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Confronting Educational Challenges and Reshaping Future Education

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“Unless you challenge yourself, you will not learn. You will not grow. Education is the art of challenging and overcoming.”

—Amit Ray

EDUCATION is more complicated and difficult than many other human activities because it involves the complexity and diversity of mankind. For centuries, numerous educational practitioners and researchers have devoted themselves to the exploration of educational practice and theories and have achieved remarkable accomplishments. However, humans are still plagued by a multitude of educational complications. *Reimagining Our Futures Together: A New Social Contract for Education* published by UNESCO in 2021 is a report that integrates investigations, evaluations, imagination, and initiatives in response to a series of crises in global educational transformation. It raises some essential questions: What should be the proper educational paradigm for the future decades leading to 2050 and beyond? What roles should future education play in improving people’s quality of life, eliminating injustices, and promoting peaceful and sustainable development of humanity? How to reshape the futures of mankind and the planet by recasting knowledge structure, teaching, and learning in a world of increasing complexity, uncertainty, and fragility (UNESCO, 2021)? The Report offers us implications in various aspects including: educational investment – to make input in education the first priority and ensure precision management of the

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funding; inclusion and equality – to provide care and service to the underprivileged and groups who needs special education; digital and AI education – to be alert to the “digital divide” and the consequential exacerbated educational inequity; changes in global environments, which might affect the patterns of international exchange and cooperation in education.

Educational development is the foundation for the renewal and transformation of the world. To better serve the growth of students and societal development, it is crucial to conduct relevant research on educational issues – to identify the fundamental, critical issues that have constrained educational development, to investigate into them, and find solutions to problems. That is what this journal has been committed to. Over the past year, it has focused on subjects such as the reform of basic education and teaching across the world, the development of regional education, the impact of educational environments on education and teaching, the application of information technology to teaching, new classroom instruction models as well as the innovation of curricula and course contents, in an effort to provide pathways to the effective solution to prevalent problems in global education.

In this issue, topics such as reliability generalization study of the computational thinking scale (Kiyici & Kahraman, 2022), scientific reasoning skills of pre-service science teachers (Sahin & Sasmaz Oren, 2022), challenges of future education (Hua, 2022), mobile game addiction among schoolchildren (Feng, 2022), reading behavior of primary and secondary school students (Zhou, 2022) are discussed. Looking to the coming New Year, the journal will, as always, adhere to its focus on promoting the development of education, resolving educational problems, and driving educational innovation. Using the UNESCO’s report as guidance, it will pay special attention to issues concerning sustainable development of education, investment in education, regional education development, educational and teaching transformation, curricular reform, comprehensive development of students, teacher professional development, educational technology, educational evaluation and tests, and more. It is proposed that discussions on these subjects will expand the body of educational knowledge, bring about new pedagogical approaches, and promote healthy, scientific development of education.

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A Meta-Analytic Reliability Generalization Study of the Computational Thinking Scale[‡]

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Abstract: This study aims to analyze the reliability generalization of the computational thinking scale. There are five dimensions of computational thinking: creativity, algorithmic thinking, cooperativity, critical thinking, and problem-solving. A Bonett transformation was used to standardize the reliability coefficient of Cronbach's alpha. A random-effects meta-analysis was conducted since the heterogeneity among the studies was high. Results supported the RG of the computational thinking scale and its sub-dimensions, which were calculated as 0.843 for general, 0.799 for creativity, 0.848 for algorithmic thinking, 0.863 for cooperativity, 0.799 for critical thinking, and 0.817 for problem-solving. Besides that, the moderator analysis was conducted for the sample type, test length, country, and language of the study. According to the findings, there were no significant moderator effects on the reliability estimation.

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Introduction

Computational thinking (CT) can be defined as thinking processes that involve formulating problems, apart from programming skills (Clark, 2015; Denning, 2017). In other words, developing solutions to the problems via algorithms and steps are degrees of CT (Aho, 2012). For instance, individuals who have developed computational thinking focus on analyzing a problem, collecting data to solve the problem, and dividing the solution into sub-steps. These individuals are not concerned with the outcome of the problem, but with the solution process of the problem and how it applies to similar problems (Vaidyanathan, 2016). Developing the CT skills of individuals is not only useful to reach goals and find solutions; it also supports other skills such as thinking scientifically, doing arithmetic, reading, and writing (Grover & Pea, 2013; Papert, 1996; Wing, 2006). Hence, individuals with a high level of computational thinking are also expected to show high academic success in different fields (Lei et al., 2020). In the relevant literature, researchers generally prefer to explain the functions, skills, and related concepts of computational thinking rather than describing them. For example, the International Educational Technologies Community states that computational thinking includes the skills of creativity, algorithmic thinking, critical thinking, problem-solving, communication, and cooperation (ISTE, 2019). Therefore, it is not surprising that supporting computational thinking will also help to develop 21st-century skills such as problem-solving, logical reasoning, and analytical thinking (Hunt & Riley, 2014).

An important question about CT is how to measure it. The proposed measurement tools generally cope with this issue by focusing on different dimensions of CT. For example, Akyol (2019) developed a CT scale and assessed the following dimensions of CT: computational thinking, robotic coding and software, professional development, and career planning. In another scale developed by Tsai and his colleagues (2021), evaluation, abstraction, decomposition, generalization, and algorithmic thinking appear as sub-dimensions of CT (Tsai et al., 2021). Another measurement tool developed by Korkmaz et al. (2017) is the most frequently used scale to determine the level of CT in the relevant literature (Avcu & Ayverdi, 2020; Çakır & Yaman, 2018; Çevik et al., 2021; Karaçalı & Korkmaz, 2018; Oluk et al., 2018; Özgür, 2020; Yalçın & İkinci, 2020). Hence, this study aims to conduct a reliability generalization (RG) of the CT scale devised by Korkmaz et al. (2017)'s CT scale.

Reliability Generalization

Reliability is a problem related to the measurement precision of test scores. To solve this problem, researchers record the number of errors of repeated measurements and determine how precisely the scale measures the specified quality (McDonald, 1999). It can be said that reliability is the degree to which the measurements are free from random error. In addition, reliability means the consistency of the scores of individuals

‡: *Supplementary materials are included for this article.*

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participating in a test (Anastasi, 1976). Therefore, the reliability of the scores obtained from a measurement tool must be investigated at every turn (Crocker & Algina, 2008). Cronbach's alpha, a coefficient used in the literature to analyze and interpret reliability, can be dissimilar for each measurement even though the same scale is used because it is a sample-dependent coefficient. Interpreting the extent of observed effects requires an assessment of the reliability of the scores. Therefore, the reliability coefficients of the scores obtained from the scale for the analyzed data should be reported (Wilkinson, 1999). RG studies aim to explain the source of the variability in the reported reliability values in different applications of a scale through a meta-analysis study. According to Vacha-Haase (1998), RG can be used to estimate the pooled score reliability of the scale used in different studies. In other words, RG studies are carried out to determine the level and source of the difference between the reliability coefficient of the studies (Eser & Aksu, 2021; Liang et al., 2021; Olderbak et al., 2021; Opitz et al., 2020; Yoon et al., 2021).

The study aimed to examine the RG of the computational thinking scale (Korkmaz & Bai, 2019; Korkmaz & Özden, 2015; Korkmaz et al., 2017). It consists of 29 questions in total divided into five sub-dimensions: creativity (8), algorithmic thinking (6), cooperativity (4), critical thinking (5), and problem-solving (6). The questionnaire was developed for undergraduate students and then it was adapted for middle school students. The adapted version of the questionnaire consists of 22 items with similar sub-dimensions. There were two main reasons for choosing this scale in this study. Firstly, although CT is mostly associated with computer science, it is a skill that can be associated with all other fields. Besides that, the number of related studies has increased with the increasing importance of CT (Kıyıcı & Yamak, 2021). Hence, it is important to ascertain the reliability of the instrument, and secondly, the mentioned scale is frequently used to assess CT in the literature (e.g. Avcu & Ayverdi, 2020). Since the language of the instrument is Turkish, the reliability can be generalized to the Turkish sample. To sum up, the present study aims to answer the following research questions:

- i. What is the overall reliability estimate of the CT scale?
- ii. To what extent does the reliability estimate of the CT scale vary by year and language of the article?
- iii. To what extent does the reliability estimate of the CT scale vary by country or level of the participants?

Method

This study aimed to calculate the pooled reliability coefficient of the computational thinking scale (Korkmaz & Bai, 2019; Korkmaz & Özden, 2015; Korkmaz et al., 2017). For this aim, the recommendations of the Cochrane Handbook for systematic reviews of primary research were followed (Higgins et al., 2003). The findings of the study were reported according to the PRISMA statement for reporting systematic reviews and meta-analyses of studies (Liberati et al., 2009).

Sample of Studies

To identify studies, online databases such as Web of Science, the Educational Resources Information Center (ERIC), and Google Scholar were searched by the research-

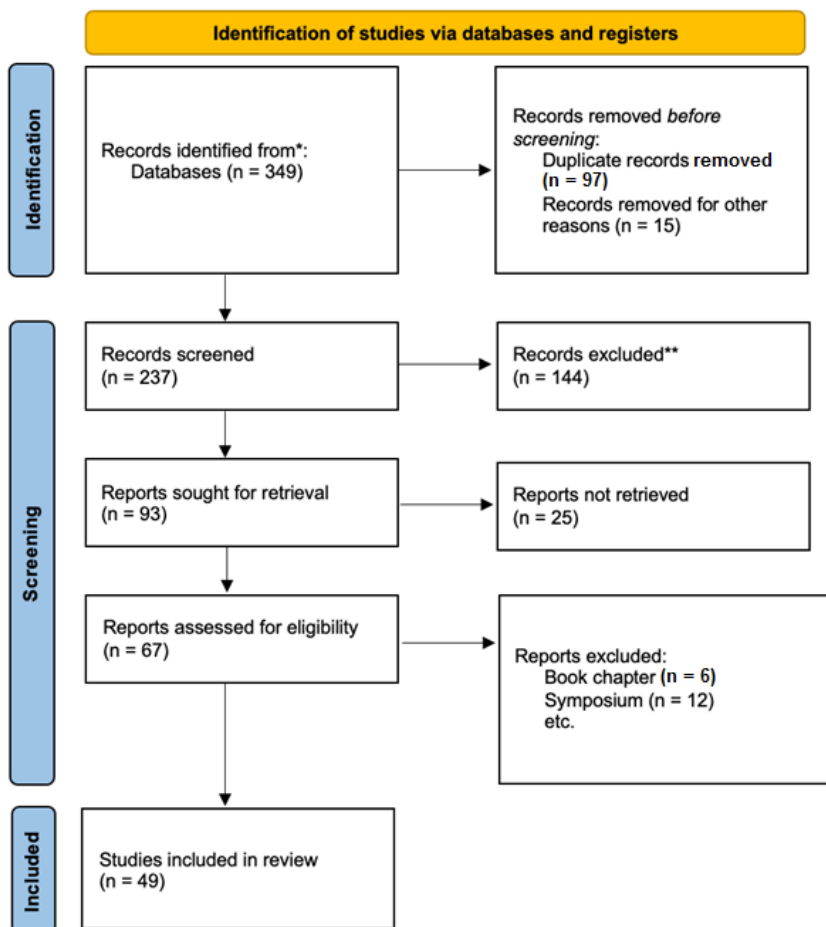


Figure 1. PRISMA Follow Diagram.

ers. The title of the questionnaire was used as the keyword. Besides that, articles that cited the questionnaire development articles were investigated.

Search Strategy

The study selection process is shown in **Figure 1** (Moher et al., 2009). As can be seen in the figure, the first step is database scanning. Studies applying the computational thinking scale developed by Korkmaz (2017) were determined by searching Google Scholar Academic, ProQuest, EBSCOhost, ERIC, ScienceDirect, Web of Science, and Taylor and Francis online databases. Searches of these databases have been conducted since 2015 when the “computational thinking” scale was developed and published. Besides that, the snowball technique was also used to reach the studies: the studies that cited the article at their reference list were also investigated. According to Korkmaz et al. (2017) and Korkmaz et al. (2015), all referenced studies were identified and it was

Table 1. Descriptive Features of the Included Studies.		
	Frequency	%
Year		
2017	1	1.9
2018	8	15.4
2019	7	13.5
2020	17	32.7
2021	19	36.5
Item Number		
15 item	2	3.8
22 item	22	40.4
27 item	1	1.9
29 item	30	53.8
Language		
English	32	61.5
Turkish	19	36.5
Country		
Canada	1	1.9
China	2	3.8
Greece	2	3.8
India	1	1.9
Jakarta	1	1.9
Korea	1	1.9
Malaysia	1	1.9
Spain	1	1.9
Taiwan	3	5.8
TR	35	65.4
USA	1	1.9
Gender of Participants		
Female	6,064	52.76
Male	5,430	42.24

seen that there were 349 studies in total. These studies were reviewed according to the research inclusion criteria.

The study group of the research seen in the Prisma flowchart consisted of 49 studies that comply with the criteria determined in this study by the researchers. In addition, for studies reporting more than one reliability coefficient for different study groups, each coefficient was coded separately. As a result, 52 Cronbach’s alpha coefficients were obtained from 49 studies (see **Appendix A**). The descriptive features of the studies are presented in **Table 1**.

Inclusion and Exclusion Criteria

To include articles in this RG study, the following criteria were considered: (i) the study had to be published, (ii) the study should be written in English or in Turkish, and (iii) the study had to report a reliability coefficient. Some studies reported the reliability coefficient of the original study instead of calculating a new one with their sample. Hence, they were not included in this meta-analysis.

Data Analysis and Interpretation

Reliability and validity are two important concepts of measurement. Reliability is related to the accuracy of the measurement process and the consistency of the scores of the same sample from the same test in two applications (Anastasi, 1976; McDonald, 1999). Depending on the sample characteristics, it can take different values for different samples despite using the same measurement instrument (Özdemir et al., 2020). The source and amount of these differences in the reliability coefficients are determined by RG analysis (Graham et al., 2006; Vacha-Haase, 1998).

The Cronbach alpha coefficient (Cronbach, 1951) is one of the most widely used reliability coefficients in social sciences (Bollen, 1989; Bonett & Wright, 2015). However, the use of the Cronbach alpha metric in the meta-analysis violates the normality assumption (Rodriguez & Maeda, 2006). To calculate Cronbach's alpha mean coefficient, it is necessary to normalize the distribution and stabilize its variances (Yoon et al., 2021). In this study, Bonett's (2002) transformation formula, presented below, was used.

$$Li = Ln(1 - \alpha_i)$$

Li = Bonett metric, α_i = Cronbach alpha, Ln is the natural logarithm

After applying the Bonett transform, reliability synthesis was made and the obtained values were converted back to the original Cronbach's alpha coefficient metric.

The heterogeneity between the reliability values of the studies included in the study was evaluated by calculating the Cochran Q statistics and I² index. Q statistics were applied to test the homogeneity assumption between alpha coefficients. The I² index is a measure of heterogeneity (Higgins & Thompson, 2002). To interpret the results, the average effect sizes obtained with the Bonett transform, the lower and upper classes of the confidence interval, and the transformed Cronbach's alpha metric were used. Additionally, they were evaluated according to the 0.70 criterion (Nunnally & Bernstein, 1994).

Significant heterogeneity was seen among the estimates of the reliability of the primary studies that were included in the RG of CT. Analogue ANOVA analysis with moderator analysis was performed to investigate the sources of this heterogeneity. These moderator variables are sample type, test length, country, and language.

No matter how appropriate the methodology, the bias of the studies included in the meta-analysis may reduce the validity of the results (Becker, 2005). To eliminate this risk, the funnel plot asymmetry test, Egger's regression test, Begg and Mazumdar's rank correlation test, and Rosenthal's error protection number method were used to determine the publication bias status of primary studies. Comprehensive Meta-Analysis V2 free trial version was used for the aforementioned analyses.

Results

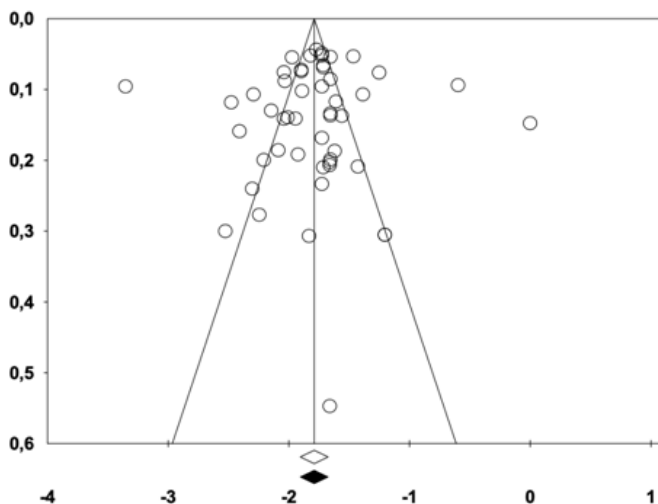


Figure 2. The Funnel Scatters Plot.

Table 2. Egger Regression Test results.

Regression line constant	SE	%95 CI		t	SD	P	
		UL	LL			(1-tailed)	(2-tailed)
-0.475	1.194	-2.88	1.93	0.398	48	0.346	0.692

UL: Upper limit; LL: Lower limit; SE: Standard error; SD: Standard deviation.

Publication Bias

In this study, the funnel scatter plot of the studies included in the meta-analysis, that is, the 52 observed studies, is exposed. The presence of tiny circles representing primary studies in the funnel means that primary studies are gathered around the average effect size. The fact that the studies are located symmetrically around the mean effect size in the funnel scatter plot shows that there is a meta-analysis without publication bias (**Figure 2**).

According to the Egger regression test, there is no bias in primary studies ($t(48) = 0.398$; $P = 0.692$, $P < 0.05$), but the finding needs to be tested with other methods as well (**Table 2**). If the Egger regression test and the funnel plot are evaluated together, the funnel plot of research without publication bias is symmetrical and the regression line is expected to coincide with the line in the center of the funnel plot (Sterne et al., 2005).

According to the Egger regression test applied to the reliability values of the primary studies included in the RG, the upper limit of the 95% confidence interval was

Table 3. Begg and Mazumdar Rank Correlation Test Results for Studies Used Korkmaz's (2017) CT Scale.

	Hypothesis
Kendall's S statistic (P-Q)	-55
Kendall's tau without continuity correction	
Tau	-0.04493
z-value for tau	0.46007
P-value (1-tailed)	0.32273
P-value (2-tailed)	0.64547
Kendall's tau with continuity correction	
Tau	-0.04412
z-value for tau	0.4517
P-value (1-tailed)	0.32574
P-value (2-tailed)	0.65148

Table 4. Rosenthal Error Protection Number Test Results for Studies Used Korkmaz's (2017) CT Scale.

