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Online Learning Business Models by Level in Mathematics and Coding

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ABSTRACT
This study aims to improve self-directed learning capabilities through immersive learning by presenting a systematic learning method for experts suitable for the type of learner and providing information related to mathematics and coding learning. With the spread of smart devices and smart learning platforms increasing, users' preference for viewing images using devices is increasing. The demand for using personal tutors rather than educational methods that only watch videos through smart devices is increasing. Accordingly, artificial intelligence technology is used for customized education, and as AI technology is gradually developing, research and investment in smart learning using artificial intelligence are increasing at the same time in the education world, which is an important area for user personalization. Comprehension and memory can be improved by computing thinking about mathematical problems using programming languages to solve mathematical problems. This approach improves the ability to solve problems on its own and becomes the driving force to prepare learners in the digital age through curriculum such as coding and algorithms, coding and artificial intelligence. By learning computational thinking and computational thinking skills through problem recognition, analysis, decomposition, algorithms, and patterns, the convergence of mathematics and coding can create synergy in various fields. You can more easily arouse interest in mathematics if you approach it using an accessible programming language rather than simply memorizing mathematical formulas. Therefore, coding learning using programming languages such as Python can increase the learning effectiveness by motivating learners through the convergence of coding learning and mathematics learning, such as Olympiad competitions and math competitions. By designing an online learning model tailored to users of mathematics and coding, we intend to improve the effectiveness of learning through research on business models that provide mentoring and content that induce optimal learning for users by analyzing learners' patterns.

Keywords: Mathematics coding, Coding learning, Continuous motivation, Computing thinking, Mentoring and content, Smart learning

1. INTRODUCTION

In the era of the 4th industrial revolution led by big data and artificial intelligence, the necessity and importance of coding are emerging with the emergence of digital learning platforms [1]. The necessity of experts is increasing as the proportion of coding in elementary education increases due to the mandatory software education. Previously, coding was an education that fostered professional programmers in high schools and universities, but now coding is used as an education that can cultivate computational thinking [2]. Many universities value software talent education, and coding capabilities are affecting elementary, middle, and high school students' college entrance. In the curriculum of elementary, middle, and high school, learning education is currently being conducted for elementary school students to understand software programs by learning actual artificial intelligence programs based on Python [3, 4]. It is thought that the convergence of mathematics of mathematical thinking and coding to improve creativity and thinking skills can help cultivate creative talents who will lead the fourth industry [5]. Block coding, which early learners usually encounter, allowed learners to enter coding easily and interestingly like games using blocks and images made in each country's language, but when learning a full-fledged computer programming language, learners often lose interest in coding and find it difficult to code due to unfamiliar grammar made up of English words and formulas. It is also necessary to give continuous motivation in coding learning using programming languages. It is not just program coding, but it can be developed into learning that improves mathematical skills by coding mathematical formulas. Mathematics education aims to improve learners' problem-solving skills, and mathematics and coding, and mathematics and artificial intelligence have a close relationship [6]. With the recent development of artificial intelligence, with the recent development of deep learning, customized tutors are attracting more attention [7,8]. Advances in deep

learning are being applied to various learning platforms, and the use of Generative AI such as Large Language Models (LLM) and Text to Image allows smart learning users to obtain the desired learning results through learning images and feedback that fit their patterns. For large language models, they have the ability to identify text, mathematical equations, and causal relationships [9]. By reinforcing personalization, accessibility, and real-time feedback, LLM is ready to change the way we learn and teach. It can provide customized models that are efficient in fostering problem-solving skills and creative thinking [10]. Coding and mathematics have common denominators such as logic and procedural problem solving. Therefore, it is expected that the learning effect can be doubled if coding learning and mathematics learning are done at the same time. In addition, solving math problems through computer programming allows learners to experience how math can be applied to other fields. Finally, math learning itself can motivate coding learning. This study is about a method of teaching mathematics using Python coding, and more specifically, by applying coding to solve math problems, we want to understand the concepts of mathematics and coding and seek to improve the quality of education. It is possible to improve individual competence by educating creative thinking and coding at the same time, rather than simply solving them with block coding [11]. If programming itself is used as a tool for learning mathematics, it is expected that learners will be able to naturally develop programming skills while learning mathematics. We intend to design a business model that provides users with mentoring and content that induces optimized learning for the users by analyzing learners' patterns based on online subscription services.

