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Empowering Sustainable Futures: Insights from the Integration and Impact of Software-Gifted Classes in South Korea

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Abstract: The purpose of this research is to introduce and analyze key insights into South Korea's unique field of gifted education, with a specific focus on software-gifted classes and the process of their integration into the education landscape. This study spans a seven-year period, divided into two parts: the first part examines insights gained during the establishment of these classes, while the second part derives structural relationships by analyzing students' perceptions during the recent three-year expansion of software-gifted classes. The findings of this research provide essential insights into the operation and expansion of software-gifted classes, highlighting the pivotal role of the educational process and content. Furthermore, the study indicates that the interests of gifted students significantly influence their achievements and career development, thereby paving the way for a sustainable future.

Keywords: gifted education; software-gifted classes; educational process; software career development; interest in software education

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1. Introduction

The primary aim of this research is to introduce South Korea's software-gifted classes and extract insights acquired over a seven-year period encompassing their introduction and integration into the educational landscape. These valuable insights are intended to inform and guide their future expansion and development. To acquire these insights, we divided the operational timeline of the gifted classes into two distinct phases. During the initial introduction period, spanning from 2016 to 2017, we conducted quantitative analysis to scrutinize the selection process for gifted students and the composition of the initial curriculum. Subsequently, during the settlement period from 2020 to 2022, we conducted surveys among gifted students to construct a structural model and gain a deeper understanding of their interests and achievements.

In recent decades, the field of technology education has witnessed a remarkable surge in the development of comprehensive courses encompassing both software and hardware components. This proliferation has introduced a gamut of challenges and opportunities in the strategic planning, execution, and enhancement of sustainable technology education. This research strives to illuminate the sustainability aspect within the domain of technology education, with a specific emphasis on the distinctive realm of software-gifted classes in South Korea.

In 2015, the South Korean Ministry of Education announced a talent development plan aimed at fostering expertise for a software-centered society [1]. Various policies were introduced to cultivate the software talent required for the future of society and industry. Based on these policies, in 2016, 30 software-gifted classes were selected and began, with the primary objective of providing diverse support for students who exhibited interest and aptitude in the software field, enabling the early development of their talents [2].

- The target gifted classes referred to in this study are special classes established and operated within elementary and middle schools, up to and including high school

level, in accordance with the Elementary and Secondary Education Act, specifically designed for gifted education;
- The target schools have added or established a class specifically for software-gifted education, applying a software education curriculum;
- A total of 17 education offices in various regions and cities in South Korea collected and submitted operational plans for these gifted classes;
- The Korea Foundation for the Advancement of Science & Creativity (KOFAC) evaluated these operational plans and confirmed the selection and support for the gifted classes;
- Once the foundation agreements were established, the software-gifted classes began to independently formulate and implement their own educational curricula;
- Software-gifted education in each of these classes was implemented through special activities, discretionary activities, and after-school programs.

At the commencement of software-gifted classes, a supporting unit, the software-gifted class support team, was established to collaborate in their operations. This support team was responsible for developing training content for teachers specializing in software-gifted education and managing teacher training sessions and workshops. The support team continues to operate to this day, providing ongoing support in various forms, including competence development for the designated teachers and assistance for software-gifted creativity competitions.

In 2023, the South Korean government introduced the 5th Comprehensive Plan for Gifted Education Promotion, including the direction and challenges of gifted education for the next five years [3]. In this plan, raising talent to lead creative innovation across various societal domains was established as a national priority. Given the current stage, over two decades since the inception of gifted education in South Korea, the plan requests to reinforce software-gifted education, find hidden talents, and redefine the national and societal role of gifted education by enhancing personalized support based on individual student characteristics. According to the plan, software-gifted classes are set to increase to 100 by 2027, playing a fundamental role in the early identification and development of digital talents. As both the scale and role of these classes grow, effective achievement of their original objectives will necessitate analyses and insights from various perspectives [4].

In this context, we have formulated our research questions, which we consider important at this stage.

Research Questions:

- First, how were software-gifted classes introduced in South Korea?
- Second, what insights can be gained from their introduction process?
- Third, what can we learn from the process of software-gifted classes becoming settled?

To address these research questions, we initially studied the characteristics of software-gifted classes that were operating in 2016 and 2017, determining their features. Building upon the results of this analysis, we defined this period as the “introduction period” and delved into an analysis of the operational hours, educational curriculum, teaching methods, and evaluation approaches of these gifted classes. Subsequently, we examined the characteristics spanning from 2020 to 2022, defining this period as the “settlement period”. During this timeframe, we used data collected by the software-gifted class support team to analyze the perceptions of students as the software-gifted classes expanded and to derive structural relationships.

The necessity and significance of our research are as follows:

In order for software-gifted classes to be included in the realm of sustainable technology education, there is a need for the development of an educational curriculum and framework that reflects and applies the characteristics of gifted students. This research aims to analyze the process of introduction and settlement to derive gifted class and gifted student characteristics that can be applied in curriculum and framework development.

Furthermore, through this research, we believe that we can contribute to the addition of new domains in sustainable technology education. By understanding the relevance between software-gifted education and sustainable technology education, we aim to introduce and expand sustainable technology education in South Korea.