Observed Studies						The number of studies that can ensure that P is greater than 0.05
Z	P	α	Z for α	Tails	# of Observed Studies	
-116.729	> 0.001	0.050	1.959	2.000	50	7,301

-2.88 and the limit inferior was 1.93. The value calculated for the regression line constant of 95 out of 100 studies to be conducted with other similar samples using the computational thinking scale developed by Korkmaz (2017) will be between the upper and lower limits of the 95% confidence interval.

It is also important to evaluate the Begg and Mazumdar rank correlation results, which quantify the result of the funnel plot, instead of the interpretation of the funnel plot, which depends on the researcher. The rank correlation between the standardized effect sizes and the standard errors of these values is 0, indicating that there is no publication bias (Hunter & Schmidt, 2004).

Begg and Mazumdar rank correlation tests were applied to statistically test that the study sample selected was not biased (Table 3). According to the Begg and Mazumdar rank correlation test, the publication bias test does not make sense ($\tau = -0.045$; $P = 0.65$). According to the analysis results shown in the chart, the primary studies included in this meta-analysis study were not biased. Rosenthal (1979) calculated the error-proof number (N) to find the summary of statistical significance (p-value) when there was little or no heterogeneity among the effect sizes of primary studies.

The Rosenthal fail-safe number calculated for primary investigations is 7,301 (Table 4). This value is statistically significant since $P < 0.05$. This figure states that for $P > 0.05$, 7,301 studies should be conducted in the opposite direction of the studies included in the meta-analysis with a zero-effect size value. A ratio [$1 < N / (5k+10)$] be-

Table 5. Results on the Estimate of Pooled Reliability of the Computational Thinking Scale and Subscales.

	α	SE	Z	LL	UL	df	Q	I^2
Computational Thinking	0.843	0.065	-28.551*	0.823	0.863	49	1093.756*	95.520
Creativity	0.799	0.078	-20.618	0.765	0.827	32	822.182*	96.108
Algorithmic Thinking	0.848	0.064	-29.677*	0.828	0.866	32	532.432*	93.990
Cooperation	0.863	0.056	-33.956	0.833	0.866	32	420.606*	92.392
Critical Thinking	0.799	0.055	-28.920*	0.776	0.820	34	433.779*	92.162
Problem Solving	0.817	0.068	-25.104*	0.791	0.839	34	665.07*	94.888

Note: k = number of reliability coefficients; SE = standard error; 95% confidence interval upper limit (UL) and lower limit (LL); df = degrees of freedom; Q = heterogeneity statistic representing total variance; I^2 = heterogeneity index; * $p < 0.05$.

tween Rosenthal’s calculated error protection number (N) and the number of primary studies in the meta-analysis (k) has been proposed (Mullen, et al., 2001) at 28, indicating that the results of the meta-analysis are robust against publication bias and that the overall reliability estimate of primary studies is unlikely to affect the combined alpha coefficient of the current meta-analysis.

Data from the funnel plot, the Egger regression test, Beg and Mazumdar’s rank correlation, and Rosenthal’s fail-safe N tests show the absence of publication bias. Considering the results of all analyzes, it was determined that publication bias is not a serious threat affecting the RG estimation.

Results of the Estimate of the Pooled Reliability of the Computational Thinking Scale and Subscales

The Cronbach’s alpha (α) coefficients and heterogeneity test results in the random-effects model are shown in **Table 1**. Cochran Q parameter and Higgins I^2 values were calculated to test the heterogeneity of primary studies. It was decided to use the random-effects model in the meta-analysis according to the results of heterogeneity tests.

As seen in **Table 5**, the Q ($df = 49$) value for the total CT scale was found to be 1093,756 ($P < 0.001$). The Q value calculated according to the chi-square (X^2) table is above the limit, with 49 degrees of freedom and a confidence interval of 0.05 ($df = 49$; $X^2(0.05) = 66.339$). Therefore, it can be said that there is heterogeneity among studies. The I^2 value (95.520) calculated for the heterogeneity test indicates a high level of heterogeneity. The random-effects model was used in this study as there was heterogeneity among primary studies. The overall Cronbach’s alpha coefficient of the total CT scale was calculated as.843 (95%, 0.823 – 0.863) according to the random-effects model.

The meta-analysis of the RG of the CT scale is presented in the forest plot in **Figure 3**. When **Figure 3** is examined, it is seen that the reliability coefficients calculated in the Bonett type of all primary studies included in the analysis are significant. It was also observed that the Cronbach’s alpha values of primary studies were between 0.70 and 0.965.

Heterogeneity tests were also performed for the sub-dimensions of the scale and creativity ($Q (df = 32) = 822.182$), algorithmic thinking ($Q (df = 32) = 0.432$), cooperation ($Q (df = 32) = 420.606$), critical thinking ($Q (df = 34) = 433.779$), and prob-

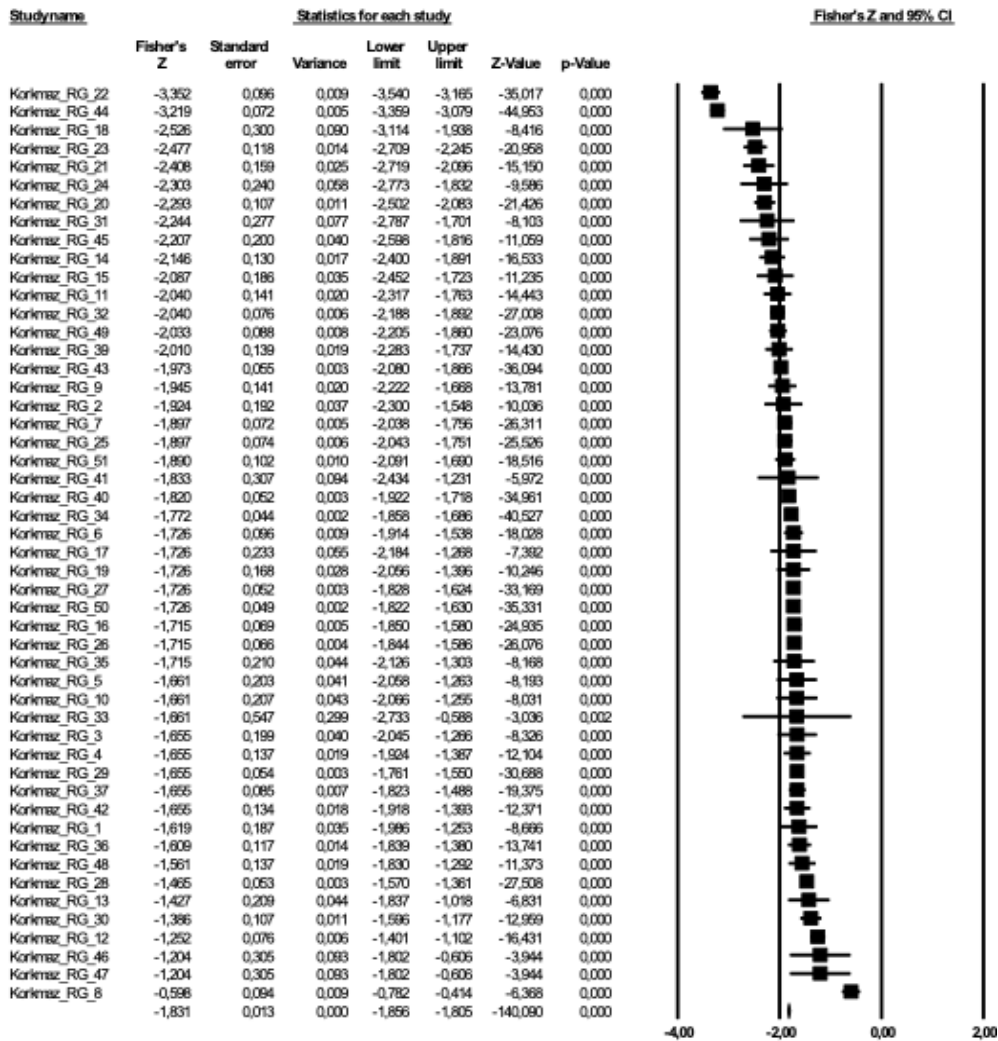


Figure 3. Forest Plot for CT Scale.

lem-solving ($(Q (df = 34) = 665.07)$. 92.392 ; $I^2_{\text{Critical Thinking}} = 93.162\%$; $I^2_{\text{Problem Solving}} = 94.888\%$) indicate a high level of heterogeneity. As a result of the heterogeneity tests of the sub-dimensions, it was decided to use the random effects model for each dimension. According to the Cronbach's alpha coefficient random-effects model, creativity was calculated as 0.799 (95%, $0.765 - 0.827$), algorithmic thinking 0.848 (95%, $0.828 - 0.866$), cooperation 0.863 (95%, $0.833 - 0.886$), critical thinking 0.799 (95%, $0.776 - 0.820$), and problem-solving was calculated as 0.817 (95%, $0.791 - 0.839$).

The Relationship between Moderating Variables and Reliability Estimates

Table 6. The effect of Moderator Variables on the Reliability Estimate.

Variable	Category	k (%)	α	95%	Q_B	df	P	
Test Length	15	2 (4)	0.700	0.370	0.857	4.667	3	0.198
	22	21 (40)	0.835	0.798	0.865			
	27	1 (2)	0.900	0.733	0.963			
	29	26 (54)	0.854	0.826	0.878			
Sample Type	Middle school	18 (36)	0.844	0.803	0.877	0.081	3	0.994
	High school	6 (16)	0.849	0.777	0.898			
	Undergraduate	22 (46)	0.842	0.805	0.872			
	Teachers	2 (2)	0.854	0.715	0.925			
Country	Asia	2 (4)	0.785	0.621	0.878	1.751	4	0.781
	Europe	3 (6)	0.800	0.652	0.885			
	Turkey	35 (73)	0.838	0.814	0.860			
	Far East	8 (17)	0.823	0.760	0.869			
Language	English	30 (63)	0.857	0.832	0.879	2.909	1	0.088
	Turkish	18 (37)	0.819	0.775	0.854			

The primary investigations of the study appear to show significant heterogeneity. It is important to identify the source of this heterogeneity. Sample type, language (categorical), test length, and (continuous) moderator of primary studies are examined as variables. Differences between subgroups are analyzed using the analogous ANOVA approach. To examine whether subgroups of all moderator variables were equally reliable, they were analyzed according to the mixed-effects model.

As in **Table 6**, it was determined that sample type, test length, country, and language variables did not affect the reliability of the measurements; in other words, there was no statistically significant difference between the subgroups ($P_{Test\ Length} = 0.198$; $P_{Sample\ type} = 0.994$; $P_{Country} = 0.781$; $P_{Language} = 0.088$).

Discussion

The present study aimed to investigate the overall reliability of the CT scale and the variability that can be explained by the moderators via the RG of meta-analysis. The CT scale was developed by Korkmaz et al. (2017) and adapted for different ages and languages (e.g. Korkmaz & Bai, 2019; Korkmaz & Özden, 2015). There are five sub-dimensions of CT in the scale: creativity, algorithmic thinking, cooperation, critical thinking, and problem-solving. To achieve these aims, research studies that used a CT scale and reported the reliability coefficient were examined. The reliability estimates of primary research showed high variability ($I^2 = 95.52$). This implies that the reliability of CT scale scores cannot be generalized to different contexts or populations. Furthermore, the variability, which was determined as I^2 , refers to the real differences among studies. Hence, the RG would be useful for the questionnaire (Graham et al., 2006; Vacha-Haase, 1998). Moreover, since I^2 is significant, the random effect method was used while calculating the reliability coefficient across the reliability estimations (Borenstein et al., 2009).

Fifty-five studies used the CT scale and reported the reliability coefficient of the scores. The average reliability coefficient was calculated as 0.840. Besides that, a reliability estimation was also calculated for each dimension and found 0.799 for creativity, 0.848 for algorithmic thinking, 0.863 for cooperation, 0.799 for critical thinking, and 0.817 for problem-solving. Hence, the findings of the current study suggest that the reliability coefficients not only for the overall scale but also for sub-dimensions were within the acceptable range (Clark & Watson, 1995; DeVellis, 1991; Nunnally & Bernstein, 1994).

To investigate the variability of scores from the subcategories, the moderator analysis was conducted by using mixed-effect models. There were four different variables as moderators: the language of the article (English versus Turkish), test length (15, 22, 27 versus 29 items), country of study (Asia, Europe, Turkey, or Far East countries), and sample type (middle-school, high school, undergraduate, and teachers). As seen in **Table 6**, none of the moderator variables was significant, which means that there were no significant differences among subgroups in terms of the reliability coefficient. Regarding the effect of the sample type, previous research also suggested no reliability differences among groups. For instance, Hess et al. (2014) compared the reliability coefficients of perceived ease of use, perceived usefulness, and behavioral intentions of questionnaires for students and non-students and the findings of the study supported that there was no moderation effect of the sample type. Concerning the length of the scale, the findings of previous research are mixed. While some of them offer a significant effect (e.g. Streiner, 2003), others suggest no significant difference between the short or long form of the scale (e.g. Negrin et al., 2017). Supporting this discrepancy Niemi et al. (1986) investigated the impact of the length of the scale on reliability and recommended that reliability does not always increase with the number of items. Last but not least, some studies also propose no significant effect on either the language of the scale or the country where data was collected (e.g. Sen, 2021).

There are some limitations of the current study, including the conversion of Cronbach's alpha coefficients to Bonett's (2002) parameter, performing the analysis in the CMA program, and examining the sample type, test length, country, and language variables as sources of reliability measurement errors. Different reliability parameters in the literature consider different sources of measurement error. In future research, reliability estimates using other reliability parameters such as Hakstian and Whalen (1976) and Fisher Z can be evaluated by examining them. Furthermore, depending on whether it belongs to the definition and measurement, if RG has not been done, the reliability value of each study must be reported. However, in the database scanning process of this meta-analysis, many studies included the reliability values reported by Korkmaz (2017) instead of reporting the reliability of their measurements. This has reduced the number of primary studies that can be included in the RG study. Besides that, it was seen that the applications of the primary research of the study were mostly made in computer science and science teaching-related fields. CT is explained as the thought process involved in solving a problem (Curzon & McOwan, 2018; Denning, 2017). Considering that these intellectual processes can also be encountered in the solution of problems in different fields, it is necessary to consider CT in the teaching of different fields.

To sum up, this study supported the RG of the CT scale. At this point, it may be useful to remember that reliability is defined as the level of explanation of the phenomenon related to the conceptual structure that is expected to be measured with a scale (Şencan, 2005). However, reliability is a value of the data, not the scale (APA, 2020; Vacha-Haase, 1998). The reliability and validity of the scores obtained from the meas-

urement tools must be investigated (Smith, 1987). Researchers are recommended to refer to a published RG study of the scale used or to report the reliability values of their measurements.

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Appendix I

Studies Used in the Meta-Analysis

- Akgün, F. (2020). Öğretmen Adaylarının Bilgi Ve İletişim Teknolojileri Yeterlikleri Ve Bilgi İşlemsel Düşünme Becerilerinin Çeşitli Değişkenler Açısından Değerlendirilmesi [An Evaluation On Pre-Service Teacher's Information And Communications Technology Competency And Comp. Trakya University Journal of Social Science, 22(1), 629–654. <https://doi.org/10.26468/trakyasobed.679581>
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Laboratory as an Instrument in Improving the Scientific Reasoning Skills of Pre-Service Science Teachers with Different Cognitive Styles[‡]

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Abstract: *In this study, it was aimed to investigate the effects of guided inquiry learning approach-based laboratory applications on the scientific reasoning skills of pre-service science teachers with different cognitive styles. Additionally, the opinions of pre-service science teachers with different cognitive styles about the effects of the application carried out in the study on the improvement of their scientific reasoning skills were also examined. The sample consisted of five pre-service science teachers studying at a state university in the west of Turkey. In the study, the partially mixed sequential dominant status design, which is a mixed-method research design, was used. The scientific reasoning skills of the participants were determined by using the Classroom Test of Formal Reasoning, and their cognitive styles were identified with the Group Embedded Figures Test. The opinions of the participants were taken through focus group interviews held after the application. As a result of the analysis, it was observed that the participants with field-dependent and field-intermediate cognitive styles achieved more targeted outcomes compared to those with field-independent cognitive styles. The potential relationship of this finding to the use of the guided inquiry learning approach and the hypothetico-deductive reasoning cycle during the applications was analyzed in terms of the concept of information processing, and recommendations were made for researchers.*

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Introduction

Scientific reasoning skills (Gray, 2016), which are among 21st century skills, have long been at the focus of developmental psychology, education psychology, and science education research (Cheng et al., 2018; Shayer & Adey, 1992). Since it would be impossible to have individuals encounter all potential problem situations in practice, it could be possible to adapt to the quickly changing world if individuals are trained with the ability to solve the problems they encounter by using and evaluating the information they gain through scientific methods and understand the information production process, in other words, have advanced reasoning abilities (Osborne, 2013; Schiefer et al., 2019). If success in science is defined as the ability to explain natural phenomena by creating hypotheses and testing them, one of the most important predictors of scientific success is scientific reasoning skills (Lawson, 1983).

It is seen that scientific reasoning skills, which have been demonstrated to have a positive contribution to students' success in science (Vadappally, 2014), can be developed through educational activities (Daempfle, 2006; Engelmann et al., 2016; Jensen & Lawson, 2011; Marušić-Sliško, 2011; Shayer & Adey, 1992). According to many studies, inquiry-based applications make a positive contribution to students' scientific reasoning skills (Blumer & Beck, 2019; Daempfle, 2006; Klahr et al., 2019; Schiefer et al., 2019; Stender et al., 2018; Van der Graaf et al., 2019; Yulianti et al., 2018; Yulianti et al., 2020). One of the points where inquiry-based applications and scientific reasoning skills intersect in science education is the laboratory.

Laboratory applications, which contribute significantly to the development of scientific reasoning skills, have long had a pivotal role in science education (Hofstein; et al., 2019; Lunetta et al., 2007). Reform movements in science education realized from the past to the present have manifested themselves in laboratory applications as well, and over time, rather than confirmatory forms of laboratory applications, laboratory applications in which investigation and inquiry are more pronounced have been emphasized (National Research Council [NRC], 2013). Although studies carried out on the effectiveness of inquiry-based laboratory applications have mostly yielded positive results (Beck et al., 2014), there are also other studies which demonstrated that the effects of inquiry-based learning in laboratory classes may not always be uniform for all students. The individual differences of students such as gender, race, ethnic origin, and age lead to differences in their performance (Blumer & Beck, 2019). One of the individual differences on which the most research has been conducted in the literature is cognitive styles. Cronbach and Snow (1977) defined cognitive styles as an information processing strategy that an individual prefers while organizing everything they see, remember, and think about. Although there are many classifications

regarding cognitive styles, field-dependent/field-independent cognitive styles are stated as the cognitive style dimensions which have a wide range of application in educational problems (Witkin et al., 1977). It has been stated in research conducted on field-dependent/field-independent cognitive styles that this construct is one of the most significant predictors of academic success, and field-independent individuals are usually more successful than field-dependent individuals (Ates & Cataloglu, 2007; Cataloglu & Ates, 2014; Idika, 2017; Morris et al., 2019). In the relevant literature, it is seen that this construct has been significantly associated with not only the student's success in science but also their scientific reasoning skills (Ahmar et al., 2018; Stamovlasis & Papageorgiou, 2012).