2. MATERIALS AND METHODS

In the era of the 4th industrial revolution, the necessity and importance of coding are emerging, led by artificial intelligence. The necessity of experts is increasing as the proportion of coding in elementary education increases due to the mandatory software education. Previously, coding was an education that fostered professional programmers in high schools and universities, but now coding is used as an education that can cultivate computational thinking. To this end, it is thought that the convergence of mathematics of mathematical thinking and coding for improving creativity and thinking ability can help cultivate creative talents who will lead the 4th industry [12]. Block coding, which early learners usually encounter, allows learners to enter coding easily and interestingly like games using block-based programs. However, when learning a full-fledged computer programming language, learners often lose interest in coding and find it difficult to code due to unfamiliar grammar composed of English words and formulas. To solve this problem, continuous motivation and systematic management are required through coding learning using a programming language such as Python.

2.1. *Development*

It aims to use programming languages to improve comprehension by learning mathematics and coding simultaneously. With advances in artificial intelligence, neural networks for natural language processing are used to train machines to solve word problems and perform symbol inference, and deep learning is also used to solve differential equations [13]. For example, the Quadratic formula, Fourier series function, and Limit formula are expressed as mathematical formulas as follows.

The root formula, also known as the quadratic formula, provides a way to find the solutions (or roots) of a quadratic equation. Here is x represents the solutions (or roots) of the quadratic equation. A quadratic equation provides a universal way to find the root of a quadratic equation. By calculating the discriminant and applying the formula, we can determine whether the root is a real number or a complex number and find the exact value of the root. The general form of a quadratic equation is:

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \qquad (1)$$

The Fourier series is a way to represent a periodic function as a sum of sine and cosine functions. Here's a brief example in Python that demonstrates how to compute and plot a Fourier series approximation of a simple periodic function, like a square wave. The Fourier series formula is:

$$f(x) = a_0 + \sum_{n=1}^{\infty} \left(a_n \cos \frac{n\pi x}{L} + b_n \sin \frac{n\pi x}{L} \right) \qquad (2)$$

The limit of a function describes the behavior of the function as its argument (or variable) approaches a certain value. It is a fundamental concept in calculus and mathematical analysis. The formula is:

$$\lim_{n \to \infty} \left(1 + \frac{1}{n}\right)^n = e \qquad (3)$$

You can learn three mathematical formulas, Quadratic formula, Fourier series function, and Limit formula, in Python code. Then, you can improve your programming ability through coding, and at the same time, you can improve your understanding of learning by learning mathematical formulas as shown in table 1. At the same time, synergy effects are expected through 14 learning. [Table 1] shows the changes from the mathematical formula to Python code.

Table 1: Change math formula to Python code

Formula name	Python coding
Quadratic formula	a, b, c = 1, -3, 2 root1 = (-b + (b**2 - 4*a*c)**0.5) / (2*a) root2 = (-b - (b**2 - 4*a*c)**0.5) / (2*a)

Fourier series function	import numpy as np
	import matplotlib.pyplot as plt
	def fourier_s(x, n_terms):
	result = np.zeros_like(x)
	for n in range(1, n_terms + 1):
	result += (4 / (np.pi * (2 * n - 1))) * np.sin((2 * n - 1) * x)
	return result
	x = np.linspace(-np.pi, np.pi, 1000)
	n_terms = 10
	y = fourier_s(x, n_terms)

Limit formula	import numpy as np def limit_function(n): return (1 + 1/n)**n n_large = 10**6 limit_app = limit_fun(n_large) print(limit_app)

2.2 Model Implementation

Research has shown that artificial intelligence is becoming increasingly influential in math education, and tutors and customized support according to artificial intelligence have an important influence on math learning performance [14,15,16]. For customized support, we intend to design a screen that will conveniently proceed with users' learning, such as counseling and mentoring services that manage learners, whether or not to proceed according to the learning level, and mentor support for learning room guidance. The platform screen design was designed for each learning level. It is a user site design required for learners and is designed with menus such as learning screen, learner service, mentor service, membership, subscription, search, notification, setting, and customer service. [Figure 1] represents a user site map in figure 2.