2. Related Works

2.1. Gifted Education in South Korea

The Special Act on the Promotion of Gifted Education in South Korea provides the definition and fundamental framework for gifted education in the country. The enforcement decree of the law specifies the detailed provisions related to gifted education. Gifted education in South Korea is organized within a system consisting of gifted schools, gifted education institutes, and gifted classes, all governed by central government agencies and local educational authorities. Additionally, there is support from the Gifted Education Research Institute [5]. We have illustrated this system in Figure 1.

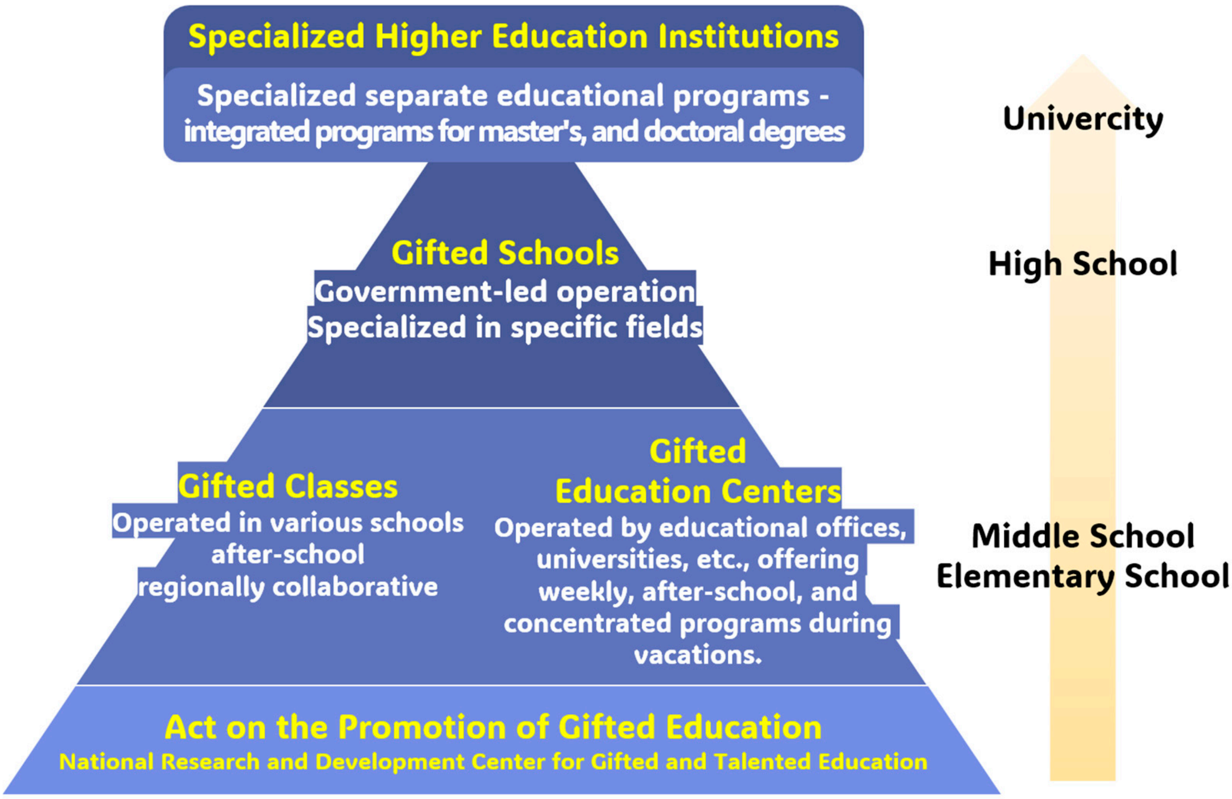

Figure 1. The Gifted Education System in South Korea.

In South Korea, candidates for gifted education are selected based on the type of gifted education institution they apply to. Gifted schools are educational institutions established within regular full-time high schools, providing gifted education. Gifted education institutes and gifted classes, on the other hand, are non-full-time gifted education institutions located in universities, educational offices, and individual schools. These institutions have introduced and applied various policies to minimize the effects of private education and pre-learning while also striving to discover the gifted potential among marginalized populations.

2.2. Software-Gifted Education in South Korea

Information-gifted education in South Korea has been implemented since its establishment in 1998 [6]. We have compiled various definitions of information giftedness from related research in South Korea in Table 1 [7–10].

Table 1. Definitions of information and software gifted.

Researcher (Year)	Definitions
Kim Yong (2008) [7]	• Grounded in creative thinking abilities, outstanding intellectual capacity, and task persistence; • Students who can contribute to the field of information by utilizing advanced information devices to apply logical and creative thinking rooted in outstanding creative ideas.
Kim Kapsu and Min Meekyung (2018) [8]	• A student with rule creation skills, reasoning ability, generalization skills, structuring skills, and abstraction ability.
Kim Ji Seon (2016) [9]	• Students with curiosity and talent in the information field. • Those who can creatively solve problems through outstanding system design and implementation capabilities.
Lee Jae ho et al. (2018) [10]	• Students with specialized talents in the software field while pursuing knowledge in various fields; • Individuals with the competence to solve problems they face by utilizing convergent thinking and creative thinking; • Students who can handle tasks independently based on a sound sense of identity and a sense of social responsibility.