Literature Review

Scientific Reasoning Skills

Scientific reasoning skills are handled within the framework of the concept of cognitive development. The theory which is acknowledged the most in the field of education in relation to cognitive development is Piaget's Cognitive Development Theory. In the theory, the development of reasoning abilities in children and adolescents has also been defined and analysed (Inhelder & Piaget, 1958). The characteristics of the concrete and formal operations included in the theory among developmental stages have particular importance for science teachers and pre-service science teachers. The groundwork of thinking and reasoning is laid in the concrete operational stage. On the other hand, abstract thinking and reasoning about unseen and unfamiliar contexts in individuals begin in the formal operational stage. In this context, hypothetico-deductive reasoning is a way of reasoning observed in individuals who are in the formal operational stage (Lawson, 2000; Melnick, 1974).

Lawson (2000) defined the reasoning process that individuals must have in the formal operational stage as a construct in which a hypothesis testing process is widely used through deduction by the control of variables, as well as proportional, combinational, correlational and hypothetical-deductive reasoning skills. Considering the steps required for the realization of the hypothetico-deductive reasoning cycle proposed by Lawson et al. (2000), it is seen that they overlap with the eight science practices (asking questions related to science, identifying the problems, using and developing models, planning and researching, analysing and interpreting the data, using mathematics, making explanations, designing solutions, discussing based on evidence, evaluating the information) included in the first dimension of the New Generation Science Standards prepared by the National Research Council (NRC, 2013) in the US. Similarly, in the inquiry research cycle proposed by White and Frederiksen (1998), as well, there are interrelated and

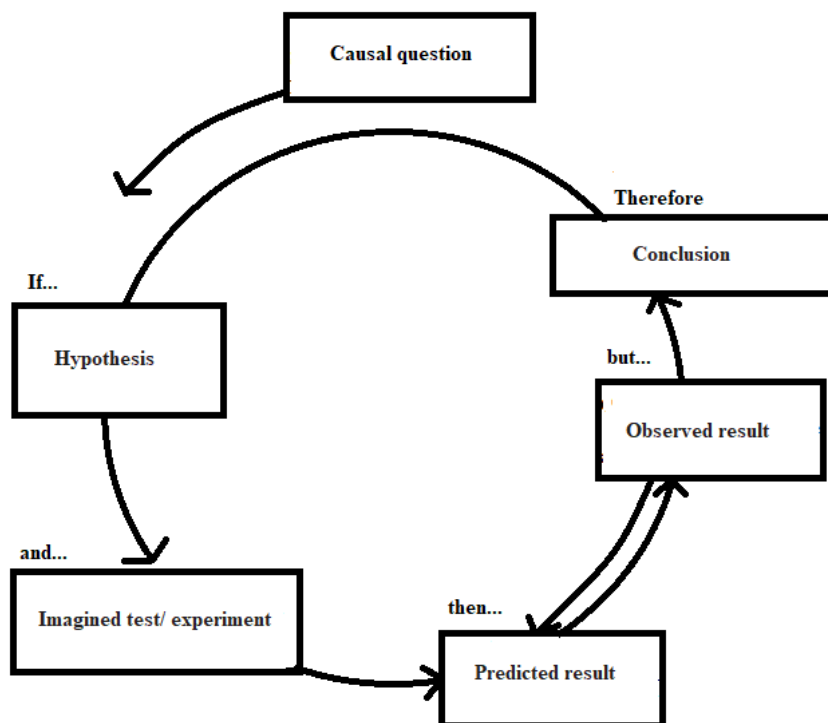


Figure 1. Hypothetico-Deductive Reasoning Cycle

Note. From *Science Teaching and the Development of Thinking* (p.115), Lawson, A. E., 1995, Wadsworth/Thompson Learning.

repetitive stages of asking questions, establishing a hypothesis, researching, analysing, and synthesizing. From this perspective, it is seen that hypothetico-deductive reasoning is an essential component in the inquiry research cycle (Pedaste et al., 2015; White & Frederiksen, 1998). For this reason, the hypothetico-deductive reasoning cycle suggested by Lawson (2000) to be used in inquiry activities was included in the experiment process. This cycle is presented in **Figure 1**.

Guided Inquiry Learning

The word “inquiry” is used with two different meanings in the report of the National Research Council that establishes the standards of science education (Bybee, 2000). The first of these is the creation of conceptual knowledge that ensures the student understands of the phenomena they encounter in daily life. The second meaning refers to the development of the student’s high-level thinking skills such as asking questions, critical thinking, problem

Table 1. Levels of Inquiry.

Levels	Source of the Research Questions	Source of Data Collection Methods	Source of Interpretations of Results
Level 0: Verification	Given by teacher	Given by teacher	Given by teacher
Level 1: Structured	Given by teacher	Given by teacher	Open to student
Level 2: Guided	Given by teacher	Open to student	Open to student
Level 3: Open	Open to student	Open to student	Open to student

solving, metacognitive, and argumentation skills (Hofstein & Kind, 2012). In this context, many science educators and curriculum developers argue that students must apply scientific methods and answer research questions by producing and analysing data to not only comprehend science concepts but also gain scientific reasoning skills (Abd-El-Khalick et al., 2004). In this context, when science laboratory applications are carried out based on inquiry, they ensure the development of metacognitive thinking skills and thus contribute to conceptual understanding (Hofstein, 2016). Inquiry-based learning in science education refers to an approach in which students actively use scientific methods to be able to answer research questions (Bell et al., 2005). Bell et al. (2005) stated that inquiry-based learning can be applied on four different levels by considering the amount of guidance provided by the teacher (**Table 1**).

In the meta-analysis and review studies on inquiry-based learning, which can be applied on four different levels, presented in **Table 1**, it is seen that the effects of inquiry-based learning activities on the first and particularly the second levels, where a certain amount of guidance is provided to students, on the students' learning outcomes are more positive compared to these effects on third-level activities, where no guidance is provided (Alfieri et al., 2011; Bruder & Prescott, 2013; Carolan et al., 2014; Lazonder & Harmsen, 2016; Minner et al., 2010; Yulanti et al., 2020). However, there are very few studies that support the positive effect of third-level activities where no guidance is provided on students' success in science. Therefore, the second-level inquiry-based learning approach was taken as the basis in this study.

Cognitive Styles

Cognitive styles are defined as a binary holistic construct which affects all activities of individuals and surpasses the limits of the human mind (Witkin et al., 1977). As a result of studies in this area, many cognitive style dimensions have been identified. Among the cognitive styles that have been identi-

fied so far, field-dependent/field-independent styles have been examined the most, and they are stated as the cognitive style dimension that has the widest range of application in educational problems (Evans et al., 2013; Witkin et al., 1977).

Field-independent individuals are affected less by external stimulants compared to field-dependent individuals in terms of analysing the complex structure of the area in which they are and being able to extract a certain element out of a complicated whole. While field-dependent individuals attach importance to external stimulants affecting their perceptions, it is not external stimulants but internal stimulants that are important for field-independent individuals (Jonassen & Grabowski, 1993). In operational terms, field-dependence/field-independence is defined as a construct that measures the individual's ability to differentiate a single figure from a complicated background. Differentiation is the ability to visually differentiate a piece from a complex whole. For this reason, field-dependent individuals are characterized by their perception of an area as a whole by ignoring the figures (Witkin et al., 1971). This perceptual and intellectual functioning leads to individual differences ranging from the analytical area approach to the holistic area approach.

As a result of many studies conducted in this field, it has been determined that the performance levels of field-dependent and field-independent students in learning activities vary. Field-dependent students show superior performance in comparison to field-independent students in activities in which group work and collaboration are required, the instructions are clearly provided, and previously learned information must be remembered. Field-independent students, on the other hand, display better performance compared to field-dependent students in terms of solving problems (especially mathematics), determining the significant aspects even if the information is poorly organized, and applying the learned information to different situations (Jonassen & Grabowski, 1993).

The Present Study

The changes experienced in the 21st century have led to changes in the roles expected from individuals. Accordingly, the education and equipment of teachers who will raise such students in terms of educating individuals in line with the requirements of the century become more important. For developing students' scientific reasoning skills, which are considered important in terms of the century we are in, it is needed to have teachers whose such abilities have developed. For this reason, for teachers to help students in terms of developing scientific reasoning skills, it is important for them to first improve themselves in this regard. Though there are many studies in the relevant literature that have demonstrated the positive contribution of guided in-

quiry learning approach-based laboratory (GILABL) applications to the development of the scientific reasoning skills of students, no study revealing the performance differences and/or similarities of pre-service science teachers with different cognitive styles in the application of this method was encountered. It is believed that determining this individual difference, which is highly important in terms of explaining the student's performance and examining the effects of guided inquiry learning approach-based laboratory applications on the development of scientific reasoning skills, will contribute to the education of pre-service science teachers in accordance with the needs of the century.

Consequently, it was deemed important in this study to determine how pre-service science teachers with different cognitive styles benefited from guided inquiry learning approach-based laboratory applications in terms of the development of their scientific reasoning skills. Additionally, to develop a better understanding of this form of utilization, the opinions of pre-service science teachers about the effects of the application in question on the development of their scientific reasoning skills were also received.

In this context, the research questions were as follows:

- (i) Do GILABL applications used in the science laboratory class have any effects on the scientific reasoning skills of pre-service science teachers? (RQ1)
- (ii) Is there a difference between the scientific reasoning skills of pre-service science teachers with different cognitive styles before and after the experimental application? (RQ2)
- (iii) What are the opinions of pre-service science teachers with different cognitive styles about the effects of GILABL applications on the development of their scientific reasoning skills? (RQ3)

Method

In the study, in which quantitative and qualitative research methods were used to find answers to the research questions, the mixed-method research design was employed. As the quantitative data were collected before the qualitative data, and the quantitative data were more dominant, this study included the partially mixed sequential dominant status design, which is a mixed-method design (Leech & Onwuegbuze, 2009). In the first and quantitative part of the study, the effects of GILABL applied to the pre-service science teachers studying science teaching on their scientific reasoning skills and the variation of these effects based on cognitive styles were investigated. In the second and qualitative part of the study, the opinions of pre-service science teachers about the experimental application in question were analyzed through focus group discussions. In the quantitative part of the study, the 'static group pretest-posttest design' (Fraenkel et al., 2011) used in ex-

Table 2. Participant Profile.

Participant Codes	Gender (Female/Male)	GPA	Cognitive Style (Field Independent/Field Intermediate/Field Dependent)
S1	Male	2.96	Field-independent (FID)
S2	Male	2.86	Field-dependent (FD)
S3	Female	3.22	Field-intermediate (FINT)
S4	Female	3.37	Field-intermediate (FINT)
S5	Female	2.80	Field-intermediate (FINT)

perimental research was employed, while the case study design was used in the qualitative part.

Sample

The sample consisted of third-year students studying in the science teaching program at the education faculty of a state university located in the west of Turkey in the fall semester of the academic year of 2020-2021. The study was designed within the scope of the Science Teaching Laboratory Applications 1 course and carried out with the voluntary participation of five pre-service science teachers. Prior to the application, all pre-service science teachers to be included in the study were informed about the purpose and process of the study, and the consent of each participant was taken. The classes could not be held face-to-face due to the ongoing COVID-19 pandemic, and they were provided online via distance education. Three of the participants were female, and two were male. To ensure confidentiality, the real names of the participants were not disclosed in the coding and reporting stages of the qualitative data. The participants were given codes from S1 to S5, each code representing one participant. Information about the genders, grade point averages (GPA), and cognitive styles of the participants is given in **Table 2**.

Data Collection Tools

In the study, the Group Embedded Figures Test (GEFT) developed by Witkin et al. (1971) and adapted to Turkish by Cakan (2003) was used to determine the participants' field-dependent/field-independent cognitive styles. GEFT, in which respondents are asked to find the desired figure out of a complex context, is composed of 18 questions. A certain pattern is followed in determining cognitive styles according to the scores the respondents obtain from the test (Dwyer & Moore, 1992). The Cronbach's alpha internal consistency coefficient of the Turkish adaptation of the test was reported to

be 0.82 (Cakan, 2013). Special permission was obtained from MindGarden to administer the test developed by Witkin et al. (1971). Information on the permit can be found in supplementary material 1.

In the study, the Classroom Test of Formal Reasoning was employed to measure the participants' scientific reasoning skills (Lawson et al., 2000). The test consists of 13 two-step questions which require conservation, control of variables, proportional reasoning, correlation reasoning, probability reasoning, combinational reasoning, and hypothetical-deductive reasoning. The administration of the test takes 40 minutes. The test was adapted to Turkish by Ates and Cataloglu (2007), and the Cronbach's alpha internal consistency coefficient of the test was calculated as 0.70.

In this study, as the qualitative data collection tool, focus group interview questions were used to identify the opinions of the participants about the GILABL applications. These interview questions were prepared by the researchers, and they had a semi-structured format consisting of eight main questions and probing questions. The semi-structured interview form was prepared by considering the literature on the opinions of pre-service science teachers regarding the use of laboratory-based methods (Ceylan et al., 2019; Evren-Yapicioglu & Yurttas-Kumlu, 2017). The focus group interview questions were evaluated by an expert in science education, and the final version was created.

Data Analysis

In the analysis of the quantitative data of the study, descriptive and predictive statistical methods were employed. In this context, descriptive analyses and Wilcoxon Signed-Rank Test were used for the quantitative data, while descriptive analyses were used in the analysis of the qualitative data. In the coding of the qualitative data, common coding was continued until there was 100% agreement between the researchers. For this reason, a percentage of agreement was not calculated separately.

Implementation

In this study, both data collection and application processes were carried out through the Microsoft Teams program. The quantitative data in the study were collected in live lecture sessions with the participants and researchers. In this process, the participants were asked to have their cameras turned on, and the necessary documents were uploaded to the system right after the application. In the process of collecting qualitative data, focus group interviews were conducted through the same program.

Within the scope of the study, the content of the Science Teaching Laboratory Applications 1 course was designed in accordance with the use of GILABL applications where the hypothetico-deductive reasoning cycle

was used, and content for 12 weeks was prepared. The course in question is one of the compulsory courses included in the science teaching program in Turkey. While preparing the experiments included in the content, attention was paid to ensure that the experiments were practical enough to be conducted individually at home by using simple materials, as the courses were being held via distance education due to the ongoing COVID-19 pandemic period.

Each experiment was completed within a period of two weeks. In the first week, a problem scenario regarding the concept to be dealt with was provided, and the participants were asked to form their hypotheses for the solution of the problem, choose one of the hypotheses, and design an experiment for testing the hypothesis. In the second week, the experiments designed for testing the hypothesis were conducted, and the participants were expected to reach a judgement by comparing the results they envisaged with the actual experimental results. Following this stage, the concept in question was explained and associated with daily life by the instructor of the course, and the class was finalized. The reports prepared by the participants before and after the experiment were compared by the researchers, and the necessary feedback was given. After corrections were made by the participants, the reports were examined again. The process that was followed in the implementation is presented in **Figure 2**, and a basic process and example scenario of experimental applications can be found in supplementary material 2.

Ethical Considerations

Ethical approval was granted by Institutional Ethical Committee on 15 September, 2020. Additionally, all potential participants were informed about the study, and those who voluntarily agreed to participate were included. Besides, codes were assigned to the participants in the place of their names to anonymize their identities.

Results

Results for RQ1

For RQ1, the data obtained using the Classroom Test of Formal Reasoning that was applied before and after the application to determine the change in the scientific reasoning skills of the participants as a result of the application were compared. As the collected data did not have a normal distribution, Wilcoxon Signed-Rank test was employed. The results revealed that the posttest scores of the participants were significantly higher (Mdn = 12, $n = 5$) compared to their pretest scores (Mdn = 9, $n = 5$), $z = -2.04$, $p = 0.04$, with a large effect size, $r = 0.93$.

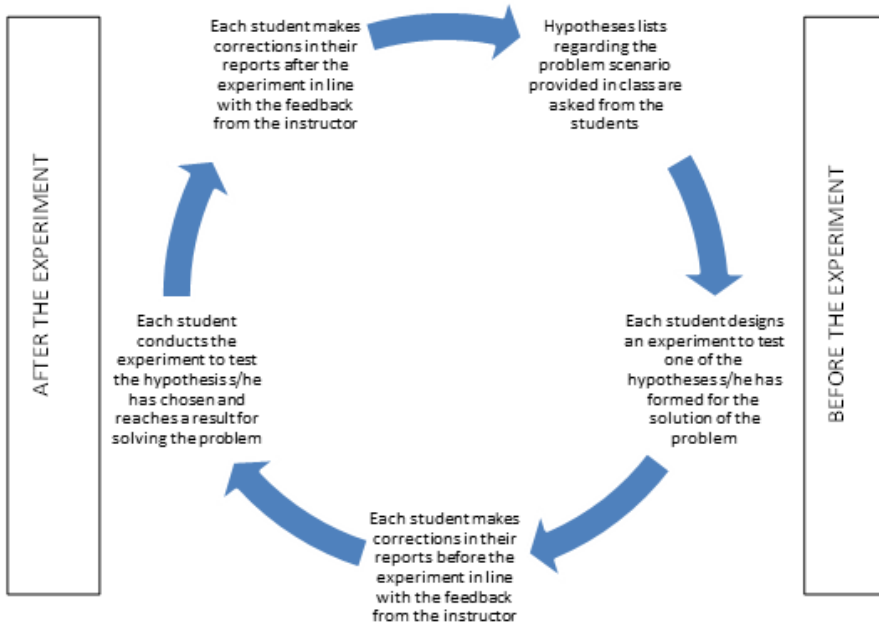


Figure 2. The Process Followed for Each Experiment.

Table 3. Descriptive Statistics of the Classroom Test of Formal Reasoning Results According to Cognitive Styles.

Group	N	Mean _{pretest}	Mean _{posttest}
Field-independent	1	10.0	11.0
Field-intermediate	3	8.0	10.3
Field-dependent	1	8.0	12.0

Results for RQ2

For RQ2, the descriptive statistics of the results of the participants in the Classroom Test of Formal Reasoning before and after the application were calculated, and the results are presented in **Table 3**.