The differentiation of online learning contents is as follows. First, lectures included in the subscription service increase the user's learning effectiveness by providing learning methods and weaknesses suitable for existing learners and increase advertising effects and sales through contents and subscription services used by learners. Second, based on the learner's data generated in the subscription service, service providers that recommend the most appropriate content for learners provide differentiation between subscription services and learning mentoring services. Third, experts in mathematics and coding education present customized learning methods through learner analysis, and through this, learners provide mentoring services that identify their own problems and perform optimized learning. Fourth, by periodically providing an analysis report on learning outcomes to the relevant learner in the learning management mentoring system and presenting step-by-step learning contents, it is provided as a service that allows learners to participate with fun and interest by conducting continuous math and coding learning on their own. The platform screen design is designed in [Figure 2] so that it can proceed after undergoing skill tests such as differentiation, integration, trigonometric functions, polynomials, factorizations, rational expressions, equations, and limitations of functions in figure 2.

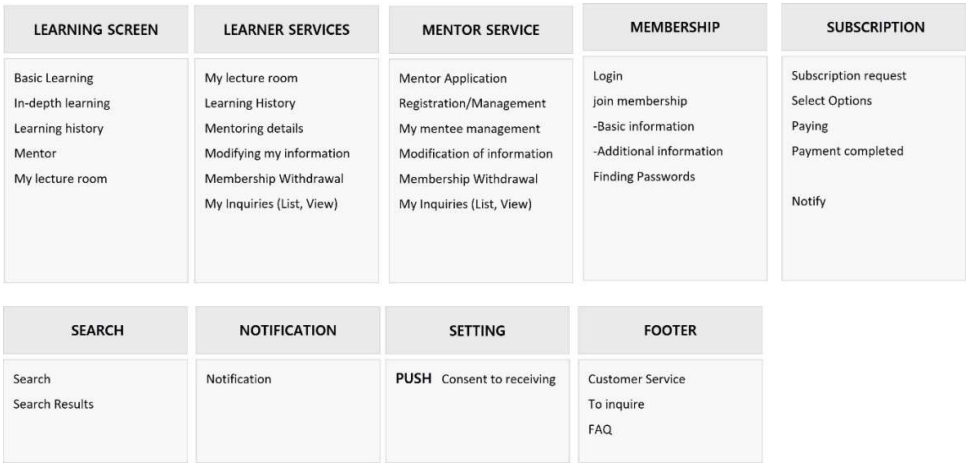

Figure 1. User Sitemap

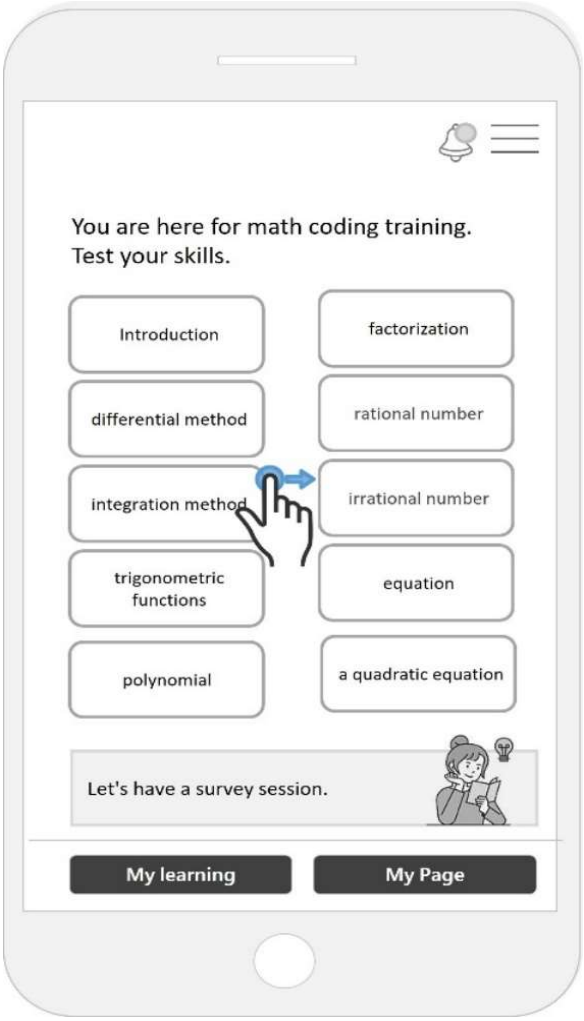

Figure 2. Platform Screen Designs

3. RESULTS AND DISCUSSION

It is necessary to provide immersive learning by arousing interest in coding. It includes a step-by-step procedure that allows learners to increase their understanding of mathematics by programming mathematics and help them understand coding through expert mentors. Therefore, first, it is necessary to arouse interest in coding and provide immersive learning. Second, it induces continuity of learning by applying coding to mathematics by transforming awareness to mathematics learning. Third, it improves individual learners' self-directed learning