As research in computer science giftedness advanced, theories regarding software-giftedness began to arise. The establishment of the software-giftedness criteria and the activation of software-gifted education led to substantial research progress.

In previous studies before this research, there have been studies such as platform analysis for guiding outputs in software-gifted students and perception and satisfaction analysis among software-gifted students, parents, and teachers. Kim conducted research on the cognitive characteristics of information-gifted students. After defining cognitive giftedness, he developed and applied information problems suitable for giftedness. The research results defined information-gifted students as those possessing informational structural memory, categorization ability, inference ability, generalization ability, structuralization ability, and abstraction ability [11]. Jung, Lee, and Park observed trends in research targeting parents in the field of gifted education to derive implications. They viewed parental research in the gifted education field as a success factor and argued that parental research should be further activated [12]. Additionally, research has been conducted on various tools and platforms that can be used in gifted education. Park and Shin conducted education in web scraping and text processing using block-based coding languages and shared their outcomes [13,14].

2.3. World Gifted Education Research

In this study, we used the term "Software Gifted Education". Although we did not find any information about the use of the term "Software Gifted Education" in national policies, we conducted a review of prior research and explored and summarized various related studies from around the world.

In 2016, Lee, Kang, and Lee introduced South Korea's gifted education law to global viewers. As mentioned in our initial related research findings, South Korea's gifted education aims for self-realization in the individual area and contributes to national and societal development in the social area, distinguishing it from Western gifted education. These distinctions are believed to have played a significant role in the emergence of software-gifted education as a specialized field. For instance, South Korea's gifted education programs often incorporate highly competitive and rigorous entrance exams and evaluation processes, which prioritize excellence and academic achievement. In contrast, many Western gifted education programs tend to focus on fostering creativity, critical thinking, and a well-rounded education that encourages self-expression and individual growth. This fundamental difference in educational philosophies and priorities has contributed to the development of distinct approaches to gifted education, including the specialized field of software-gifted education in South Korea [15].

There are also varied cases of research on gifted education in Asia [16]. Ibata-Arens analyzed gifted education in Asia in a paper that compared Asian countries' science and mathematics achievements, reading abilities, and gifted education policies and practices with those of the United States and Canada [17]. She provided insights into gifted education policies and practices and highlighted how Asian countries are rapidly developing various policies and national systems to support outstanding students. Additionally, she proposed further development strategies for gifted education in the United States. Ford, Moore III, and Milner conducted research on cultural models influencing gifted education [18]. They studied the impact of culture on gifted education outcomes among culturally diverse students, highlighting that giftedness may be evaluated differently based on culture and emphasizing the importance of understanding cultural differences.

3. Research Method

3.1. Introduction of Software-Gifted Classes

We analyzed the activities of the software-gifted class support team that has been operating since 2016 [19,20]. They managed and supported individual software-gifted classes, which numbered 30 at the beginning, to achieve their goals. To gain insights into the introduction of software-gifted classes, we analyzed how software-gifted classes were operated each year by obtaining answers to two questions.

- Question 1: How were students selected, and what methods were used for selecting gifted students?

To answer this question, we compiled and analyzed the selection competition rates and methods for software-gifted classes that were operated in 2016 and 2017, during the introduction period. We categorized the selections into elementary and middle school levels and collected data on applicants, the number of selected students, and competition rates. We classified the methods used for selecting gifted students into five categories: written exams, interview assessments, observation assessments, recommendations, and school records. We also identified cases where multiple methods were used.

- Question 2: How was the curriculum of software-gifted classes structured?

To answer this question, we analyzed the curriculum of software-gifted classes that were operated in 2016 and 2017 during the introduction period, year by year. We established criteria by setting the fields and core concepts of information science and categorizing which fields and core concepts were highly covered.

3.2. Settlement Period of Software-Gifted Classes

We utilized the perception survey results from the software-gifted class support team for the years 2020 to 2022 [21–23]. Students participating in the software-gifted class program responded to perception surveys twice a year. The purpose of the survey is to understand the perceptions, attitudes, and satisfaction levels of the members of the software-gifted class and utilize this information to establish directions for improved support. The questions were developed through collaboration among the research team of the software-gifted class support team and consist of [4 categories] with a total of 31 questions. Examples of survey questions for each category are as follows:

- [Interest] I believe that software education can enhance my computational thinking skills;
- [Interest] I feel interested when solving software coding assignments;
- [Achievement] While studying software, I can now easily solve what I found difficult at first;

- [Career] If I go to college, I will choose software as my major;
- [Career] I have decided on a career related to the software field and know what I need to do.

The targeted students responded to questions on a Likert 5-point scale ranging from "Strongly Agree" to "Strongly Disagree", and all students in the software-gifted class were surveyed. Students voluntarily participated in the perception survey.

Overall information about the students targeted in this study is presented in Table 2. The one-year educational program for software-gifted students starts in March, but the first perception survey was conducted in June, shortly after the completion of the support team's composition. We designated the period from November to December, which coincides with the Software Gifted Creative Competition organized by the KOFAC, as the timeframe for the second perception survey.