As seen in **Table 3**, while the mean test score of the participants with the field-intermediate cognitive style was higher before the application (mean = 10.0), the mean score of the participants with the field-dependent cognitive style was higher after the application (mean = 12.0). Another inter-

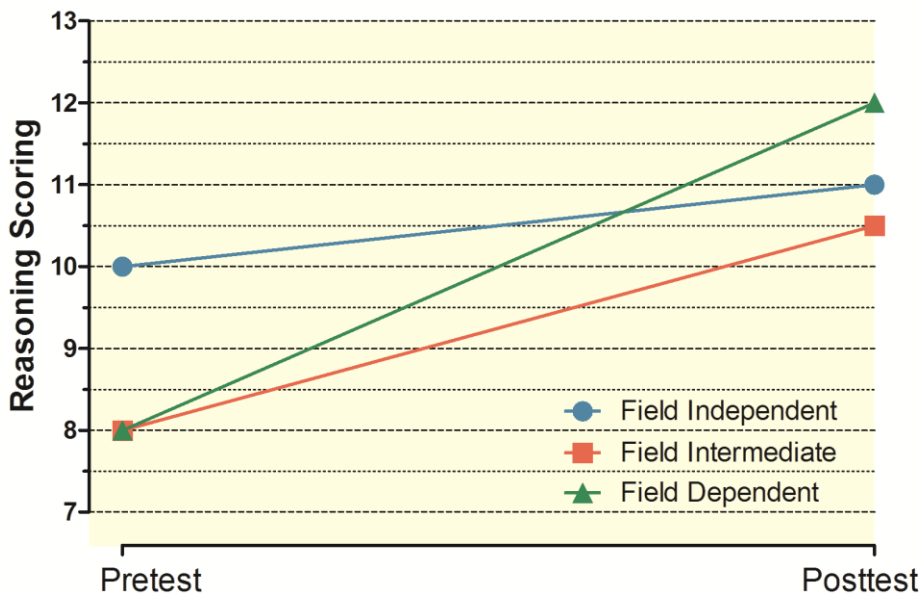


Figure 3. Pretest-Posttest Classroom Test of Formal Reasoning Scores According to Cognitive Styles.

esting point that draws attention in **Table 2** was that while a 4-point increase was observed in the mean test score of the participants with the field-dependent cognitive style after the application, only a 1-point increase was seen in the mean score of the participants with the field-independent cognitive style. The chart regarding the results is presented in **Figure 3**.

Results for RQ3

The opinions of the participants about the use of the GILABL applications were coded under the themes of their effects on the development of scientific reasoning skills with the headings of probability and combinational reasoning, correlational reasoning, hypothetical-deductive reasoning, and controlling of variables, and the results are presented below.

Contribution to Probability and Combinational Reasoning Skills

The point that was emphasized the most by the participants regarding the use of the GILABL applications was that the technique that was applied contributed to their understanding that they could approach events from different

perspectives. All participants' field-dependent and field-intermediate cognitive styles expressed that as a result of the application, they saw that there was not a single cause of events, but there might be other causes, and in other words, they could systematically think of all possible relations regarding an event or a situation. One participant with the field-dependent cognitive style stated that the requirement of writing at least three hypotheses to solve the problem situation in the provided scenario developed this ability:

Professor, for example, you know, there is the part that required writing three hypotheses. The number being three is also very important; if it were only one, we would write one and leave it there, but when it is three, we are supposed to think more. In the experiment regarding fluid pressure, what I did was to think that we were on another planet. Yes, it is impossible to be there, but we had to write this up. (#S2/FD)

The participants with field-intermediate cognitive styles expressed that thanks to the experiment, they could now approach events from different perspectives, and they became more inquisitive:

...thanks to the experiments we conducted, I now approach an event differently and in an inquisitive manner; therefore, my scientific reasoning skills have been improved. (#S5/FINT)

Contribution to Correlational Reasoning Skills

One of the points that the participants mentioned regarding the use of the GILABL applications was that this technique contributed to their thinking about what type of relations existed between events and situations and whether they were connected or not. In this context, one participant with a field-intermediate cognitive style reported that the applications developed their abilities regarding the correlation of one variable with another:

... I look at things more critically and inquisitively, I can see the differences more clearly. I used to look at things aimlessly, but now, I started to look at life more scientifically. (#S5/FINT)

One participant with the field-independent cognitive style expressed that their correlational thinking ability which they already had turned into a conscious action thanks to the techniques applied. In other words, their mind gained a systematic of scientific thinking:

...This course has been very beneficial for me; yes, I used to think about many things, you think about why sugar dissolves in tea, yes, you can say, because it is hot or something else, but I needed a sci-

entific reference. This course has been very efficient in terms of forming this reference. (#S1/FID)

Contribution to Hypothetical-Deductive Reasoning

Another point that the participants emphasized in regard to the use of the GILABL applications was that this technique contributed to them in terms of developing possible solution methods for an encountered problem that needs to be tested and trying these methods by using the solution methods systematically. In this context, the thinking processes and implementations of one participant with the field-dependent cognitive style in solving a problem that they faced were proof of the development of this ability. The participant thought that the implementation contributed to them becoming a solution-oriented individual:

... I have become solution-oriented, too... For example, I have a bird, but it is too active, I cannot hold it though it has been with me for two years. I would give it feed every day, and it would scatter the feed all around. Finally, professor, I made a feedbox so that it could not spill the feed, and now the problem is solved. (#S2/FD)

One participant with a field-intermediate cognitive style stated that the application helped them become a solution-oriented person who forms hypotheses in their mind about a problem they face and designs a thought-based experiment, thus indirectly expressing that their hypothetical thinking ability improved:

... I think forming a hypothesis about an issue and creating a mental experiment developed my perspective. When faced with a problem, I immediately visualize the cycle we used, and I can design a mental experiment within my capacity. I design all steps of the mental experiment appropriately. Consequently, it helped me become a more solution-oriented person. (#S5/FINT)

One participant with the field-independent cognitive style, on the other hand, stated that their inquiry ability that they previously used actively was now based more on scientific foundations, and their hypothetical-deductive reasoning, which they used to believe, was a difficult one, and improved as a result of the techniques applied:

...As a result of this course, I came to understand that forming a hypothesis was a difficult task, but it became simpler when certain steps were followed, and I started to think more scientifically. I mean, I was actually thinking about some other things ... but there were always some things missing. Now, I both form hypotheses and

look at things from different perspectives. When I compare myself at the beginning of the semester to the present time, I am aware that I have improved in scientific terms. If you gave me a problem situation related to walking and asked me to form a hypothesis, I could form it. (#S1/FID)

Contribution to the Skill of Controlling of Variables

Another issue that the participants mentioned regarding the use of the GILABL applications was that the applied technique developed their thinking ability which includes identifying and controlling the variables by determining dependent and independent factors that affect a situation. In this context, one participants with the field-intermediate cognitive style expressed that their ability to identify and control the variables with which they used to have difficulties at the beginning of the application improved a lot in the process:

...but it was difficult to design an experiment appropriate for my hypothesis. In this design, too, identifying the dependent and independent variables was challenging for me. (#S5/FINT)

Well, did you feel more competent later in identifying the dependent and independent variables? (#R1)

I definitely did. Before designing an experiment, I started to design it in accordance with the dependent and independent variables. When I moved to the other stages after identifying the independent variable, I was able to conduct a more accurate experiment. (#S5/FINT)

Discussion and Conclusion

In this study, first, the effects of GILABL applications on the scientific reasoning skills of the participants were investigated, and the impact of these effects on the scientific reasoning skills of the pre-service science teachers with different cognitive styles was examined. In the application carried out in this context, as a result of the analysis of both the quantitative and qualitative data, it was observed that the development in all participants' scientific reasoning skills was in a positive direction. This result of the study was consistent with the literature (Blumer & Beck, 2019; Daempfle, 2006; Engelmann et al., 2016; Jensen & Lawson, 2011; Marušić –Sliško, 2011; Shayer & Adey, 1992; Schiefer et al., 2019; Van der Graaf et al., 2019; Yulianti et al., 2020; Yulianti, et al., 2018). As the development of scientific reasoning skills is considered one of the objectives of science education (NRC, 2013), it has also been emphasized in many studies in the literature conducted for

the development of these abilities that some of the most effective practices are guided inquiry activities (Alfieri, et al., 2011; Bruder & Prescott; 2013; Carolan, et al., 2014; Lazonder & Harmsen, 2016; Minner et al., 2010; Yulanti, et al, 2020). This situation is believed to be in compliance with Piaget's cognitive development theory. This is because according to the theory, when students are exposed to teaching processes in which they can express their opinions, can make alternative explanations, and test their opinions, they will notice the missing points in their own reasoning processes and proceed in the direction of developing them. In classrooms where teaching is based on the presentation or transfer of knowledge, students cannot be motivated to solve their internal conflicts. Instead, they use their time to memorize the relevant knowledge. Jensen and Lawson (2011) placed students in three groups based on the scores they obtained from a scientific reasoning skills test to evaluate the effects of inquiry-based teaching (as opposed to conventional teaching) and the achievement of collaborative student groups with different compositions. In their study, the students with low scientific reasoning skills achieved more targeted outcomes in research and inquiry activities than the students with medium and high-level abilities. The students with low scores in the scientific reasoning skills test obtained significant increases in their scientific reasoning skill scores when the group was homogenous (the scores obtained from scientific reasoning skills being close), and the teaching method was based on research and inquiry. The researchers reported that the explanation for this situation was in Piaget's theory. The students achieved this result by taking the opportunity to self-organize without the guidance or direction of a more talented peer. Similar results were seen in the studies conducted by Beck and Blumer (2012) and Blumer and Beck (2019). In these studies, as well, the authors determined that the scientific reasoning skills of all students were developed with the guided inquiry laboratory method, but the highest gains were obtained by the students whose pretest scores were in the lowest quarter. The results obtained in this study were similar to the findings of the studies reported above. In this study, it was determined that the development of the scientific reasoning skills of the field-dependent participants with low scores from the scientific reasoning skills test was higher as a result of the guided inquiry techniques that were applied in comparison to their field-independent peers.

This effect of guided inquiry laboratory activities on the participants' scientific reasoning skills can also be explained in terms of their activities of information processing. In Pascual-Leone's (1970) Theory of Constructive Operators, the mental capacity of an individual is explained as a cognitive variable that defines their ability to process multiple phenomena or concepts simultaneously. In the theory, it is stated that individuals mostly do not use the entirety of their mental capacity, and individual differences such as some motivational variables and cognitive styles affect the utilization of this ca-

capacity (Pascual-Leone, 1970). Accordingly, when a student faces a problem situation or context in which relevant and irrelevant information about a topic is presented, the irrelevant piece of information uses a certain part of their mental capacity, and thus, less time is left for the processing of the relevant piece of information. In this case, field-independent students who can easily distinguish relevant information from irrelevant information have more functional mental capacity that they can use (Johnstone & Al-Naeme, 1991). In this theory, it is argued that the more complicated an activity is, the more the activity's mental demand is. Besides, the importance of the difference between the individual's mental capacity and the activity's mental demand is also emphasized. As a matter of fact, studies conducted on this field support these characteristics indicated in the theory. Previous studies have demonstrated that as the complexity of the activity (its mental demand) increases, the student's performance decreases, and small interventions made to the mental demand without changing the logical structure of the problem cause an increase in the student's performance (Danili & Reid, 2004; Niaz & Robinson, 1992; Tsaparlis & Angelopoulos, 2000). In fact, in the inquiry activities carried out by Kirschner et al. (2006), it was stated that as the teacher's guidance decreases, the activity's mental demand will increase, and therefore, the student's success will be negatively affected as more mental capacity will be needed. Moreover, the increase in guidance in the activities will reduce the load on mental capacity, and thus, there will be the opportunity to code new information and store it the long-term memory. These explanations are consistent with the results of this study. In this study, it was observed that the participants with the field-dependent and field-intermediate cognitive styles benefited more from the application compared to the students with the field-independent cognitive style. Accordingly, the much lower pretest scores of the field-dependent participants compared to the field-independent participants increased to a higher level than the scores of the field-independent participants as a result of the application. In the study, by both adopting the guided inquiry learning approach and using the hypothetico-deductive reasoning cycle, a contribution was made to the increase in the comprehensibility of the experiments by the field-dependent participants, and the activity's mental demand was reduced. It is thought that the integration of the hypothetico-deductive reasoning cycle into the experimental process for the field-dependent participants who needed the provided information to be organized contributed to their success in the guided inquiry activities positively. This is because in the relevant literature, researchers who have based their studies on students' cognitive styles and the characteristics of the activities related to mental demand have aimed to mitigate the effects of the field by removing unnecessary information from activities, and thus, they have observed increases in the performance levels of students (Danili & Reid, 2004; Tsaparlis & Angelopoulos, 2000).

Recommendations, Limitations, and Implications

The results obtained in this study demonstrated the case which was expressed by Koran and Koran (1984) as ‘There is no one best educational treatment or environment suited to some general, average individual, but different individuals thrive in different environments suited to their own characteristics and needs’ (p. 795). In the study, the participants with the field-dependent cognitive style achieved higher success compared to their field-independent peers in a teaching design that was suitable for their cognitive styles and in an activity in which guidance was provided only on the research question and which had a high mental demand in this sense. Considering the results obtained in this study and the fact that the construct of cognitive style is in the high effect category in terms of predicting students’ success (Authors, 2020), it is seen that the concept of cognitive styles is a variable that should not be overlooked. Therefore, it is important that both educators and curriculum developers be aware of the cognitive styles that students have and design the learning environment and materials by considering the characteristics of students with different cognitive styles.

In the study, the effects of GILABL applications where the hypothetico-deductive reasoning cycle was used on the scientific reasoning skills of pre-service teachers with different cognitive styles were examined. However, the effects of whether this cycle was used in GILABL applications or not on students with different cognitive styles were not investigated. Although a positive contribution of the application was observed, especially for the participants with the field-dependent cognitive style, more experimental research is needed to reveal how effective the integration of the hypothetico-deductive reasoning cycle with guided inquiry activities is and to determine students’ opinions on the integration of this cycle with guided inquiry activities.

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Appendix I

Materials

mind garden
Tools for positive transformation

Mind Garden, Inc.
707 Menlo Avenue, Suite 120
Menlo Park, CA 94025 USA
Telephone (Pacific time): (650) 322-6300
FAX: (650) 322-6398
08/08/2020
Order #36834

Billing & Delivery Address:
feride-celik84@hotmail.com
Alper Mizrak
534 Curie Dr
San Jose, California 95123
United States
+18583373791

Order Reference: ESQWVAUKC
Order Date: 08/08/2020
Payment Method: Credit Card \$103.29
Carrier: Fedex express saver

Product / Reference	Unit Price (Tax Excl.)	Discount	Qty	Total (Tax Excl.)
Group Embedded Figures Test: A measure of cognitive style GEFT Booklet Pack (25 booklets) - Translation : Turkish	\$62.50	--	1	\$62.50
Product Total (Tax Excl.)				\$62.50
Product Total (Tax Incl.)				\$67.97
Shipping Cost				\$35.32
Total Tax				\$5.47
Total				\$103.29

Tax Detail	Tax Rate	Total Tax Excl.	Total Tax
Products	8.750 %	\$62.50	\$5.47

**Group Embedded Figures
Test
Instrument and Scoring Guide**

Developed by

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Appendix II

Basic Process and Example Scenario of Experimental Applications

Completion of each experiment during the implementation process of the study covers a two-week period. In the first week, a problem scenario is presented by the instructor regarding the concept to be discussed, and students are asked to form their hypotheses regarding the solution of the problem in the scenario, and to design an experiment to test one of these hypotheses. In this context, one of the scenarios presented to the students during the implementation process is shown below. [In the preparation of this scenario, TUBITAK's (Türkiye Bilimsel ve Teknolojik Araştırma Kurumu-The Scientific and Technological Research Council of Turkey) Science Youth page (<https://bilimgenc.tubitak.gov.tr/makale/kartezyen-dalgicini-tasarla>) was used.

Cartesian Diver's Movement

"When a cartesian diver is placed in a water-filled bottle in the figure below, it is seen that the diver floats, and if the bottle is squeezed from both sides, the diver sinks. You are expected to identify hypotheses that may reveal the reasons for this situation; test these hypotheses and explain the cause of the event."



After this scenario was presented during the implementation process, a discussion environment was created and the possible reasons for the situation were discussed with the students. At this stage, no teacher guidance was made regarding the reasons for the event, the students' opinions about the event were taken, and the lesson was concluded by creating a curiosity about the event. This stage covers a period of approximately 15-20 minutes. 3 days after this stage, the students sent their pre-experiment reports containing their

possible hypotheses (at least 3 hypotheses) regarding the problem situation to the instructor in charge of the course via the Microsoft Teams program. The instructor examined and evaluated the pre-experiment reports in terms of the suitability of the hypotheses (in terms of the structural features of the hypothesis) and designing an experiment in accordance with the determined hypotheses. Then, she gave the necessary feedback and corrections to the students 1 day after the same program.

Below is the pre-experiment report of the student with the code Ö1/FID.

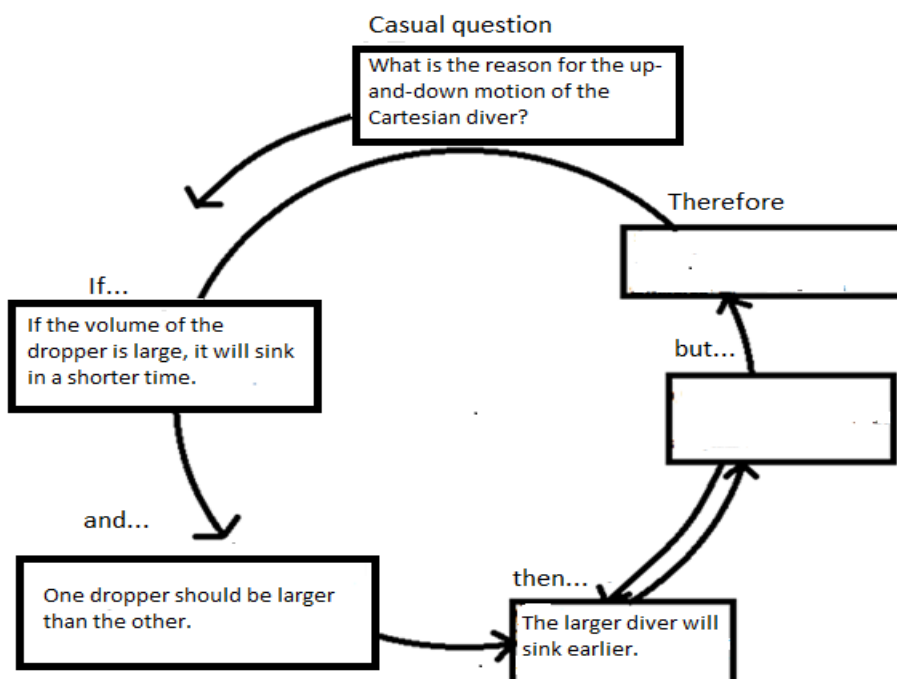
Pre-Experiment Report of Student with Ö1/FID Code:

(1) Hypotheses

a) My hypothesis/hypotheses for this experiment are:

- When we put a liquid with less density instead of water in the bottle, the diver will sink faster.
- When salt is put into the water, its density increases and the diver sinks more difficult.
- If the volume inside the dropper is large, the diver's sinking time will decrease.

