education

21st-century education diverges significantly from classical education, as it is now intricately intertwined with technology. In today's educational landscape, schools lacking computer technology are considered outdated. This study aims to evaluate the effectiveness of computer-aided instruction (CAI) on students' behavior and achievements in Mathematics. Utilizing a quasi-experimental research method, the researcher formed two groups: one receiving traditional teaching and learning, and another using computer-aided instruction. The collected data underwent analysis through weighed mean, standard deviation, and a two-tailed T-test at a 5% level of significance to determine if a performance mean difference existed between traditional learning and teaching and CAI in the group of respondents.

This research critically assesses the effectiveness of CAI as an alternative instructional method. The findings are valuable for educators, providing insights into alternative delivery modes that align with desired outcomes. The results indicate that CAI effectively meets expected learning outcomes, demonstrating a more promising impact on effective teaching, especially in the multiplicative skill of multiplying two-to-three-digit numbers by a one-digit number for grade three students. Both traditional approaches and CAI are effective in teaching multiplicative skills for routine and non-routine word problems. Consequently, this study suggests that teachers incorporate CAI into their teaching methodologies. To address associated issues and concerns, schools should organize training workshops on effectively utilizing computers for delivering lessons through methods such as PowerPoint presentations (Suson, R., & Ermac, E., 2020).

Online Teaching Management System

With the rapid advancements in computer science and technology, Computer-Aided Instruction (CAI) has assumed an increasingly pivotal role in modern teaching management and education. Specifically, within teaching modules related to the art of programming, the traditional role of human graders can now be effectively fulfilled by automated programming assignment graders, such as Online Judges (OJ). Presently, a significant number of universities and institutions have incorporated their own developed OJ programs into programming modules. However, this practice incurs substantial costs in terms of human resources for development and maintenance. This paper introduces an online teaching management system, named Tsinghua University Online Judger (THUOJ), designed to address this issue in a public and university-oriented manner.

Apart from fundamental management functions, THUOJ primarily concentrates on programming assignment grading and program assessment customization for various programming courses. This adaptability makes the system suitable for diverse needs across different modules, offering personalized programming grading services. The author, in this article, presents the system's design, taking into consideration potential users and proposing a structural design based on the Linux+Apache+MySQL+PHP (LAMP) framework. Notably, the author employs C and PHP to program the online judge module. The paper concludes with the implementation of a simple website demo based on the OJ module, serving as a showcase for the functionality of the system and the online judge module (Zheng, N., Tian, S., & Chen, Y., 2016).

COMES: A CAI System Oriented to Programming Languages

COMES, a computer-aided instruction system tailored for programming languages. This system facilitates a seamless integration of theoretical learning and practical applications by providing two distinct teaching strategies. One corresponds to a purely tutorial environment, while the other is dedicated to a programming and problem-solving environment customized for a specific programming language. This allows for a learning process that alternates between theory and hands-on practice, emphasizing personal experience over the memorization of abstract information. The paper delves into the key design decisions of the system, and it includes two examples of dialogues to illustrate its functionality (Manzo, M. D., et al., 1978).

Synthesis

These studies talk about how computers are helping students learn programming better. One way is by checking their work automatically, saving teachers time. Several studies delve into the integration of computer-aided instruction (CAI) in education, particularly within the domains of programming and didactic approaches. Gupta, S., Dubey, S.K. (2012) emphasize the need for automated assessment in programming education due to the increasing number of students. Their system, an automatic assessment platform, utilizes a verification program for programming assignments. This approach, tested in C programming courses, demonstrates promising results in combining theory and practice, enhancing the learning process.

Another facet of CAI is explored by Wang, F.L., Wong, T.L. (2008) in the context of teaching computer programming to large classes. Recognizing the challenges in traditional instruction, they propose an intelligent computer-assisted instruction technology to provide immediate support to students. The system enables instructors to configure programming challenges and automates the assessment process, offering efficient feedback to students based on expected outputs.

The paper by Wang (2020) discusses didactic principles and models in e-learning, emphasizing the shift from subject-centric to a broader approach in course development. The BEST1 initiative aims to create a virtual learning environment based on principles such as purpose-driven learning, learner-defined objectives, social context, and collaborative learning. This aligns with the evolving landscape of education, focusing on vocational training and the increasing importance of universal knowledge.

Suson, R., & Ermac, E. (2020) evaluate the effectiveness of CAI in teaching Mathematics. The study compares traditional teaching with CAI, revealing that CAI is promising in enhancing learning outcomes, especially in complex mathematical skills.

The recommendation is for educators to incorporate CAI into their teaching methodologies, supported by training workshops on effective computer utilization.

The related studies in this chapter also touches upon an online teaching management system, Tsinghua University Online Judger (THUOJ), designed to automate the grading of programming assignments. This system streamlines the assessment process, providing exhaustive information with minimal effort, though it has specific constraints that may be addressed in future iterations.

The COMES system (Manzo, M. D., et al., 1978) is introduced, focusing on CAI oriented to programming languages. COMES emphasizes two teaching strategies, one tutorial and one focused on a programming and problem-solving environment. This system aims to integrate theory and practice, emphasizing personal experience in learning programming languages.

Looking through these related studies provided the researcher a way to base and incorporate the expertise of these systems in the currently developed study. The system created by Gupta and Dubey can run students' programs to see if they work correctly. Another way is using special computer programs that teach and give feedback to students when they write code. Wang, Wong, and their team made a system like this. They also talk about different ways to teach using computers, like making learning more about students and how they learn best. Some studies show that using computers to teach math, for instance, helps students learn better. Finally, some projects are working on systems that can grade students' work and give personalized help. These systems use computers to check and teach programming, making it easier and more personalized for students to learn.

Table 1.0 Summary of Matrices and Studies

	Enrollment	Content Based Module	Performance Tracking	Assessment	Chat bot	Video Conferencing
Automatic Assessment of Programming Assignment	✓			✓		
Designing Programming Exercises with Computer Assisted Instruction		✓	✓	✓		
On the Didactic Principles , Models and E-Learning						
Computer Aided Instruction to Teach Concepts in Education		✓		✓		
Online Teaching Management System		✓		✓		✓
COMES: A CAI System Oriented to Programming Languages		✓	✓	✓	✓	
Computer Aided Instruction using Natural Language Processing Algorithm	✓	✓	✓	✓	✓	✓