Table 2. Recognition survey overview.

Year	Number of Classes (Elementary, Middle, Ungraded)	Number of Respondents	Survey Period
2020	29 (19, 9, 1)	1st: 255	8 June 2020, to 8 July 2020
		2nd: 139	9 December 2020, to 16 December 2020
2021	30 (19, 10, 1)	1st: 251	15 June 2021, to 27 June 2021
		2nd: 260	20 November 2021, to 17 December 2021
2022	40 (29, 12, 1)	1st: 381	7 June 2022, to 26 June 2022
		2nd: 301	31 October 2022, to 26 November 2022

3.2.1. Variable Setup

Lee, Jang, Shim, and Kwon conducted research on Software Giftedness. Their research results proposed Software Giftedness with three core competencies, 12 characteristic factors, and 36 specific elements [10]. In this study, Software Giftedness was defined as individuals with diverse characteristics, including a pursuit of knowledge in various fields, specific talent in software, creative and convergent thinking in problem-solving, a strong sense of identity and social responsibility, and the ability to work independently. We believe that the targeted software-gifted students encompass these competencies and various characteristics, and that these traits can influence their achievements and career choices.

To measure the characteristics and growth potential of participating gifted students, we established numerous variables and then defined three latent variables. We utilized the categories identified in the research by Lee, Jin, and Jeong, specifically "Software Education Interest", "Software Achievement", and "Software Career Development". We determined that these three variables could effectively abstract a larger set of measurement variables and selected structural equation modeling as the appropriate model for estimating the relationships among these abstracted variables [4]. Table 3 presents the analysis variables used in our study.

Table 3. Analysis Variables.

Latent Variables	Measurement Variables	Characteristics and Summaries of Items
Software Education Interest	Perception of Future Value	• The importance of SW gifted education; • The future utility of SW gifted education.
	Perception of Growth	• Whether SW education can help their growth; • The potential of SW education to assist in their self-development.
	Interest in Learning	• Interest in the SW education program; • Interest in the specific learning elements of SW education.
Software Achievement	Learning Achievement	• Achievement in SW education field learning.
Software Career Development	Career Planning	• Career planning for students directly applying SW education to majors and careers.
	Preparatory Actions for Career	• The level of career decision-making in fields related to SW education; • The extent of specific preparatory actions.

3.2.2. Hypothesis Formulation and Research Model Design

We established variables and categorized various measurement variables based on software education interests. Upon reviewing the characteristics of each variable, we inferred that if students recognize their future value, acknowledge their personal growth, and maintain a keen interest in learning, their academic achievement is likely to naturally increase. Furthermore, assuming that engaging in various activities and achieving high levels of accomplishment can also have a positive impact on career development, we formulated the following hypotheses:

Hypothesis 1. *The interest of software-gifted students in software education will influence their achievements.*

Hypothesis 2. *The interest of software-gifted students in software education will influence their career development.*

Hypothesis 3. *The achievements of software-gifted students will influence their career development.*

Based on prior research and hypotheses, we designed the research model as shown in Figure 2 [4].

3.2.3. Analysis Method and Procedure

To address the research questions and test the validity of the hypotheses, we used the following analysis methods and procedures: Initially, we preprocessed the data using SPSS 24.0 and constructed a structural equation model using AMOS 24.0. First, we conducted descriptive statistics and frequency analysis to identify outliers in the variables included in the research model, check for missing data, assess data normality, and understand the characteristics of the study participants. Second, using SPSS 24.0, we performed reliability analysis, correlation analysis, and factor analysis on the variables. Third, we utilized structural equation modeling to assess model fit and examine relationships between variables. Additionally, we used the bootstrap analysis method to validate mediating effects.

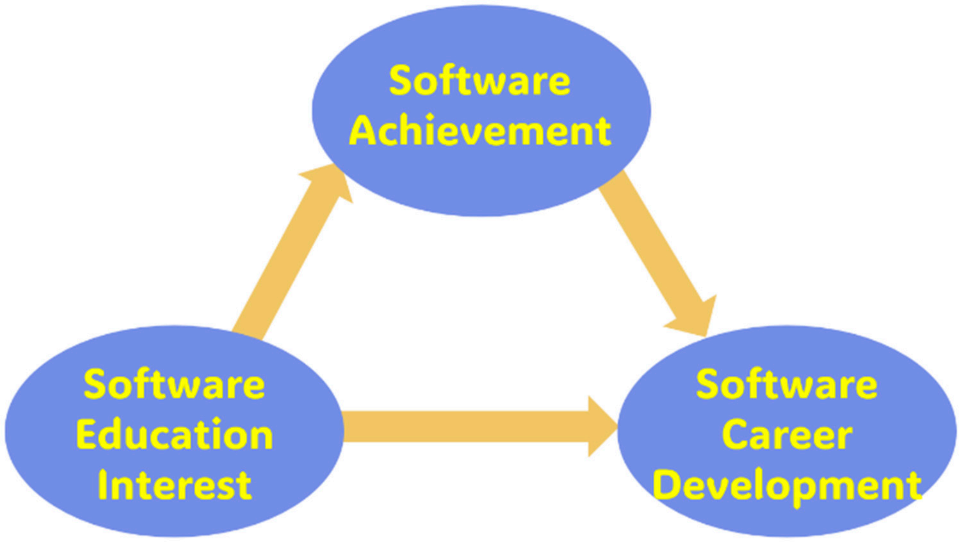

Figure 2. Research model.