(2) The hypothetico-deductive reasoning circle I used during the experiment



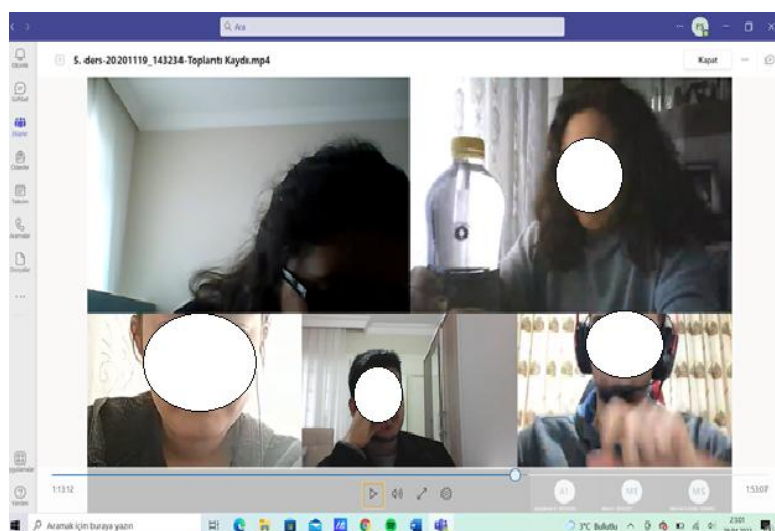
(3) The concepts covered in this experiment are:

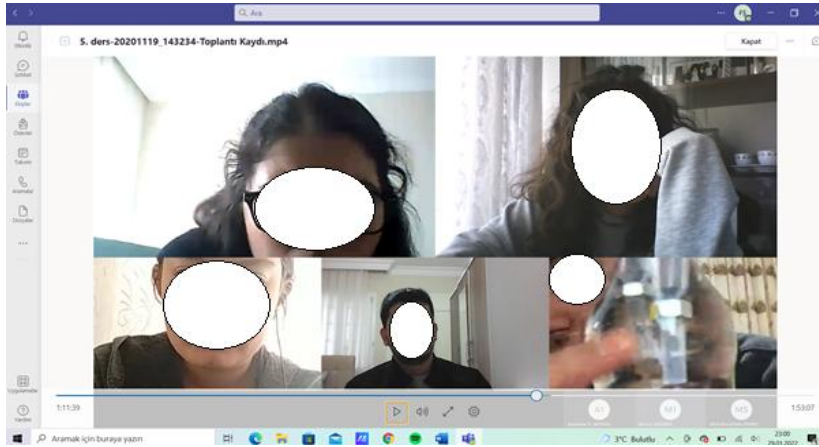
- Pressure
- Density
- Buoyancy force
- Force
- Sinking
- Swimming

In the second week of the guided inquiry learning approach-based laboratory practices in which the hypothetico-deductive reasoning cycle is used, the experiments designed to test the hypothesis were applied by the students. In this process, the students were expected to explain the judgment they reached by comparing the predicted results before the experiment with the actual experimental results (they were asked to construct this explanation by taking into account the steps of the hypothetico-deductive reasoning cycle). After this stage, the lecture was concluded by introducing the concept discussed by the lecturer (also one of the authors of the study) and associating it with daily life.

The students sent their post-experiment reports about the experiment 3 days later via the Microsoft Teams program. In this process, the students were given the necessary feedback and corrections again. In the post-experiment reports, students were asked to design a scenario related to the basic concept discussed in the experiment, and it was tried to deepen the connection of the concept with daily life and its application. In other words, students were asked to prepare a thought experiment at this stage.

Below are the images of the students regarding the experiment and the post-experiment report of the student with the code Ö1/FID. (Ethical permission regarding the use of sound and video within the scope of the study and voluntary consent from the students were obtained. However, the clarity of the students' images was somewhat reduced.)





Post-Experiment Report of Student with Ö1/FID Code:

(1)

(i) Here are the procedures I followed during this experiment:

- First, I tried to figure out how the diver would sink.
- Later, I learned the mechanics of the diver's sinking.
- I thought about how to change the diver's sinking time.
- I thought that when I changed the size of the diver, the sinking time would also change.
- I made two divers in the experiment and calculated the sinking times.

(ii) My experimental setup is as follows.



(2) Observations and Findings

(i) The independent variable(s) in this experiment are:

Divers size

(ii) Dependent variable(s) in this experiment:

Sinking time

(iii) Variable(s) controlled in this experiment:

Applied force

(iv) Here are the situations I observed in this experiment:

The big diver sank later than the small diver.

(v) Here are the information/data I recorded throughout the experiment:

I found it convenient to show the data I recorded with a table.

Divers size	Force	Sinking time
4 cm	Equal	2 seconds
8 cm	Equal	5 seconds

(3) Evidence

Here is my evidence supporting/rejecting my hypothesis:

- That made my hypothesis rejected was that the great diver sank later.
- The logic was correct, but the opposite happened, so I rejected my hypothesis.

(4) Reflection

(i) Here are the conclusion(s) I drew from this experiment:

The big diver sinks later than the small diver.

In the experiment, I learned that the sinking time of the object (cartesian diver) depends on the applied force.

The water entering the dropper compresses the air and the density increases.

The floating or sinking of the object (cartesian diver) in the liquid is related to the density.

(ii) My thoughts at the beginning and end of this experiment were the same/different. This may be due to:

My thinking at the beginning of this experiment was different. Because I thought the big diver would sink faster. But when I did the experiment, the little diver went down faster.

(iii) Here's what this experiment has given me:

In order for the diver, which is larger in volume, to sink to the bottom of the water, more water must enter it. Therefore, it sinks later.

(iv) I can use/apply the result of this experiment in the following events in daily life:

I learned the effect of density on the sinking and floating state of an object.
What I learned;

Diving to the bottom of the sea and

I can use it to explain the physiology of fish swimming in water.

(v) Here are the experimental mistakes that I have made / may have made in this experiment:

I couldn't get the result I wanted when I first did it while adjusting the size of the divers. I could not observe the difference. But then when I increased the size of the diver, the experiment was correct.

(vi) The challenges I faced in this experiment are:

I had difficulties in creating different sizes of Cartesian divers.

(vii) To overcome these difficulties, I did the following:

Since we were in the classroom during the experiment, I adjusted the diver dimensions with the help of our teacher and completed the experiment without any errors.

(5) Daily life examples and thought experiment

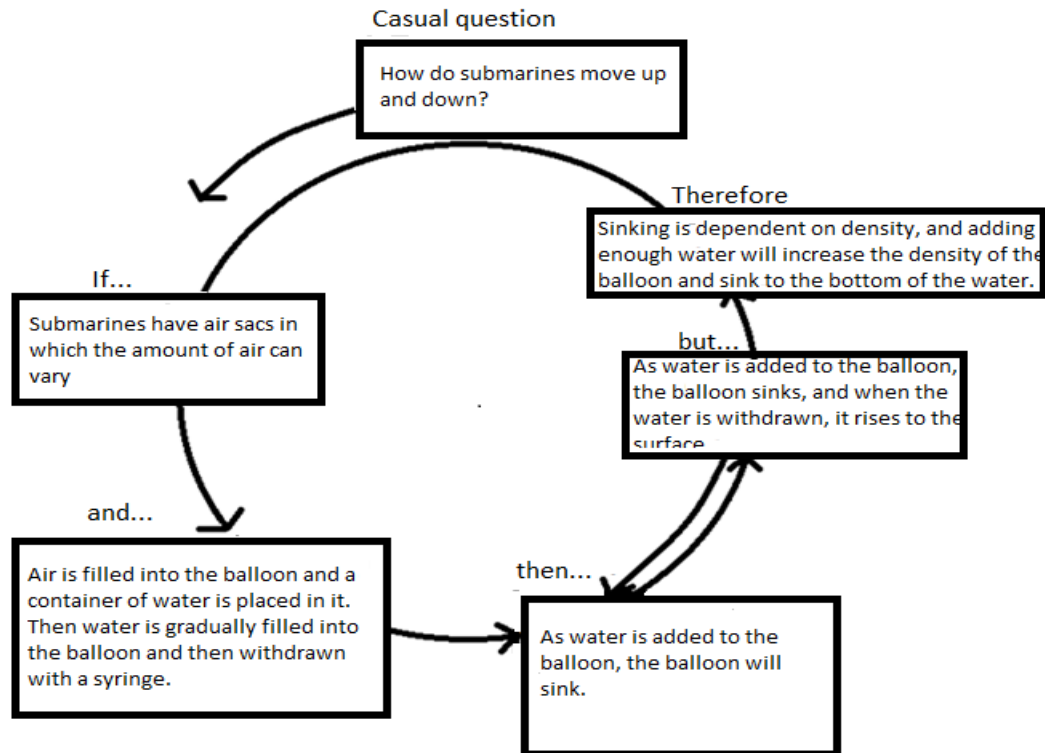
At this stage, you are expected to design a thought experiment that includes your hypotheses about this concept by giving daily life examples of the information you have learned as a result of the experiment.

Research question: What allows submarines to be on the surface whenever they want and at the bottom when they want?

Hypotheses:

Submarines sink depending on the load.

Submarines sink into the water with a special mechanism.



At the end of the lesson, a scenario presentation for the next week's experiment was made and a similar process was run for all experiments except the example.

In this experiment report presented, the student's (S1/FID coded student) writing is presented here without any changes. During the application process, students were given feedback on the parts that made mistakes or were missing, especially in the pre-experiment reports. The same feedback process was used for the post-experimental reports. For example, in the 'b' part of the 'reflection' part of this experiment report, the difference between the thoughts at the beginning and the end of the experiment was explained by the student, but it was understood that no explanation was given about the reason. Therefore, feedback was given to the student regarding these parts by the instructor of the course. Similarly, in the "daily life examples and thought experiment" section in the 5th chapter, the student prepared the thought experiment but did not present daily life examples. In this regard, the instructor of the course gave feedback to the student.

As a result, the example presented here; it was used to provide information on how the guided inquiry learning approach-based laboratory applications, in which the hypothetico-deductive reasoning cycle is used, is carried out. The main purpose is to show the order of the process steps and the way they are implemented, to exemplify at what stage and how the cycle is used, thus making the process more understandable for the reader.

Pathways to Successful Transformation of Basic Education amid Educational Crises: A Case Study of the Experiments in Educational Reform by 271 Education Group

Mengyuan Hua

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Abstract: *The 2021 release of Reimagining Our Futures Together: A New Social Contract for Education by the United Nations Educational, Scientific, and Cultural Organization was a reaction to a number of serious problems discovered in worldwide educational reforms. It sought to establish a new social compact for education to fulfill its unmet promise in the face of many educational crises and to combat future uncertainty. Using the methods of 271 Education Group as a case study, this article examines China's efforts to transform basic education in response to widespread educational issues and how they have represented the major principles espoused by the UNESCO report. The article elaborates on the coping strategies of 271 Education Group, such as incorporating eco-civilization education into basic schooling, constructing life-based curricula that are built on knowledge commons, introducing pedagogy rooted in cooperation and solidarity, and promoting teacher professional development through collaborative educational research.*

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HUMANITY has been presented with a decision about its survival: either to continue on the current path of unsustainable development or to make a major shift in order to maintain their existence on the planet. Their shared future will be determined by their decision. People must consider how to shape the future of mankind and the planet in a complicated, precarious, and sensitive environment by recasting knowledge structure, teaching, and learning (Lin et al., 2022). The COVID-19 pandemic has exacerbated global crises, made education more precarious than ever, and increased people's anxiety about the future (Yue et al., 2022).

Given this context, the report “*Reimagining Our Futures Together: A New Social Contract for Education*” (hereafter referred to as the Report) was published on November 10, 2021, by the International Commission on the Futures of Education with UNESCO. The Report suggests creating a new social contract for education in the ensuing decades that is based on human rights and seeks to rebuild our relationships with one another, the environment, and technology. It also aims to correct injustices and aid in the development of peaceful, just, and sustainable futures (UNESCO, 2021).

The Commission asserts that a number of interconnected crises are plaguing humanity, including unsustainable economic development paradigms, extreme wealth polarization, frequent violent conflicts between and within countries, rising populism, democratic backsliding, and gender inequality. Unsustainable economic development models have exacerbated factors such as climate change, environmental degradation, resource depletion, biodiversity loss, and a reduction in the amount of land that can support human habitation (UNESCO, 2021). Digital technology may both unite and divide people in the age of the internet. They can facilitate the sharing of knowledge and information, but they also pose a serious threat to knowledge diversity, cultural inclusivity, private space, and privacy security. They reshape human production, life, and education while also eliminating some industries and jobs, leading to increased unemployment. The “digital gap” might make it more challenging for those who are less fortunate to acquire excellent education and good jobs.

Approximately 2,500 million children worldwide do not have access to formal primary education; 1 in 5 young people are NEETs (not in education, employment, or training); and 7,000 million people are still illiterate. In the COVID-19 pandemic, school closures affected 1.6 billion students worldwide; many girls may never again have the chance to attend school; the percentage of qualified primary school teachers fell from 85% to 65%; and the lack of funding for education is made worse by the epidemic's negative effects, making it more difficult to achieve the objective of “sustainable development of education.” The epidemic, according to UNESCO Director General Azoulay, has demonstrated both our vulnerability and our interdependence. The United Nations secretary general, Antonio Guterres, emphasized that the right to education as a fundamental human right has not yet been universalized, that the 2030 sustainable development of education goal is in jeopardy, that education is still far from being realized as a global common good, and that the educational crises are affecting all of us (Zhang & Bian, 2022).

Commitment is necessary for the realization of the common good, and teamwork is required for the accomplishment of global goals. What ought to serve as the foundation? The Report makes transformational suggestions for various nations, particularly for nations and populations that are most seriously threatened by the current crisis. What direction and action China should follow for basic education is a topic well worth debating in light of the educational crisis, a planet in danger, and uncertain futures.

The 271 Education Group of Shandong, which began as a typical rural middle school 20 years ago, has grown into a conglomerate with 16 separate schools, approximately 6,000 teachers, and 90,000 students. It includes teaching management, in-service teacher training, study trips, and the development and operation of farms for the practical instruction of students. It also includes educational research and development. It has gained widespread recognition in the area for providing high-quality education; its member school, “Changle No.2 Middle School of Shandong,” has set the bar high for China’s basic education. In the process of education and teaching reform, the Group has produced numerous effective teaching initiatives and research findings, such as the holistic module learning model, a significant experiment in teaching paradigm innovation (Zhao, 2022), and home-school partnership courses based on Xingzhi Tao’s life education theory (Zhao & Wei, 2021). In light of the escalating educational crises, this essay focuses on the Group’s investigation of routes to successful reform of basic education.

Eco-Civilization Education Based on Ecological Consciousness

“We must rethink and reimagine curricula to instill a fundamentally new way of looking at the place of humans as part of the planet,” the Report adds. The urgency of environmental sustainability—living within the limits of the planet without endangering future generations or the natural ecosystems of which we are all a part—should be stressed to students in all subject areas (UNESCO, 2021. p.66). This is surely significant and forward-looking thinking about how education will develop in the future from the standpoint of humanity’s and the Earth’s sustainable development (Yue, 2022).

Education about eco-civilization will always be important to education, both now and in the future. The majority of Chinese schools only offer ecological education as a minor module in their basic education curricula right now; it is not as developed and comprehensive as that in Western nations. Therefore, it is crucial to create new paradigms for teaching eco-civilization. The following ideas should be kept in mind when doing so: (i) to create a deep-ecology-based educational idea to reject human exceptionalism. (ii) to establish eco-civilization education paradigms by drawing on outstanding traditional Chinese and Western heritage as well as modern culture. (iii) to develop subject-integrated, school-based curricula for ecological education that are “rewilded by developing deep connectivity with the natural world and embracing the biosphere as an educational space,” are progressive and consider the characteristics of students at different levels (UNESCO, 2021. p.66).

The 271 Education Group has placed a strong emphasis on eco-civilization education. The Group’s educators hold the views that harmonious coexistence between humans and nature is necessary for sustainable development and that human survival is a gift from nature. As a result of the world’s rapid industrialization, the environment has been severely damaged and human society is currently experiencing serious ecosystem issues. Environmental protection depends on increasing public ecological consciousness, which calls for thorough and organized eco-civilization education. According to the varied stages of students’ thinking abilities, which continue to advance from lower to higher orders as they mature, 271 Education Group carefully chooses instructional materials and methodologies for ecological education.

The learners’ thinking is rather simple in the primary level, as they are transitioning from imaginable to abstract thinking. Teachers focus on guiding students to

“perceive the ecological environment” at this stage, and a situational learning technique based on students’ perceptual experience is used. Teachers present the teaching content using concrete teaching tools and vivid language to help students feel and understand the surrounding environment, encourage students to tell stories about environments based on prior experiences, and design various games and activities to inspire students’ reflection on environments based on their perceptual knowledge. Teachers, for example, can tell kids stories about forest conservation and teach them to sing the children’s song “Take Care of the Sapling” to help students consider why they should care for young trees. Students will gain an understanding of the importance of plants and begin to build an awareness of environmental protection through activities like these.

At the junior secondary level, students’ abstract-logic thinking has greatly developed and plays a crucial role in their thinking processes, although it still relies on perceptual experiences for the most part. At this stage, teachers concentrate on “arousing students’ care for the ecology” and attempt to heighten their ecological consciousness by analyzing contemporary ecological issues. In order to arouse students’ awareness of the plight of the ecosystem, teachers first introduce scenarios of environmental devastation by displaying images, texts, and films. Then, problem-based group cooperative learning is implemented to involve students in the discussion of specific ecological challenges, allowing them to increase their ecological knowledge via discussion, analysis, and reflection. When discussing the freshwater environment, for instance, teachers pose the topic, “What will happen to people once they consume polluted freshwater organisms?” and let students to discuss it freely. In terms of the relationships between humans and animals, students are supposed to debate whether or not snake catching should be authorized, given that snakes can attack humans and livestock, resulting in human and economic consequences.