capabilities by using online services. It overcomes temporal and spatial constraints and provides low-cost self-directed online education services. Second, it provides math learning contents through computer programming. Third, it improves confidence and fun in math and coding. It induces learning habits through mentoring management of net coding learning.

The learning manager mentoring system is a learning manager mentoring system that periodically provides the learner with analysis reports on learning outcomes and presents step-by-step learning content based on this, allowing learners to habituate continuous math and coding learning on their own and participate with fun and interest in figure 3.

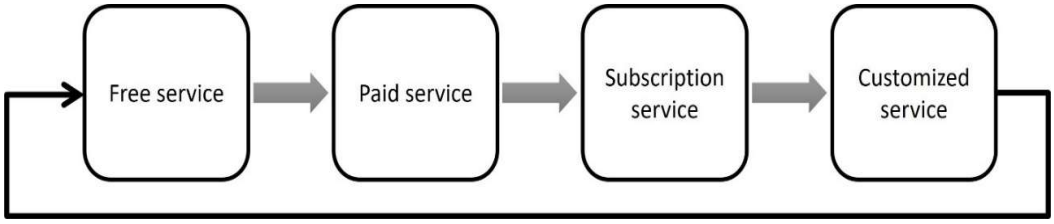

Figure 3: Conceptual diagram of learning services

The conceptual diagram of the learning service can be carried out as a paid service that provides feedback, starting with a free coding lecture that can code mathematics with Python [Figure 3]. And the service was constructed by providing a monthly learning method according to the learner's level and then providing a customized service. In addition, it has the characteristics of providing non-face-to-face consulting services through the online web for learning contents suitable for learner and providing non-face-to-face services to recommend information necessary for learning to learners. A non-face-to-face online-based, learner-level customized math coding education device model was designed that includes a learner coding evaluation unit that receives learner coding responses through coding learning content to construct program codes and checks syntax and semantic errors about the program code above [Figure 4]. An online learning business model was designed and applied for a patent. The online learning business model was designed and represented by level in figure 4.