4. Research Results

4.1. Insight from the Introduction Period

4.1.1. Selection Competition Rates and Method

We have summarized the selection competition rates and methods for the software-gifted class in 2016 and 2017 in Table 4.

Table 4. Selection-related information.

Year	Applicants		Number of Selected Students	Competition Rate
2016	Elementary	623	345	1.81
	Middle	373	230	1.71
	Overall	996	575	1.77
2017	Elementary	583	376	1.6
	Middle	239	189	1.3
	Overall	822	565	1.5

Competition ratio = number of applicants/number of selections made.

The competition ratio during the initial two years of the software-gifted class was not high. As observed in Table 4, the competition ratio ranged from 1.3 to 1.81, and we anticipated it would be lower than the competition ratios for gifted students in other categories, such as mathematics, science, and other fields. We found the reasons for this in the statistical yearbook representing the overall state of gifted education in South Korea for the year 2016. In that year, the percentage of students receiving education in mathematics, science, and math-science combined gifted programs was 79.5%, while the percentage of students receiving education in information science, including software, was only 3.4% [24].

This phenomenon can be attributed to the fact that mathematics and science education have traditionally been the focal points of gifted education in South Korea. It underscores the need to introduce various strategies to establish software-gifted classes successfully.

We organized the student selection methods in Table 5 and analyzed their implications. Written exams and interviews are suitable assessments for selecting students with a certain level of interest and achievement. To identify potentially gifted students, a variety of methods are necessary, and in the early stages of the software-gifted class, observation and student records were utilized.

Since 2009, a teacher recommendation system called the “Teacher Observation Recommendation Criteria” has been introduced for selecting gifted students. This system focuses on using various selection criteria rather than relying solely on written exams.

It includes teacher recommendation checklists, descriptive recommendation letters, and tools for observing creative problem-solving skills. Our analysis of the results highlights the need to reduce the weight of written exams and establish selection criteria tailored to software-gifted education [24].

Table 5. Gifted student selection methods.

Year	Grade	Written Exam	Interview	Recommendation Letters	Observation	School Records
2016	Elementary	88.9	77.8	61.1	33.3	0
	Middle	100	83.3	41.7	0	8.3
	Overall	93.3	80.0	53.3	20.0	3.3
2017	Elementary	85.0	80.0	45.0	70.0	5.0
	Middle	77.8	100	44.4	33.3	11.1
	Overall	82.8	86.2	44.8	58.6	6.9

Unit: %.

4.1.2. Curriculum Composition

We analyzed the curriculum of the software-gifted class in 2016 and 2017, grouping which fields and key concepts were covered. The initial curriculum of software-gifted classes is not standardized. Some content is determined at the national level, but individual schools operating gifted classes construct and manage their own educational programs. In the early stages, the operational criteria primarily focused on providing over 100 h of specialized software education within a year, and the specific educational programs were heavily influenced by the discretion of the supervising teachers. Therefore, in the early curriculum of software-gifted classes, a significant portion was aligned with the information domain curriculum of that time, and differences in teaching methods and evaluation methods emerged depending on the teachers' perspectives [19,20].

The categorization criteria for 2016 were based on the fields and key concepts of the information curriculum then applied in South Korea. We classified them into four fields, including educational content that was not part of those fields, as shown in Table 6.

Table 6. Composition of the curriculum in 2016.

Fields	Core Concepts	Total	Elementary School	Middle School
Information Culture	Information Society	2.1	2.9	0.6
	Information Ethics	0.8	1.2	0.1
Data and Information	Representation of Data and Information	6.5	6.2	7.0
	Analysis of Data and Information	9.7	9.3	7.5
Problem Solving and Programming	Abstraction	8.6	9.3	10.5
	Algorithms	11.8	12.5	10.5
	Programming	28.8	27.3	31.5
Computing Systems	Principles of Computing Systems	7.6	6.7	9.3
	Physical Computing	22.4	22.3	22.5
Topics not included in the above		1.7	2.3	0.5
Total		100	100	100

Unit: %.

In 2016, the software-gifted class curriculum placed the most emphasis on two areas: programming and physical computing. What these two areas had in common was their foundation in computational thinking. We discovered that software-gifted students were learning to enhance their computational thinking skills through educational processes that included abstraction, algorithms, and data analysis, among other aspects. Furthermore, it was evident that the conducting teachers of the gifted classes were making various attempts and applying diverse areas during the introductory period.

We used improved criteria in 2017. Since the establishment of the software-gifted class in 2016, various studies have been conducted, especially on the development of the base curriculum for software-gifted education. We categorized the curriculum of the software-gifted class in 2017 based on the fields and key concepts of the basic curriculum using Table 7.

Table 7. Composition of the curriculum in 2017.