At the senior secondary level, abstract-logic thinking dominates the cognitive activities of students, and their theoretical abstract-logic thinking ability begins to increase. In addition, as a result of their increased life experiences and scientific knowledge, high school students are capable of a greater comprehension of the fundamental relationships between things. At this stage, students are motivated to “study ecological problems” and their application of ecological knowledge is emphasized. Teachers assist students in establishing a somewhat orderly framework of ecological knowledge through the use of linkage and mind mapping so that they can acquire an all-encompassing awareness of the ecosystem and its principles. Students are also encouraged to apply their ecological knowledge to the examination of complicated environmental issues in the actual world. For example, the teacher introduces students to environmental concerns involving value conflicts, such as “how can a region dependent on the logging industry shift from ‘logging economy’ to ‘green growth with ecological safety as the primary priority? What ethical risk does it pose for some nations to discharge sewage into the ocean in order to safeguard the ecosystem of their home country? Then, students are asked to apply their ecological knowledge to the exploration of resolution strategies and the evaluation of the viability of various solutions in order to develop a critical understanding of environmental issues and sound ecological perspectives and values.

In sum, 271 Education Group considers the cognitive level of students at each stage in the selection of instruction methods and chooses relevant education content based on the complexity of knowledge to ensure the successful implementation of ecivilization education at the basic education level.

Life-Based Curricula based on the Knowledge Commons

Where does knowledge come from? What must be taught and acquired? What should be forgotten? At this crucial point, when the common future must be remade, the International Commission on the Futures of Education replies to these extremely significant questions. The Report claims that “curricula should approach knowledge as a great human accomplishment that belongs to everyone” and that “education can enhance people’s abilities to build on the knowledge commons, with each generation contributing their own reinventions of the world” (UNESCO, 2021. p.65). Knowledge is never complete; educators should encourage and facilitate student participation in the co-creation of knowledge commons. In order to design open and shared curriculum, it is necessary to renounce the disciplinary and topic borders as permanent or essential constraints and to incorporate the perspectives of complexity, plurality, and transversality. Only by doing so can we move beyond the old notion of filling the school curriculum with existing subject knowledge and integrate ecological sustainability, scientific inquiry, information technology, human rights protection, gender equality, cultural diversity, and inclusion and coexistence into the curriculum, which is designed for the future of humanity.

The goal of education is not just to provide students with knowledge, but also to develop their ability to criticize and apply current knowledge, as well as their potential to generate new knowledge. According to the Report, school curricula should strive to increase students’ literacy and promote multilingual opportunities; to develop students’ numeracy, which combined with mathematic knowledge should be utilized to resolving individual, societal, and human challenges; to nurture students’ empathy, morality, and imagination and foster their capacities to grasp human and non-human experiences and analyze the evidence of historical events; to pique students’ enthusiasm in scientific inquiry, which is far more important than memorizing scientific symbols, formulas, and theorems, and to increase their discrimination and ability to undertake honest and complex inquiries; to improve students’ digital literacy in order to secure their personal development in a world of rapid scientific and technological advance; to bolster students’ social and emotional abilities as well as their overall humanity-related competencies through art education (UNESCO, 2021). Education through such curriculum aims to mobilize individuals’ agency, assisting them in achieving complete growth, and, most importantly, preparing them to be qualified citizens in morality, democratic participation, knowledge production, and happy life creation.

These recommendations from the Report show that the main objective of education is to develop all-around people, which call for curriculum that are entwined with all facets of life and derived from life. The curriculum should include all elements in the outside world that are important to students’ personal development, including both cognitive and non-cognitive activities, according to the 271 Education Group’s perspective.

According to the Group’s philosophy of life-based curricula, a curriculum that is generated from life and totally connected to life enables students to develop the skills necessary to expand life, create life, and ultimately live a happy life. Life supplies every youngster with crucial learning material. For students, society, the home, and school all act as classrooms. Life-related disciplinary knowledge makes sense to them and is therefore easily assimilated and digested.

The following principles guide the Group’s life-based curricula:

- i. The program is based on real-life experiences. It adds “live teaching resources” to curricula and adapts them to the needs of the time. Only by integrating the curriculum into the vibrant life can it fully demonstrate its vitality and value. Furthermore, life is the most potent motivator for student academic achievement. Curriculum based on students’ life experiences might better increase students’ interest in learning, raise their awareness of accepting knowledge, and hence produce better results. Additionally, learning in real-life settings necessitates emotional engagement on the part of the learner. As a result, knowledge gained via life practice is more true and profound.
- ii. Although curricula are derived from life, they are meant to go beyond it. Avoid teaching just for the sake of teaching. The main objective of life-based education is to help students develop the skills they will need to survive in the future and to grow their capacity to change society. A dynamic process in which the educated are enduring physical and mental change and growth is the implementation of life-based curricula. In order to provide students with timely support and guidance, educators should approach each student with appreciation and from a developmental perspective, consider their particularities at various stages, pay attention to how each student’s emotion, personality, and values change over time, and work to identify their implicit, individual qualities.
- iii. Life-based curricula should emphasize the subjectivity of student learning. Modern education needs to introduce the concept of “inter-subjectivity.” The functioning of students’ initiative in learning is not supported by teacher-centered instruction; students’ subjectivity should be fully utilized. In the curriculum that is based on real-world experiences, the educators and the educated are seen as agents of equal importance who interact and support one another (Hu, 2007). Students are able to study in a democratic, egalitarian, and open teacher-student relationship when teachers approach them as actors with initiative rather than passive learners who need to be instructed.

Pedagogical Approaches Rooted in Cooperation and Solidarity

One key objective of education in a fast-changing world is to improve learners’ skills in collaborating with others in problem-solving and innovation, as well as their potential to create a better life that is closely connected with rather than isolated from the world. The Commission believes that “in a new social contract for education, pedagogy should be rooted in cooperation and solidarity, building students’ and teachers’ capacities to work together in trust to transform the world,” and that “teachers and students need to form a community of knowledge-seekers and builders nourished by and contributing to humanity’s knowledge commons” (UNESCO, 2021. p.50). Such pedagogies recognize that every individual, including teachers and students, has the right to study and share information with others. Thus, the goal of education is not to teach students how to memorize information, but rather to help them develop into actors capable of discovering and creating new knowledge in collaboration with others.

Solidarity- and cooperation-based pedagogical approaches emphasize that teaching should not only emphasize the transmission of single-subject knowledge, but also the development of interdisciplinary, formative, and meta-cognitive knowledge, which are essential for comprehending and addressing the complex, multifaceted chal-

lenges facing humanity. Collaborative problem-based learning is vital for acquiring such knowledge. In addition, it can motivate students to expand learning venues to nature and communities, beyond the confines of classrooms and schools; to learn to cooperate effectively with others; to abandon discrimination and segregation; to embrace diversity and pluralism; and to gain an understanding of the relationship between scientific knowledge and the real world.

By implementing “collaborative group learning” in classroom instruction, schools affiliated with 271 Education Group put into practice a pedagogy based on solidarity and cooperation. In order to improve student academic quality and train student cooperative ability and skills, the group defines “collaborative group learning” as an approach where classroom activities are carried out in groups, interaction between group members is maximized to promote student learning, and group performance becomes the criterion for the evaluation of academic achievement (Zhao, 2022). To be more precise, it has five key components: (i) The study group is the fundamental building block of classroom structure. It is characterized by “heterogeneity,” which means that members of each group are chosen to aid and complement one another based on their differences in gender, academic standing, and subject of highest achievement, learning style, and family background. (ii) Interaction between peers and between teachers and students encourages collaborative learning. The most engagement possible between group members can enhance students’ abilities and fully showcase each person’s special traits; teachers can improve the quality of their lesson plans and delivery methods through increased communication with students. (iii) The group learning is purpose-driven. To avoid pointless extension and to ensure that the lesson plan is carried out, all classroom activities are set up to address specific issues. (iv) Group performance, not individual scores, is used to evaluate academic accomplishment. Academic success of each student is related to the combined achievements of all group members, including formative and summative assessment scores. With the help of this evaluation system, study group cohesiveness and cooperation are enhanced, and attention is turned away from individual student competition and toward intergroup comparisons. (v) Multidimensional learning objectives for cooperative group learning are established. Teaching activities are designed to foster students’ cooperation skills and help them grow as individuals, not just to impart knowledge.

Different types of cooperative group learning are now being used. In some way, 271 Education Group emphasizes that this strategy must always include these five components:

- *Mutual Dependence* - The student must recognize that he or she is not only working for himself or herself, but also for the group as a whole; team members are bonded by shared interests.
- *Face-to-Face Interaction*: to provide students with the opportunity to put their cooperation into practice and learn from one another.
- *Assumption of Responsibility* - There must be a clear division of responsibilities among group members, and each student must execute the assigned assignment in a timely and effective manner.
- *Social Skills* - The teacher should add social skill training into the curriculum to promote successful student participation.
- *Self-evaluation*: The study group is expected to check the development of collective actions and evaluate their results on a regular basis in order to enhance the efficacy of cooperation.

Teacher Professional Development via Collaborative Educational Research

“Teaching is a complex, intricate, and challenging vocation that labors in the tensions between the public and the personal,” according to the Report. In order to carry out this difficult work, teachers require collaborative learning communities that are rich in freedom and support. Supporting teachers’ autonomy, professional growth, and collaboration is a crucial demonstration of public support for the future of education (UNESCO, 2021, p. 80).

Teachers’ unique skills and talents need to be fostered through cooperation and assistance. In order to provide students with the connections, environments, and resources they need, modern education requires more intensive collaboration between teachers as well as between teachers and specialists. Examples of this collaboration include group educational research, partnerships between teachers and parents to better understand students and provide them with social and emotional support, and collaboration between teachers and communities.

Teachers are both reflective practitioners and creators of knowledge. There are never two similar teaching scenarios. Because of this, no machine, no matter how advanced, can take the place of teachers’ “relational” and “interactive” labor. The scope of information, particularly the body of educational knowledge, is expanding as a result of the complex job that teachers are conducting on a daily basis. As a result, teachers should be given a lot of liberty and assistance in doing joint research and creating new knowledge.

Collaborative educational research has been regarded by 271 Education Group as a vital means of fostering the professional development of teachers. Collaboration is connected to all facets of social interaction, including approaches, abilities, and techniques. Students can acquire knowledge and finish coursework independently, but learning through collaboration typically enhances the subject matter and increases the efficacy of classroom instruction. Similarly, teachers can prepare courses and conduct scientific research on their own, but teacher collaboration often increases lesson preparation quality and expands scientific research. Teachers at 271 Education Group benefit in numerous ways from collaborative educational research, including:

i. Bolstered Verbal Dexterity

Collaboration in research requires a substantial amount of verbal communication. Effective expressiveness enhances communication with others and prevents miscommunication. Proper expression, accurate evaluation, and even justifiable refusal on the part of educators are advantageous to the growth of collaborative educational research.

ii. Improved Communication Skills

In collective educational research, opposing viewpoints may continually emerge, necessitating a high level of communication skills to keep the activity running successfully. Patience, tactical expression, and attentive listening to others are required for effective communication. Teachers in the Group learn to be aggressive while also becoming more inclusive, compassionate, and flexible as a result of collaborative teaching research.

iii. Improved Reflective Competence

Reflection is the interaction of knowledge and practice as well as the dialogue between the ideal self and real reality. Teachers’ reflective competence can be increased

through the following acts of collaborative teaching research: (i) Self-questioning—to determine whether they comprehend the research material and whether it is applicable in daily instruction. (ii) Self-diagnosis: to recognize their difficulties in group inquiry and seek solutions. (iii) Observations and debate: to mutually foster professional development by engaging in in-depth discussions and learning from and complementing one another. (iv) Maintaining reflection diaries: to self-examine their participation in and contributions to the activity following each session of collaborative research; to reconsider the value and flaws of the ongoing research in order to project follow-up remedial measures.

In addition, schools affiliated with the 271 Education Group engage in “class-based educational research,” which is conducted by teachers teaching diverse disciplines to the same class, in order to supplement multidisciplinary joint research. Presently, the majority of collective teaching research is conducted by teachers of the same subject area, but collaborative research by teachers with diverse academic backgrounds is uncommon. Disciplines, particularly in school instruction, do not exist in complete isolation from one another but overlap to varied degrees. It is difficult for teachers to utilize this relationship between disciplinary knowledge if they lack cross-disciplinary conversation. As a result, it may limit the variety of classroom topics and teachers’ responses to “unconventional” queries involving several academic disciplines, so hindering students’ grasp of the connections between knowledge. In contrast, class-based collaborative educational research focuses on examining the interconnections between subjects and identifies topics ideal for project-based, interdisciplinary, and cooperative student learning. It also plays a significant role in widening the horizons of educators and increasing their knowledge bases beyond the confines of their specialization.

Conclusion

In light of current global crises and educational challenges, UNESCO’s *Reimagining Our Futures Together: A New Social Contract for Education* offers a number of implications for China’s basic education. In response to these difficulties, 271 Education Group created its unique educational philosophy and associated instructional techniques. To create a new social contract for education, all parties and social forces must be involved. Education must address the negative effects of the pandemic on all students as well as the challenges posed by uncertain futures in the context of global radical change and the once-in-a-century pandemic. Education must also safeguard individual human rights and well-being while promoting societal development and preserve civilization heritage while transforming and innovating. To achieve the aim of sustainable development in education and fulfill the pledges for the future, it requires every individual’s effort and devotion. Although education cannot solve all of humanity’s problems, human agency and action in education will undoubtedly help create a more peaceful, just, and sustainable future for all.

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The Detrimental Effects of Mobile Game Addiction on Chinese Primary School Students and Possible Interventions

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Abstract: *Smart phones have permeated every part of people's lives in the mobile internet era and are virtually taken for granted on a daily basis. Chinese primary school students are facing a serious problem with mobile gaming addiction as a result of their easy access to cell phones. The excessive usage of mobile games has negative impacts on children's academic performance, physical health, and mental health, and may possibly have severe, irreversible implications. It is crucial for educators and the general public to address the issue of mobile game addiction in primary school students. This article examined the current state of mobile gaming among primary school students and the negative effects of mobile game addiction on schoolchildren, looked at the contributing factors from the perspectives of students, parents, schools, and society, and suggested some coping mechanisms.*

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CONSUMERS now frequently use smart phones for everything from communication to financial transactions as a result of the widespread use of mobile internet. Additionally, they are now more readily available to primary school students, which have led to an addiction issue with mobile games among them. Mobile games provide students with fun and relaxation when they are played in moderation, but extreme video game reliance might have detrimental effects on students' development. When a person becomes compulsively and uncontrollably dependent on a certain action, they are said to be behaviorally addicted. When this habit is discontinued, the person experiences physical or mental pain. In spite of the detrimental effects on their health, employment, or education, mobile game addiction happens when gamers heavily rely on their smart phone's video games, experience an overpowering need to play them, and spend disproportionately lengthy periods of time doing so (Yang, 2016). In China, smart phone gaming addiction is currently getting worse among primary school students, raising serious worries throughout the entire country. Although the government's enactment of pertinent regulations and the introduction of several intervention strategies by video game firms have helped to lessen students' reliance on mobile games, the problem still requires the efforts of all parties. The current state of mobile gaming among Chinese primary school students is discussed in this article, along with the root reasons for mobile game addiction and how it negatively affects children. Relevant countermeasures are also suggested to help with the prevention and treatment of schoolchildren's reliance on mobile games.

Mobile Game Addiction among Chinese Primary School Students

The 49th Statistical Report on Internet Development in China was made public by the China Internet Network Information Center (CNNIC) on February 25, 2022. It demonstrated that by December 2021, China had 1.032 billion internet users, a rise of 42.96 million from the previous year, and an internet penetration rate of 73.0%. 99.7% of Chinese internet users use their mobile phones to access the internet, making them the most popular device for this purpose (CNNIC, 2022). Primary school students accounted for almost one-third of China's juvenile internet users in 2020, according to CNNIC's Annual Report on the Internet Use of Chinese Minors, and the percentage is rising each year. 92.2% of them select mobile phones as their main means of accessing the internet. According to data, one of their most popular mobile phone pastimes is playing video games (CNNIC, 2021).

In Liqiao Chen's (2019) study, 92.2% of the student subjects had prior experience with mobile gaming. 25% of them became addicted to mobile games, with boys accounting for 93% of the addicts. The majority of them are between the ages of 10 and 12, with the youngest being only 8 years old. In terms of time spent on mobile gaming, 13.5% of the students questioned played for 1-2 hours per day, while 5.21% played for more than 2 hours per day. These two groups spent the most of their free time playing mobile games. When asked if they would voluntarily quit playing, 71.95% of the subjects indicated that they must be persuaded by others to stop, 21.47% said that they must be urged by others several times to cease, and all of them expressed significant reluctance when forced to stop. In terms of self-regulation in mobile gaming, 63.25% of the students polled said they constantly desired to reduce the number of game times but couldn't stop themselves from starting the next game. Wang's (2021) study found that most primary school junkies would significantly increase their mobile gaming time on

weekends and holidays. On weekends, they could spend up to three to four hours a day playing video games, much more than on school days; especially during the winter and summer vacations, the situation deteriorated, with some students playing mobile games for up to five or six hours a day.

The Negative Impact of Mobile Game Addiction on Primary School Students

Students in primary schools are the most vulnerable to mobile game addiction because many of them lack the self-discipline required to restrict gaming time and resist the attraction of the virtual reality presented in game settings. They will uncontrollably increase the time and energy invested in mobile games once they become addicted to them. This is exceedingly damaging to their growth and development and may possibly have lasting consequences.

Damaging Students' Physical and Mental Health

The primary school years are a critical time in a child's physical development. Young children need enough sleep and physical activity for healthy growth. Long periods of time spent texting and playing mobile games can result in issues like pain in the cervical spine, vision loss, spinal curvature, decreased brain development, and more. Playing video games for extended periods of time can cause high levels of stress, which can worsen neurasthenia and weaken immunity. An adolescent in Guangzhou had a cerebral infarction and came dangerously close to death in 2017 after playing the smart phone game "Honor of Kings" for 40 straight hours (Chen et al., 2018).

Long-term video gaming has a detrimental effect on schoolchildren's mental health as well. The early years of education are crucial for the development of a person's viewpoint. Some of the most well-known mobile games right now, like "Honor of Kings" and "Game for Peace," are violent and not suitable for young children. By killing adversaries and performing other heinous deeds in games like this, players can increase their levels or rankings. Too much exposure to violent culture may result in children who have not yet established the correct viewpoint and values becoming violent in real life (Lu, 2018). Due to the effects it has on children's thinking and communication, excessive virtual reality play in mobile games can cause them to become disconnected from reality. They could experience anxiety disorders and even depression if they are forced to leave the virtual world.