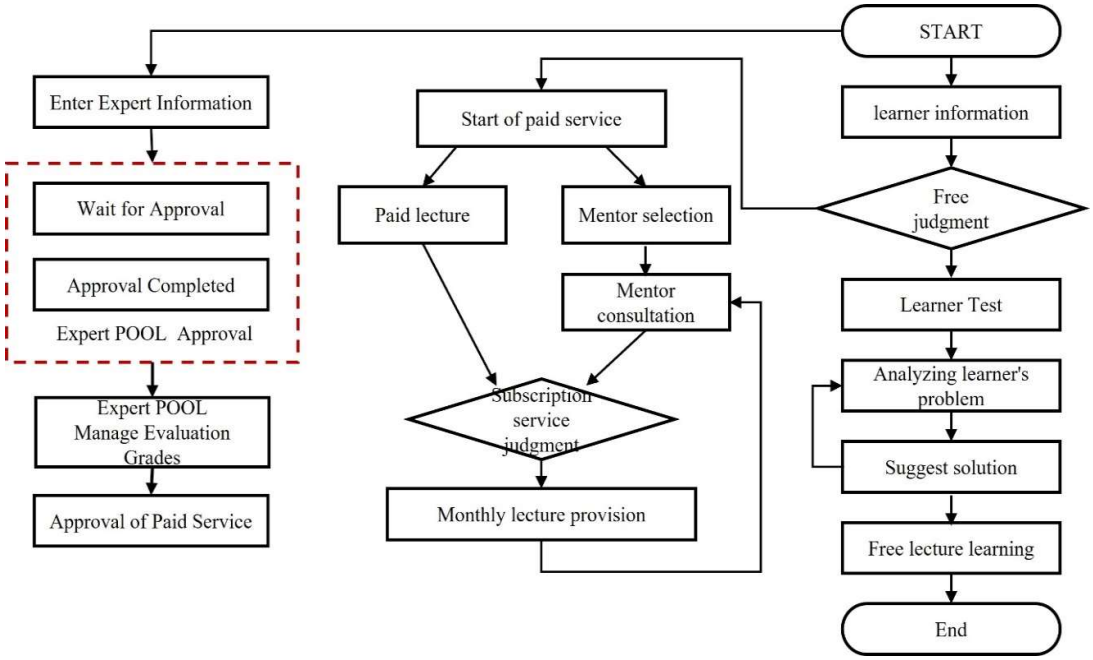

Figure 4: Online Learning Business Model Design

First, a learning model was designed to diagnose the level of mathematics by qualitatively determining the level of mathematics by receiving a mathematical sample response to a level-specific mathematics sample problem from the learner terminal and providing it to the expert terminal. Second, a coding sample response to a level-specific coding sample problem was received from the learner terminal, provided to the expert terminal, and a coding process and coding result of the level-specific coding sample problem were evaluated by the expert terminal to diagnose the learner's coding level by determining the coding vulnerability. Three, a learning content determination unit was designed to construct content for learning mathematics based on the mathematics level and determine the content for coding learning based on the above content for learning mathematics. A coding

learning content control function was designed to adjust the blank level of the coding learning content based on the net learner's coding level and provide hints about the blank.

4. CONCLUSION

With the spread of smart devices and the increase of smart learning platforms, users' preference for viewing images using devices is increasing. The demand for using personal tutors rather than educational methods that only watch videos through smart devices is increasing. Accordingly, artificial intelligence technology is used for customized education, and as AI technology is gradually developing, research and investment in smart learning are increasing at the same time in the education world, which is an important area for user personalization. Mathematics and coding are at the center of it. Coding and mathematics have common denominators such as logic and procedural problem solving. Therefore, it is expected that the learning effect can be doubled if coding learning and mathematics learning are performed at the same time. In addition, solving math problems through computer programming allows learners to experience how math can be applied to other fields.

Finally, mathematics learning itself can motivate coding learning. This study is about a mathematics education method using Python coding, and more specifically, by applying coding to solve math problems, we try to understand the concepts of mathematics and coding and seek to improve the quality of education. It is believed that individual competencies can be improved by simultaneously educating computational thinking and coding, rather than simply solving them with block coding. If programming itself is used as a tool for learning mathematics, it is expected that learners will be able to naturally develop programming skills while learning mathematics. This research model aims to differentiate it from the existing services by increasing learners' satisfaction by fusion of mathematics and coding, beyond the framework of the existing video class that provides simple math problem solving. In conclusion, this innovative educational model, developed by a team of experienced math and coding experts, not only enhances problem-solving skills by combining math and coding by incorporating customized learning methods focused on computational thinking skills, but also fosters deeper understanding and interest in the subject. This approach is tailored to the individual learner level, providing step-by-step guidance and real-time feedback through an automated scoring system. By providing a subscription service that provides customized content, it ensures effectiveness and participation in learning. In addition, the mentoring system supports the development of consistent learning habits, making the process enjoyable and increasing learners' confidence in both math and coding. The model ultimately seeks to improve the effectiveness of learning through a design model that provides mentoring and content that induces learning by overcoming traditional teaching methods and maximizing learners' potential.

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