Fields	Core Concepts	Total	Elementary School	Middle School
Understanding Information Science and Technology	Computing Systems	20.0	20.7	18.3
	Networks	10.	0.3	2.8
	Data Structures	1.9	1.0	3.9
Computational Thinking and Integration	Real-World Data Formats	11.9	12.0	11.7
	Data Abstraction	1.9	1.5	2.8
	Algorithm Modeling	11.6	8.3	18.9
	Automation	36.4	40.4	27.2
Exploration and Representation of Knowledge Information	Information Evaluation	0	0	0
	Information Graphics	0.7	0.5	1.1
Information Society and Exploratory Communities	Empathy, Responsibility, Justice, Challenge	6.2	8.0	2.2
Topics not included in the above		8.4	7.3	11.1
Total		100	100	100

Unit: %.

We found that second-year software-gifted students were learning in an environment that emphasized the concepts of computing systems and automation. As conducting teachers developed and implemented their own curriculum within the school, they referenced existing curricula while also tailoring them to accommodate the specific characteristics of the school and its students.

Additionally, we observed that both the 2016 and 2017 curricula consistently included a significant proportion of content related to computational thinking. If this characteristic continues to persist in the future, it may allow us to summarize the relevance of software-gifted education to computational thinking.

4.2. Implications of the Settlement Period

4.2.1. Key Variable Descriptive Statistics

In our research, we constructed a model with three latent variables: interest in software education, achievement, and career development. The minimum and maximum values for all variables ranged from 1 to 5. Additionally, descriptive statistics were used to examine the mean, standard deviation, skewness, and kurtosis of the key variables in the structural equation model.

To enhance reliability, we conducted a reliability analysis by removing items that did not adequately explain the measurement variables. Cronbach's alpha coefficient, which typically considers values between $0.6 < \alpha < 0.7$ as acceptable, $0.7 < \alpha < 0.8$ as good, and

0.8 < α < 0.9 as excellent [25], was used to assess reliability. Table 8 presents the reliability of the six models used in our research, along with the mean and standard deviation for each variable's overall items.

Table 8. Variable reliability analysis results.

Variables (Number of Items)	Category	Yearly Perception Survey Rounds and Participants					
		20-1 *N* = 255	20-2 *N* = 139	21-1 *N* = 251	21-2 *N* = 260	22-1 *N* = 381	22-2 *N* = 301
Software Education Interest (15)	Mean	4.01	3.94	3.91	3.9	4.09	4.28
	Standard Deviation	0.828	0.979	0.938	0.944	0.928	0.933
	α	0.828	0.912	0.83	0.864	0.879	0.927
Software Achievement (5)	Mean	3.72	3.68	3.43	3.49	3.73	4.05
	Standard Deviation	0.895	1.021	1.118	1.178	1.088	1.071
	α	0.853	0.889	0.707	0.789	0.845	0.88
Software Career Development (5)	Mean	3.6	3.54	3.57	3.6	3.38	3.74
	Standard Deviation	1.032	1.189	1.161	1.24	1.29	1.289
	α	0.804	0.876	0.846	0.891	0.962	0.973

4.2.2. Structural Model Analysis Results

To assess the fit of our structural model, we initially analyzed the measurement model. To validate the model, we used fitness indices such as CFI, RMSEA, and SRMR to assess model fit. In cases where the model fit was not appropriate, we first removed measurement variables that were not significant in their relationship with latent variables. In some models, we additionally removed measurement variables with SMC values below 0.4. Finally, we confirmed that all six measurement models showed fitness above the threshold.

Furthermore, we examined six structural models and represented the relationships between variables in Table 9. Variables with significant impacts are denoted with bolded C.R. values.

Table 9. Structural model analysis results.

Order	Software Education Interest to Software Achievement				Software Education Interest to Software Career Development				Software Achievement to Software Career Development			
	Estimate		S.E.	C.R.	Estimate		S.E.	C.R.	Estimate		S.E.	C.R.
	B	β			B	β			B	β		
20-1	0.862	0.57	0.123	**6.984** ***	0.816	0.461	0.157	**5.195** ***	0.082	0.07	0.092	0.899
20-2	0.933	0.848	0.081	**11.486** ***	0.452	0.355	0.178	**2.539** *	0.443	0.382	0.164	**2.704** **
21-1	0.951	0.689	0.119	**8.01** ***	0.445	0.254	0.157	**2.836** **	0.618	0.487	0.123	**5.027** ***
21-2	0.928	0.822	0.078	**11.863** ***	0.076	0.054	0.182	0.417	0.959	0.77	0.179	**5.356** ***
22-1	1.045	0.835	0.076	**13.82** ***	0.036	0.024	0.151	0.241	0.856	0.703	0.13	**6.602** ***
22-2	1.325	0.917	0.101	**13.102** ***	−0.296	−0.169	0.361	−0.82	1.141	0.94	0.263	**4.332** ***

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

4.2.3. Hypothesis Testing Results

Based on the analysis of the structural model, we finally confirmed the acceptance of the hypotheses. The hypothesis testing results obtained from the structural equation model analysis are presented in Table 10.

Table 10. Final adoption status of the hypotheses.