Degrading Students' Academic Performance

After being hooked on mobile games, students will devote more time and effort to advancing their "levels" and "rankings," and some may even play games in their sleep. Therefore, it is impossible to guarantee their normal rest and study time. According to World Health Organization research, adolescents sleep less each night the more time they spend on their mobile phones. Mobile gaming is likely to keep minors up late, contributing to the problem of insufficient sleep (World Health Organization, 2019). Despite the fact that some video game enthusiasts can manage their play time and get enough sleep, it is often difficult for them to concentrate on learning since their minds are still preoccupied with the game's plot and substance from the previous evening. In addition, the content of the textbooks is so monotonous in comparison to the exciting

and engaging mobile apps that it is difficult to motivate them in the classroom. As a result, many young game addicts are unable to pay attention in class and must rush through their homework after school, resulting in deterioration in their academic performance. The negative effect of excessive mobile gaming was confirmed by Li's (2019) study, in which nearly 14.4% of the subjects believed that their participation in mobile games caused their inability to concentrate on lessons and homework, 46.9% believed that playing mobile games could occasionally distract them from classroom learning and homework, and 31.3% reported that their academic performance declined as a result of their participation in mobile gaming.

Impairing Students' Social and Emotional Ability

Currently, the majority of primary school children live in homes with only one other child. Because their parents are too busy working to spend meaningful time with them, they become accustomed to living alone in their personal world at home. The young students would rather play in the virtual world than speak to their always-hurried parents. They can find emotional engagement in the virtual world of games that they lack in their family life. Such emotional benefits increase their virtual reality addiction, which distances people over time from real connections in the outside world (Jing & Liu, 2019). Because of this, students with video game difficulties generally have unapproachable and indifferent facial expressions and are indifferent to interactions with peers and teachers at school as well as with their parents. A shocking news story from 2017 described a youngster in a primary school in Hangzhou City who attempted suicide by jumping from the fourth floor following a disagreement with his father about playing mobile games. Surprisingly, after he regained consciousness in the hospital, he expressed more worry for the development of the game he had been playing than for the feelings of his family. Relevant studies have shown that while most mobile gaming addicts have issues with rejecting communication, being cold and aloof to others, and being irritable, on the inside they often have complex and original ideas that are unapproachable to those around them. Overindulging in mobile games might cause students to experience varied degrees of interaction impairment, according to numerous studies and news stories.

Inducing Students' Misbehavior

The majority of mobile game apps provide a paid service, allowing users to top up their accounts in order to purchase virtual goods or gaming-related equipment. In general, students only receive pocket money from their parents as a source of income. It can be challenging for people with poor self-control to resist the temptation of virtual objects in games. One approach is to steal money from their parents. For instance, a sixth-grade student in Fuzhou City covertly linked the bank card account of her father to her WeChat account and spent 110,000 CNY in three months, the majority of which was spent topping off several game accounts. Similar incidents have occurred often in recent years, causing a great deal of public discussion. Some of the youngsters who tried to obtain the passwords to their parents' bank accounts but were unsuccessful were bold enough to perpetrate crimes, including robbing younger children in schools, stealing other people's property, and more (Li et al., 2021).

Reasons for Schoolchildren’s Addiction to Mobile Games

The Attraction of Mobile Games

The most prominent benefits of cell phones are mobility and convenience. Due to the development of internet and communication technologies, mobile phones can now be used as an alternative to desktops for internet access. They are no longer required to use computers to play games, as they were many years ago. They can play games on their phones at any time and from any location. Popular smart phone games such as “Honor of Kings” and “Game for Peace” are literally competitive games that players find interesting, intriguing, and daring. In “Game for Peace,” players are just required to use their fingers to do a sequence of tasks, including altering the direction, opening the magnifier, and firing. The simple operation makes it easy for young players to begin playing after a few practices (Kuang, 2017). The developer of “Canal Towns” attempts to create the background and content of the game in response to seasonal changes and to simulate the buildings at scenic spots and historic sites across the country in order to design those in the game, so that players can feel a sense of immersion and participation in scenarios that are similar to reality (Zhu & Li, 2022). All mobile games offer awards to entice players, who can receive system rewards or special titles based on their game level. These prizes can effectively raise player engagement and excitement for the game.

Student-related Factors

First off, primary school students frequently lack self-control and willpower, making it simple for them to become excessively obsessive with particular topics. In contrast to the dry schoolwork, video games represent vibrant, captivating worlds. Students who become gaming addicts may become completely preoccupied with their game-related thoughts. Second, students this age want to impress their parents and teachers, but some of them don’t succeed, so they turn to virtual reality games where they can improve their levels and boost their confidence. Third, students have a propensity for group thinking. If a student sees friends and classmates playing a mobile game, their curiosity will be piqued, and they will want to participate in the activity (Che, 2019). Many students in primary school participate in mobile games despite not actually playing them; they do so because their peers and classmates are observed playing. Students typically form their own little social “coteries.” When playing mobile games is highly desired in a social group, a child who has not done so appears less social and finds it difficult to engage in discussion with others. He or she is probably going to become isolated or even excluded over time. The original non-mobile game user will join in on the fun and then suggest the game to more of his or her friends in order to become a part of the group.

Family- and School-Related Factors

Today’s fast-paced lifestyle makes it difficult for parents to spend much quality time with their students because of their demanding job schedules and need to support their families. Additionally, the youngster often has few siblings or, more likely, none at all, due to the typical small family size in China. Mobile games then provide a comforting emotional outlet for the lonely students in this situation. A team effort is required in

several running games, such as “Honor of Kings” and “Game for Peace,” where players support one another rather than fighting alone for victory. In these games, young children can discover the thrill of teamwork and feel wanted and emotionally gratified (Fan, 2014). Additionally, the inability of parents to provide adequate role models for how to deal with video gaming contributes to the addiction to mobile games among primary school students. According to social psychology, imitation happens when a person is motivated by the behavior of others and duplicates it consciously or unconsciously without being constrained by outside factors. Young children are indirectly and subtly affected by how their parents behave in daily life. When parents regularly spend a lot of time playing mobile games at home in front of their children, the latter become subconsciously influenced and start to replicate this habit. They would believe that playing mobile games is a socially acceptable activity at home. Parents’ advice is essentially useless if they recognize they need to restrict the amount of time their children spend playing video games. Children already have the defiant mindset of “you can play them while I cannot” ingrained in their minds, even if they are made to give up playing mobile apps. Later, when students approach puberty, this thinking will get stronger and harm parent-child interactions (Li, 2021).

Aside from family factors, students’ addiction to mobile games is also linked to poor school education. Under extreme academic pressure, video games have become a welcome distraction from the monotony of academics. Despite the recent emphasis on academic burden reduction in education reforms, most schools continue to view test scores as the only essential factor in the academic evaluation system. The type of middle school students who can go on to secondary school is determined by their test scores. Unable to find an alternate way to relieve the stress of exams, some of them seek to escape the worry by engaging in virtual reality activities. Furthermore, the day-to-day school routine is tedious enough for primary school students. When schools do not provide any exciting and exhilarating activities, students can quickly become engrossed in fun games.

Ineffective Social Regulation

One of the reasons efforts to limit student mobile gaming have failed is the poor system for preventing students from becoming addicted to video games. Numerous gaming companies have implemented a number of anti-addiction measures in response to the public’s strong concerns regarding this issue. For instance, Tencent, the company behind “Honor of Kings,” debuted the “Growth Protection Platform” in February 2017 so that parents could link their students’ gaming accounts to their smart phones and keep an eye on how much time they spend playing. One feature of this system that allows parents to limit their children’s gaming time is the “one click stopping play” button. Tencent upgraded the platform and started asking users to submit their real names in July after determining that this measure was insufficient in addressing youngsters’ addiction to mobile games (Chen, 2021). However, survey findings revealed that many primary school students could exploit “loopholes” in this security measure and use adult family members’ ID cards or identity information purchased online to pass the verification, despite the fact that game companies required real name verification for every user. News stories like “a 60-year-old geriatric starting a game at 3 a.m.” have garnered a lot of attention and made the public doubt the anti-addiction system’s efficacy. Some students admitted that they could easily get around the “Teenager Mode” restrictions by “flipping the wall,” buying an accelerator, or going into tourist mode” (Qiu, 2021). The

available data showed that the current system for preventing gaming addiction is ineffective and that the regulation implemented by the appropriate agencies is not stringent enough to adequately handle the problem.

Recommendations for Reducing Students' Dependence on Mobile Games

Students should Strengthen their Willpower to Reject Mobile Game Addiction

In primary school, students should first learn to approach challenges and difficulties with a positive attitude. No actual issues are helped by the sense of escapism offered by video games. Dependence on mobile games is mostly a waste of time and does nothing to help with their development. They must understand that time is valuable and should be used for worthwhile endeavors. Second, students should make an effort to pursue some constructive interests and hobbies in order to divert their attention from playing mobile games. Many students start playing video games out of boredom, but over time, they unintentionally become compulsive players. They will naturally stop playing mobile games once they realize there are a lot of other intriguing things they can do, such as play football, dance, and draw. Third, students should try to develop their social and emotional competencies through more contact with friends and parents. They might be able to break free from the grip of video games if real-world interaction replaced virtual interaction.

Parents Ought to Use their Phones Responsibly and Incorporate Video Games into their Children's Home Education as Role Models

First and foremost, parents need to exercise caution when using their smart phones around their children. Words are less powerful than deeds. By reducing their personal reliance on games and mobile devices, parents can make their counsel for children on video gaming more persuasive (D.C. Chen, 2019). They ought to read rather than browse the web or even play games on their smart phones, especially while they are watching over the schoolwork of young children while seated in the study. Second, when children want to play games for entertainment and relaxation, parents should strive to come to an understanding with them regarding the time limit, say 30 minutes. Parents can limit their children's gaming time in this way while also teaching them the importance of keeping their word. They might also think about rewarding youngsters with video games when they finish their chores, their homework, or other significant duties. It is not a good idea to forbid students from playing mobile games because this will just encourage their rebellious behavior. Third, parents might benefit from mobile games' educational features. "Education includes games, and games can help education," goes a well-known proverb. Playing meaningful games can help primary school students develop. Some video games, such as those designed to improve users' intelligence, are especially beneficial and instructive, and can be recommended to students based on their age characteristics (Chi & Li, 2020). Children can play carefully made puzzle games to improve their thinking skills, or they can use games to learn Chinese and Eng-

lish vocabulary. Fourth, parents can encourage students to participate in other worthwhile pursuits that will divert them from their desire to play video games. After-school activities for students should not primarily consist of extra tutoring; rather, they should focus on outdoor pursuits like skateboarding, basketball, and other sports, which not only give them the opportunity to get enough exercise but also help them develop as people. Parents can plan excursions throughout the winter and summer breaks to maximize their children's opportunity to interact with nature.

Schools should Teach Students about the Significance of Responsible Mobile Gaming Play

Various methods can be used by the school to improve students' understanding of mobile games. It can hire experts to offer seminars on the dangers of mobile gaming addiction, or it can broadcast the message through school radio, campus tabloids, and other outlets. Teachers can organize class debates in which students fully discuss the benefits and drawbacks of mobile gaming and gain a clear understanding of how mobile games work, the importance of limiting game time, and how to avoid overindulging in them (Yan, 2018); for those who are severely addicted to mobile games, the school should assist them in accessing counseling and professional therapy so that they can extricate themselves from the mobile gaming plight and resume normal studies. Simultaneously, the school must improve its life education for students in order to develop their practical abilities and their capacity to separate fact from fiction. Multidimensional evaluation should be used to assess students' performance in order to reduce academic stress. It should also try to enrich its campus culture and involve students in the development of extracurricular school events in order to guide them in developing healthy hobbies and making good use of their free time (Tang, 2020).

Social Regulation of the Mobile Game Industry should be Strengthened

To determine the appropriateness of digital games for different age groups, many European nations use the Pan European Game Information (PEGI) grading system. Operators who run games with no violent or unlawful content are the only ones to receive the certificate of qualification from PEGI. Similarly, North American nations have a specialist rating committee to determine the game's difficulty level. The game's developer is required to disclose comprehensive information about the game, including the game's nature, content, and age requirements for players. A governmental body for the regulation and oversight of internet gaming has been established in the UK. Additionally, there are formal guidelines for game rating in South Korea. China lacks a rating system for mobile games, in contrast to these developed nations. Relevant authorities can adopt strict approval and rating requirements for mobile games by studying overseas trends. Young students should not have access to violent video games.

The rapid growth of China's digital game sector needs more structured legislation and regulations. Without legal restrictions, gaming corporations will not regard the interests of minor players and will instead concentrate on attracting more players and increasing earnings. Legislation is the most efficient method of management. With the law's necessary requirements, relevant authorities can improve the supervision of the mobile game industry, force game developers to correct harmful game content, and es-

establish a safe and positive gaming environment for primary school students (Wang & Chen, 2019).

Game companies should improve their systems to keep people from getting addicted to games. Game companies can set up information databases using integrity investigations, improve ways to verify personal information, and use data analytics to check if the identity of the mobile game user matches the information of the account holder. This will help them find minors who use the information of adults to sign up for games. For instance, the need for facial recognition can pop up at any time during the game to see if the player's face is the same as the holder's account. For controlling game time, it has been suggested that game developers use the method of reward discrimination. This means that the game should be split into three parts: healthy, fatigued, and unhealthy, and each part should have a different level of rewards (Chang, 2019). When a minor gets too tired to play mobile games, their "points" will be taken away. When a young player gets too sick to play, their "proceeds" from the game will be taken away. This idea was put forward to stop players from wanting to play all the time.

Conclusion

In this age of mobile internet, smart phones are ubiquitous in our daily lives. Students in primary school, like all other groups, benefit greatly from the convenience provided by high-tech devices. However, their detrimental effects on youngsters should not be ignored. As a result of the increasing popularity of video games, mobile game addiction among students has become an increasingly serious problem that can inflict irreparable harm and lead to serious societal issues. There are numerous reasons why children become addicted to smart phone games. Participation from all parties is necessary for the intervention and prevention of this behavioral disease. Parents, schools, game firms, and the government should each make their own efforts to protect schoolchildren's healthy development.

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Reading Behavior of Chinese Primary and Secondary School Students: A Systematic Review

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Abstract: *This paper's objective is to give a thorough summary of research on the reading behavior of Chinese primary and secondary school students. The majority of existing research in this field focuses on the importance of extensive reading, the status quo of reading practices among Chinese students, factors that influence student reading behavior, and techniques for enhancing student reading accomplishment. It is proposed that this review will generate more interest in the development of basic education students' reading skills.*

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READING has been a crucial element of education for strengthening students' cognitive skills and cultivating their humanity. Since the 1990s, however, the attainment of reading literacy among Chinese primary and secondary students has been hampered by the prevalence of internet-based fragmented reading, the decline of brick-and-mortar bookstores, and the outmoded method of teaching Chinese. Under the influence of profit-seeking capital, the book industry has become saturated with superficial and entertaining reading materials; the popular culture-influenced reading environment is detrimental to the spiritual development of students. In addition, reading in class has become tedious and routine as a result of exam-focused classroom instruction. Students may rarely recognize the pleasure of high-quality reading in this environment, let alone improve their cultural literacy, increase their cognitive capacity, and develop their character through reading. The decline in reading competence will not only hinder the intellectual, moral, and humanistic literacy development of students but will also result in talent scarcity in the cultural industry and a decline in the overall quality of the nation. To improve the reading literacy of students, it is required to undertake a logical analysis of the difficulties in their reading behavior and the underlying causes in order to develop appropriate tactics for improvement. Based on an examination of relevant journal articles and degree theses and dissertations, this study attempted to provide an overview of student reading behavior research in China against the backdrop of basic education curriculum reform in order to provide implications for future discussion on this topic.

Literature Sources

The Chinese academic database “CNKI” (China National Knowledge Infrastructure) was searched using the phrases “primary and secondary school children” and “reading behavior” to locate papers on this subject. Using 3,759 publications that were published between 2003 and 2022 as a starting point, keywords and frequently mentioned literature were screened.

The History of Research on the Reading Behavior of Primary and Secondary School Students

Research on the reading habits of elementary and secondary school students began in 2003, grew significantly starting in 2011, and peaked in 2019 (a total of 331 articles). It experienced a decline from the year 2019 until a turning point came in 2021. In the past, student reading behavior was a matter of discussion and debate in the educational world. However, due to teachers', parents', and students' fixation with high-stakes exams, advocates for voluntary or free reading were silenced. This was reflected in the volume of publications. Following recent changes to the nation's basic education curriculum program and course requirements that emphasize the development of student comprehensive competencies, the importance of student reading literacy has returned to the forefront of academics. This review concentrates on pertinent publications that have been released since 2011 to guarantee the representativeness and concentration of the review.

Keywords in Existing Student Reading Behavior Research

The frequency of keywords is calculated using data visualization analytics, and high-frequency terms like “reading guidance,” “reading interest,” “reading literacy,” “present state of student reading,” and “reading practices” are detected. In the most recent studies on the reading habits of Chinese primary and secondary school students, these keywords also constitute the hottest discussion points. The vast majority of academics and educators concur that reading literacy is a must for students to succeed academically overall and that students who ignore or lack it are hindered in their academic advancement and long-term development. Therefore, the primary issues in reading research now center on ways to enhance reading literacy, heighten reading interest, and boost voluntary reading among children in basic education.

Studies on the Value of Reading for Primary and Secondary School Students

In most cases, a well-written book has a lifelong impact on its readers. A nation’s spiritual depth is heavily dependent on its reading proficiency. However, there is no clear and systematic instruction for extensive reading teaching in current Chinese textbooks. Students’ free reading time is crowded out by examination-focused instruction. Children are deprived of the opportunity to engage in voluntary reading due to their parents’ utilitarian educational views. Additionally, the fragmented reading environment impairs students’ ability to read in depth. As a result, many Chinese language instructors do not place sufficient emphasis on reading instruction and do not know how to direct students to engage in substantial reading. In this context, a growing number of researchers have emphasized the importance of reading for enhancing students’ language competence and holistic competencies.

The Importance of Reading in Chinese Language Teaching

Researchers concur that increasing free reading can compensate for the shortcomings of in-class reading. Students should be encouraged to concentrate on reading motivational, educational, and literary works with average comprehension requirements and a variety of subject matter. In the meanwhile, students might jot down those helpful sayings, maxims, and proverbs as well as their thoughts on the books they have read. Students’ language competence, writing abilities, and capacity for reasoning can all be enhanced as a result.