Number	Hypotheses Content	Adoption Status					
		2020		2021		2022	
		20-1	20-2	21-1	21-2	22-1	22-2
Hypothesis 1	The interest of software-gifted students in software education will influence software achievement.	Accepted	Accepted	Accepted	Accepted	Accepted	Accepted
Hypothesis 2	The interest of software-gifted students in software education will influence software career development.	Accepted	Accepted	Accepted	Rejected	Rejected	Rejected
Hypothesis 3	Software achievement of software-gifted students will influence software career development.	Rejected	Accepted	Accepted	Accepted	Accepted	Accepted

We confirmed that interest in software education has a static impact on achievement. However, it was observed through the hypotheses that interest in software education does not always affect career development, while achievement mostly has a static impact on career development.

5. Conclusions

Through our research, we have conducted a comprehensive investigation into gifted education worldwide. We have explored various studies, ranging from comprehensive research to in-depth investigations into the characteristics of gifted students. Drawing from the findings of Boettger and Reid, we examined how European countries approach support in the field of gifted education. They emphasized that many European educators should receive training for selecting gifted students and advocated for equitable and successful education for all students [26].

Similar insights have emerged from research on gifted education in Asia. In their study, Vialle and Ziegler analyzed the rapidly evolving landscape of gifted education in Asia and presented several ways for its further enhancement. In this study, we refer to their insights to derive our conclusions. Firstly, they underscored the importance of considering a specific country's cultural strengths when developing specialized gifted education, highlighting it as a key factor for success. Moreover, they emphasized the need for a detailed analysis of the characteristics of gifted students to strengthen gifted education, which is a primary focus of our research [27].

In our study, we introduced South Korea's software-gifted education program and shared insights into the challenges during its introduction and settlement. Leveraging the insights gained from the research, we can propose recommendations for the future development of the software-gifted education program:

- Conclusion 1: We observed the dedicated efforts of teachers within South Korea's software-gifted education program as they employed diverse selection methods to recruit exceptional students during the introduction period. The selection of students with potential and their effective education through appropriate processes are foundational to nurturing talent in South Korea. We believe that the insights from the introduction period will continue to be invaluable as the software-gifted education program expands in the future;
- Conclusion 2: We underscored the significance of fostering interest in software-gifted education. The results of our hypothesis testing provided partial confirmation of its importance. However, we also recognized certain limitations, as interest alone may not be directly linked to career development;
- Conclusion 3: Among the various components of the annual software-gifted education program, the creative competition plays a particularly vital role. As gifted students develop their own projects, present them, and address real-world problems, the significance of interest, as highlighted in this research, becomes even more pronounced.

The amalgamation of these three conclusions paints a comprehensive picture of the significance and potential of South Korea's software-gifted education program. Together, they contribute to a holistic understanding of how this program can effectively nurture talent, facilitate meaningful learning experiences, and ultimately drive sustainable development in the field of software and technology:

- Conclusion 1 reveals the critical role of dedicated teachers and a well-thought-out selection process in identifying and nurturing exceptional students. These foundational elements ensure that gifted students receive the necessary attention and tailored education to thrive. As the software-gifted education program expands, the insights gained during the introduction period become invaluable guides, ensuring that the program maintains its effectiveness and relevance. This approach not only benefits individual students but also contributes to a sustainable talent pipeline in South Korea's technology sector;
- Conclusion 2 highlights the importance of fostering interest in software-gifted education. While the results offer partial confirmation of the significance of interest, they also underscore the need to recognize its limitations in direct career development. This finding emphasizes that nurturing interest should be part of a broader strategy that includes additional support systems to guide gifted students from education to professional success. By doing so, the program can help students not only develop their skills and interests but also navigate the complexities of career development, thus contributing to the sustainable growth of South Korea's technology industry;
- Conclusion 3 delves into the role of creative competition within the program. It shows how this component provides a platform for gifted students to apply their skills, address real-world challenges, and deepen their interest in software development. The competition fosters active learning and practical skill application, reinforcing the significance of interest in the learning process. This not only enriches the educational experience but also prepares students for future careers in the software industry, aligning with the broader goals of sustainable development in technology.

In conclusion, these three conclusions collectively emphasize the multifaceted nature of South Korea's software-gifted education program. It recognizes the importance of dedicated educators, emphasizes the need to foster interest, and underscores the role of practical engagement and competition. When these elements work in synergy, they not only nurture individual talent but also contribute to the sustainable development of South Korea's technology sector by creating a well-prepared, motivated, and innovative workforce.

Our forthcoming research will concentrate on two primary domains of inquiry. Firstly, we are committed to crafting a computational thinking process model intricately woven with the fabric of students' interests. This model is poised to emerge as an indispensable tool for educators when crafting the software-gifted education curriculum, underscoring the pivotal role of interest and its integration into the developmental journey of gifted students. Our aim is to illuminate the significance of nurturing talent within the software-gifted classes by fostering an environment where interest-driven learning thrives.

Secondly, we envisage the design of a specialized career program meticulously tailored to cater to the unique needs of software-gifted students. With an unwavering commitment to cultivating future talents within the realm of software-gifted education, we recognize the paramount importance of exploring and elucidating students' career development pathways comprehensively. Consequently, we will institute a program intended to ensure that every software-gifted student in South Korea can avail themselves of its benefits, fostering a sustainable talent pipeline for the technology sector.

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References

1. Republic of Korea Government, Ministry of Education. *Software-Centered Society Promotion Plan*; MOE: Sejong, Republic of Korea, 2015; pp. 12–29.
2. The Korea Foundation for the Advancement of Science & Creativity. *2016 SW Gifted Class Support Project Operation Announcement*; KOFAC: Seoul, Republic of Korea, 2016.
3. Republic of Korea Government, Ministry of Education. *Comprehensive Plan for Gifted Education Promotion*; MOE: Sejong, Republic of Korea, 2023.
4. Lee, J.; Jin, S.; Jeong, H. A Study on the Relationship between Interest, Achievement, and Career Development with a focus on Student Participation in Software Gifted Classes. *J. Gift./Talent. Educ.* **2023**, *33*, 189–210. [CrossRef]
5. Republic of Korea. *Gifted Education Promotion Act*; Act of LAW: Seoul, Republic of Korea, 2017.
6. Jun, W. A Study on the Current Status and Improvement Plans of Gifted Elementary Information Education Curriculum. *J. Gift./Talent. Educ.* **2010**, *20*, 347–368.
7. Kim, Y. Development of On-line Learning Tools Evaluation Criteria for Gifted Students in Informatics. Ph.D. Thesis, Korea University, Seoul, Republic of Korea, 2008.
8. Kim, K.; Min, M. The Effects of Characteristics of Information Gifted Students on the Selection of Science Gifted Students. *J. Korean Assoc. Inf. Educ.* **2018**, *22*, 367–374. [CrossRef]
9. Kim, J. The Development and Application of On-Line Programming Learning Tutoring Strategy Based on Affective Learning Style of The Informatics Gifted. Ph.D. Thesis, Korea National University of Education, Cheongju, Republic of Korea, 2016.
10. Jang, J.; Lee, J.; Shim, J.; Kwon, D. A Study on Establishing the Concept of the Gifted in Software. *J. Creat. Intell. Converg. Cult. Technol.* **2018**, *4*, 69–81. [CrossRef]
11. Kim, K. A Study on Cognitive Characteristics of Information Gifted Children. *J. Korean Assoc. Inf. Educ.* **2013**, *17*, 191–198.
12. Jung, Y.; Lee, M.; Park, C. Research Trends for Parents-related Issues in the Field of Gifted Education. *J. Gift./Talent. Educ.* **2021**, *31*, 103–128. [CrossRef]
13. Park, Y.; Shin, Y. Novel Scratch Programming Blocks for Web Scraping. *Electronics* **2022**, *11*, 2584. [CrossRef]
14. Park, Y.; Shin, Y. Text Processing Education Using a Block-Based Programming Language. *IEEE Access* **2022**, *10*, 128484–128497. [CrossRef]
15. Lee, J.; Kang, B.; Lee, D. Law for Gifted and Talented Education in South Korea: Its Development, Issues, and Prospects. *Turk. J. Gift. Educ.* **2016**, *6*, 14–23.
16. Jin, W.S. An Analysis of Gifted Teachers' Interest in the Standards of National Gifted Education Program. *Asia-Pac. J. Converg. Res. Interchange* **2021**, *7*, 67–81. [CrossRef]
17. Ibata-Arens, K.C. Race to the Future: Innovations in Gifted and Enrichment Education in Asia, and Implications for the United States. *Adm. Sci.* **2012**, *2*, 1–25. [CrossRef]
18. Ford, D., III; Milner, H. James Beyond cultureblindness: A model of culture with implications for gifted education. *Roeper Rev.* **2005**, *27*, 97–103. [CrossRef]
19. Korea Foundation for the Advancement of Science and Creativity. *Final Report of the 2016 Software Gifted Class Support Team*; KOFAC: Seoul, Republic of Korea, 2016; pp. 8–49.
20. Korea Foundation for the Advancement of Science and Creativity. *Final Report of the 2017 Software Gifted Class Support Team*; KOFAC: Seoul, Republic of Korea, 2017; pp. 15–57.
21. Korea Foundation for the Advancement of Science and Creativity. *Final Report of the 2020 Software Gifted Class Support Team*; KOFAC: Seoul, Republic of Korea, 2021; pp. 12–42.
22. Korea Foundation for the Advancement of Science and Creativity. *Final Report of the 2021 Software Gifted Class Support Team*; KOFAC: Seoul, Republic of Korea, 2022; pp. 6–38.

23. Korea Foundation for the Advancement of Science and Creativity. *Final Report of the 2022 Software Gifted Class Support Team*; KOFAC: Seoul, Republic of Korea, 2022; pp. 27–68.
24. Ministry of Education and Korea Institute for Curriculum and Evaluation. *Gifted Education Statistical Yearbook*; Statistical Data SM-2016-09; GED: Seoul, Republic of Korea, 2016.
25. Devellis, R.F. *Scale Development: Theory and Application*; Sage: Los Angeles, CA, USA, 2012.
26. Boettger, E.R.H.; Reid, E. Gifted education in various countries of Europe. *Slavon. Pedagog. Stud. J.* **2015**, *4*, 158–171. [CrossRef]
27. Vialle, W.; Ziegler, A. Gifted Education in Modern Asia. *Gift. Educ. Asia Probl. Prospect.* **2015**, *1*, 273.