Zhang (2014) asserted that reading plays a crucial role in developing students’ comprehension, which is the ability to comprehend the meaning of words and sentences and the ideas of the text through a series of thinking processes such as summary, analysis, evaluation, and comparison based on their prior knowledge and reading experience. Through reading instruction, Chinese language instructors can enhance students’ comprehension of fundamental Chinese concepts, such as word choice and sentence structure.

Most students find writing challenging since they frequently don’t know what to write about. Despite the fact that they may have read a lot, they do not intentionally make the connection between writing and reading. Wang (2012) recommended that teachers incorporate reading-for-writing activities into their lesson plans to provide additional reading instruction. They may suggest excellent books for students to read out-

side of class and give them a variety of responsibilities to do afterward, such as creating reports or reviews, leading seminars, etc. Students could develop their ability to use lovely words, phrases, amazing sentiments, aesthetic experiences, and profound ideas learned from reading to produce creative writing in this way.

Li's (2019) research found that teachers' guidance and teaching for reading have a significant impact on students' selection of reading resources. Due to their calming effects, online novels, cartoons, and other leisure activities are very likely to pique the interest of primary and secondary school students, particularly when they find classics to be too serious and challenging to comprehend. As a result, students imitate those unusual and ungrammatical network phrases that run counter to the grammatical and syntactical principles that the teacher tries to transmit in class. That gives Chinese language instructors a headache. In order to reduce students' predilection for leisure reading over serious reading and to foster in them good reading habits and a love of reading, educators should establish effective reading instruction programs.

The Significance of Reading for the Cultivation of Student Comprehensive Competences

Reading, rather than being the end goal of student personal development, is one of the means by which individual character is developed. Students can gain experience in voluminous reading, develop personal reading methods, and improve their reading appreciation ability through consistent reading, so that reading can truly become a source of spiritual support for students' growth and assist students' multi-dimensional development of emotions, attitudes, and values.

He (2020) highlighted that influential works were frequently rich in significant content. Literary works, for instance, frequently feature exciting storylines, elegant language, and complex character interactions; academic works, on the other hand, are characterized by profound thought, rigorous arguments, and a wealth of specialized knowledge. Students can only fully understand the work and make creative use of its worth through memorization, understanding, analysis, and other thinking processes. Students can develop systematic thinking and broaden their perspectives by reading books in depth and skillfully that have tightly structured material and strong reasoning.

Cai (2016) claimed that each kind of literary work has a unique instructional value. A historical novel, for example, allows students to put themselves in a specific historical situation to understand the characters in the work and their fates and, as a result, to cultivate the ability to distinguish between good and evil, beauty and ugliness, in the conflicts represented by the story. Cai's point of view echoes the requirement of national course standards for reading instruction: by appreciating well-organized language expressions, touching events, and overall artistic constructs of literary works, students improve their cognitive ability and emotional skills, completing the "inheritance of culture" naturally.

As per Li's (2017) study, reading has a fundamental value in its capacity to foster spiritual communication, and teachers should encourage their students to incorporate their personal experiences into the reading process in order to pique their emotions, reflections, and desires for communication. When students have a certain base of knowledge under their belts, they will naturally examine texts critically, and group discussions may then inspire their creativity and sharpen their analytical skills. In order for students to voice their particular opinions from multiple viewpoints and gain a custom-

ized comprehension of the text in the discourse, teachers should purposefully give them opportunities for dialogue, discussion, and inquiry throughout reading instruction.

Studies on the Current State of Student Reading

Reading Motives and Preferences of Primary and Secondary School Students

Zhang's (2013) study found that students read a lot for different reasons depending on where they are in their learning, but the top three reasons were the same for all of them: to learn more, to do better in school, and for fun. But in the current education system, which is focused on tests, students tend to spend more and more time and energy on required subjects and extra learning materials that are directly related to the senior secondary and college entrance exams as they move up through the grades.

Zhang (2018) emphasized that many schools continue to evaluate students solely based on their test scores, resulting in an unnecessary amount of schooling for students. Students must complete large amounts of homework after school and have little time for leisurely reading. Under such conditions, even the restricted reading time is devoted to reading for predetermined reasons. Students who do poorly in writing, for instance, would focus on reading instructional books and may even memorize different types of model essays to imitate on tests.

Wei (2010) revealed that many students regard after-class reading as merely an extension of the subject of Chinese. They are primarily interested in reading activities that will improve their comprehension and expression skills, which will directly affect their exam scores, while ignoring classical, significant works that have no immediate connection to academic success. Students' enthusiasm for reading becomes suppressed and warped over time, and after-class reading not only fails to relieve students' mental tension but instead becomes a hefty scholastic load for them.

Extensive reading, on the other hand, may just be a recreational leisure-time pastime for some students; picture-text mixed books, such as comics and cartoons, which are amusing, vibrant, and straightforward, can readily resonate with teenagers. This phenomenon reflects a tendency in the extensive reading of teenagers: a move from "text" to "image" reading. Teenagers' understanding and reasoning abilities are likely to suffer as a result of a lack of text reading.

Wang (2015) observed in his questionnaire study that elementary school kids chose comic books, such as *The Journey to the West* and *The Legend of Deification*, as their preferred genres of reading. This is partially a result of young children's inherent curiosity, which is more likely to be piqued by magical mythologies and the aesthetic qualities of books, such as color, pattern, and binding style. Junior secondary students are anxious to expand their life experience through reading as they go through a quick period of physical and mental development. As a result, novels have become their preferred genre. Students in senior secondary schools are getting closer to adulthood and starting to consider their future growth; therefore, they are more interested in biographies and other motivational literature.

Xie (2020) revealed via visits to local primary schools that picture books accounted for the biggest amount of students' free reading resources, which was about 65%, whereas language books made up only 4.2%. This illustrates that primary school students have a relatively restricted range of options for voluntary reading, with pleasure and recreation serving as the primary motivation. As teachers would propose certain

simplified classical literary works for after-class reading, students are more likely to be lured to read “fast food” books after completing “serious and challenging” reading assignments.

According to Zhou’s (2019) analysis of the sales data of Fuzhou No. 8 Middle School Bookstore, a branch of Fujian Dream Bookstore, foreign literature works account for nearly half of the sales and Chinese literature books account for about a third of the turnover, indicating that literary works are the preferred category of reading materials among secondary school students. Middle school kids’ reading habits are becoming increasingly recreational and fast-food-like, according to sales data from the school bookstore. For example, sales of science-thriller novels such as *Dragon Family IV* and tomb-robbery novels such as *Ghosts Blow the Lamp*, the majority of which are taken from online writings of dubious quality, have surged dramatically. As a result, it is critical to provide students with guidance so that they can broaden their reading selection and engage in extensive reading.

Reading Practices of Primary and Secondary School Students

Existing research on the reading practices of primary and secondary school students discovered that, while the majority of them are very interested in reading, a large proportion of them are unable to do scheduled, ample reading, let alone take notes and write down some reflections during the reading process. The great academic strain produced by high-stakes exams is the cause of this phenomenon.

In Lu’s (2013) survey of first through ninth graders in Shanghai, 73.4% said that reading was one of their favorite things to do in their free time. 51.5% spent about 30 minutes a day on extensive reading, and 27.8% spent about 60 minutes a day. The other 20.7% did not read every day. The data showed that the amount of time students in Shanghai spend reading is far from enough.

Ren et al. (2015) conducted a survey of urban primary and secondary school students from six provincial administrative regions in China using a random sample to collect data on self-evaluation of reading behavior, personal reading practices, unhealthy reading behavior, and factors that influence reading. The findings revealed that the majority of students believed that reading practices had a significant impact on Chinese language proficiency; that the mean degree of preference for reading was between “above average” and “average”; and that less than one-third of the students read every day, with the majority devoting approximately one hour per day to reading. Notable is the fact that 14.4% of students conducted no independent reading. According to percentage rankings, the reasons for “dislike” and “intense dislike” of extensive reading are as follows: lack of time due to heavy homework loads (50.5%), limited access to books for free reading (27.3%), lack of interest in reading (22.8%), high book prices (22.3%), a preference for watching television and playing online games (21.1%), and parental prohibition against child free reading (14.4%). The statistics indicate that a significant proportion of instructors and parents do not adequately create reading opportunities for youngsters and spark their interest in reading.

Tah (2015) conducted an extracurricular literature reading survey with 834 primary school students in Horqin Right Front Banner of Inner Mongolia Autonomous Region and discovered that their reading participation rates and reading time were far below the criterion for literary reading stipulated by national course standards. Only

24.2% of third and fourth graders and 41.7% of fifth and sixth graders engage in daily voluntary reading.

The General Secondary School Student Reading Behavior Questionnaire 2018 was developed by Liu (2020), who then conducted a survey of 40,012 students, who were chosen at random from all junior and senior secondary schools in Changsha City. According to the online survey's findings, the majority of students read for one hour and thirty minutes each day; just one-fourth of them read for more than an hour each day; and more than seventy percent of them read in bed at night or on weekends. As a result, reading time is brief and dispersed, which is not good for enhancing students' reading skills.

Li (2019) noticed that although quite a few students genuinely enjoy free reading, only 40% of them read intermittently without planning in his random sampling survey of more than 100 junior secondary school students in Shanghai. 60% of the students said that a lack of time prevented them from reading as much as they would have liked. Implementing a set reading schedule consistently is necessary to improve reading literacy. Random and interrupted reading has little impact on students' comprehension.

Reading Instructions for Primary and Secondary School Students

Self-regulation is still developing among students in basic school, necessitating external guidance for their considerable reading. Consequently, it is vital to investigate the ways of encouraging students continued reading. Existing research indicates that the majority of schools aim to provide children with reading instruction through reading-specific lessons and reading-related extracurricular activities.

Hao proposed (2020) that masterpieces often have profound meaning, cover a wide range of subject matter, and pose significant difficulties to the cognitive ability of elementary and secondary school students. Young kids may find acclaimed literary works confusing and boring. Therefore, reading-focused courses are essential to encouraging students to read classics since they allow teachers to explain the social context of the work and the humanistic concepts it contains. Nevertheless, Hao discovered that even though all schools offer reading lessons, the majority of them are treated as sessions for reading "exemplary articles," which are merely extensions of the Chinese language course. Her survey sampled 716 primary and secondary schools in 9 counties under the jurisdiction of Xiangyang City.

Nearly a quarter of the students in Changsha City who participated in Liu's (2020) investigation said that their school had never offered any reading-specific courses, and a third said they had one or two reading sessions each semester. Although reading lessons are offered weekly in almost half of the city's secondary schools, and senior secondary school students receive significantly more of them than their junior secondary school counterparts, the overall frequency of reading lessons is insufficient to meet the demands of the students.

Chen et al. (2019) conducted a field investigation in 80 primary and secondary schools in Ningbo City to examine how the school libraries functioned and how the schools attempted to foster a reading environment. Only 10 of the surveyed schools had built regular reading programs with their own distinctive features, they discovered, even though 92% of the schools held extracurricular reading events annually. About 90% of school libraries are larger than 300 square meters, 67% have librarians working full-time, and 58% receive annual funding for book purchases.

Studies on Factors Influencing Students' Reading Behavior

The Influence of Popular Literature Reading

As a result of the information boom and the accelerated speed of life, there has been an increase in popular literature and a loss in serious reading. The proliferation of new media such as the Internet, mobile phones, and e-books has led to an explosion of writing like fast food. Young students are naturally susceptible to peer influence and groupthink; therefore, this setting will surely have a significant impact on their ability to read freely. Those who lack the proper guidance of teachers and parents are more likely to gravitate toward reading materials that are offensive and provide no benefit.

According to Yuan (2007), there are two basic reasons why elementary and high school students enjoy reading popular literature. To begin with, popular culture is more accessible to young kids; it does not need a great deal of work because it is designed to provide fun and pleasure through direct and simple techniques. Popular literature caters to the demands of young people while simultaneously shaping their reading preferences. Once individuals become accustomed to superficial reading, real literature that requires significant time and effort becomes foreign and unappealing to them. The second cause is teachers' and parents' preoccupation with test scores. Numerous teachers and parents are compelled to overburden children with excessive quantities of homework, despite the fact that basic education should create a spiritual foundation for children's development. Under the influence of their peers, even though some students are interested in books with artistic and intellectual merit, they may turn to popular novels for mental comfort.

Long-term exposure to "culture fast food," according to Bi (2012), would dull students' awareness of superb language and deprive them of spiritual discourse with remarkable authors. The compositions of students contain an increasing amount of network slang and excessive language. In their works, personal expression and self-discovery are absent. Ironically, the students' self-assumed desire for identity culminates in similarities and mediocrity.

Luo et al. (2020) determined that the most significant disadvantage of popular literature is that it lacks the teaching role of serious literature. Popular literature is limited to the expression of personal emotions and serves as a form of pleasure, entertainment, and emotional release. Traditional literature, on the other hand, can provide students with profound insights into human nature as well as play the role of moral instruction. Due to the fact that popular literature is aimed at maximizing audiences and commercial success, its literary and artistic merit is debatable, and its harmful impact on elementary and secondary school students should be investigated.

The Impact of Fragmented Reading

The ideal reading list for elementary school students would include a wide range of books on various topics. Due to the limited amount of time for free reading, the bulk of students may currently only learn about masterpieces and classics through their distilled forms, extracts, or fragments. Whole book reading, as opposed to fragmented reading, can educate students about the author's overall viewpoints, engulf them in a wealth of knowledge, and foster students' global perspective on the world. When students become

accustomed to reading in fragments, their comprehension and motivation to learn will suffer. Over time, information retrieval will take the place of students' autonomous thinking while reading.

According to He's (2020) study, current reading instruction places an overabundance of emphasis on fragmented reading while underestimating the relevance of whole-work-based sustained reading. Another concern is the usage of so-called "reading reference resources," which include summaries and main concepts from articles and books. Such predetermined direction or "authoritarian" interpretation really interferes with students' reading experiences and has a negative impact on students' reading interest and accomplishment, as well as their ability to think creatively.

Min Zhang (2019) believed that the snippets from full works included in modern textbooks are relatively easy in structure and subject matter compared to the originals and can be comprehended without in-depth thought or advanced reading skills. Reading only excerpts limits students' horizons and has no positive effect on their reading proficiency. Such training in literacy and reading abilities cannot provide students with the capacity to comprehend texts with a more complicated structure and content. In contrast, students' higher-order reading skills can be developed through the reading of an entire book with more expansive scenes and emotional depth.

However, Zhang and Zhang (2015) argued that fragmented reading has its own set of benefits. Students in a highly competitive educational setting must accomplish mountains of schoolwork and attend multiple specialization programs, leaving little time for free reading. This is not going to change in the near future. In this context, it is an appropriate approach for relevant specialists to create "introductions" to masterpieces for students based on their professional interpretation and make classics accessible to students. When fragmented reading becomes an inescapable practice, students can use it to their advantage by learning about classics through well-written introductions.

Disparities in Reading Facilities between Cities and Towns

Shanghai's primary and secondary students rated first in the PISA 2000 and 2009 reading literacy surveys. Their reading brilliance is intimately tied to the optimal reading conditions established by communities, schools, and families (Lu, 2015). The fundamental parts of reading are reading settings, readers, and reading materials. As a vital condition for students' enjoyable and engaging reading, a good reading environment can increase their reading interest and improve their reading achievements. At the moment, concerns such as the public's low reading literacy, a scarcity of high-quality books, and a poor reading environment are negatively affecting the reading behavior of primary and secondary school students in China's large, underdeveloped areas, particularly rural areas.

There is a significant difference in the reading environment between rural and urban regions, according to Chen's (2020) study. Urban students gain a lot from a supportive reading environment and a variety of reading promotion activities, whereas in rural regions there are not enough facilities for reading and there are not enough ways to evaluate reading activities scientifically. Additionally, some migrant workers who live in rural areas are separated from their children who were left behind and are unable to monitor their reading. Even if they share a home with their kids, some parents in remote areas don't read much themselves, let alone recommend books to their kids or make the environment conducive to their avid reading.

Wang's (2019) analysis found that, due to financial constraints, the majority of rural elementary schools frequently lack their own libraries. Students often have access to a tiny collection of books in the few schools that have libraries. As a result, rural students rarely carry any additional reading materials in their schoolbags besides their textbooks and practice books. The majority of teachers in rural areas are fully aware of the value of substantial reading, but for a variety of reasons, they are unable to provide students with the reading instruction they need. Rural students find it challenging to develop their reading literacy and all-around competencies in such educational circumstances.

The Influence of Electronic Devices on Student Reading Modes

The ease availability of the internet and digital media is drastically altering how students read. Students now read in a wider variety of ways because of the widespread use of digital gadgets. Students' information-gathering and information-outputting behaviors have changed as a result of reading electronic texts, which unavoidably changes their cognitive patterns and, in turn, influences how they read.

Yuan et al. (2018) determined that reading electronic text is comparable to rapid screen browsing. During this process, fresh reading material is continuously stored in short-term memory, although only a small amount can be preserved in long-term memory. After using electronic devices, the majority of students are able to increase their reading speed, which is one consequence of their altered reading habits. Long-term reliance on electronic media may result in a propensity for superficial reading and a poor level of information internalization.

On the other hand, Liu (2018) asserted that because electronic media offer aids for taking notes, including real-time text highlighting, intercepting, and marking, they are advantageous to students' reading outcomes. If properly applied, these tools will alter students' thought processes, encourage full participation in their own learning, and improve reading effectiveness.

He (2021) has relatively neutral opinions. He stated that while conventional print media should continue to dominate student reading, electronic text reading should not be overlooked because of its growing popularity in the digital era. There is no significant difference between the two types of reading media in terms of the functions and outcomes of reading. Students can utilize electronic devices to read books they are interested in at any time and in any place, which gives electronic media a distinct edge in after-class reading.

Studies on Improvement Measures for K-12 Students' Reading

Researchers agreed that communities, schools, and parents must collaborate to improve the reading skills of students. All parties should increase their knowledge of the significance of excellent reading behavior among students and contribute to the construction of optimal reading environments for the kids' long-term development.

Recommendations on Community-Level Efforts

Existing studies include enhancing reading facilities, strengthening reading instruction for kids in basic education, and organizing meaningful reading activities as means of improving student reading proficiency at the community level. The local education department and community libraries are obligated to provide students with high-quality reading materials and reading guidance; they should also host reading activities on a regular basis to pique students' interest in reading classical works and reduce fragmented, superficial reading.

Chen (2020) claimed that the government should take the initiative to provide enticing reading environments for all residents in order to close the gap between urban and rural reading circumstances and resources. To ensure that every elementary and secondary school student has easy access to high-quality reading materials, the government should increase its investment in the construction and modernization of reading venues. To maximize the use of publicly funded reading resources, the government should also distribute books from urban libraries to public reading services in small towns and villages.

Li (2016) proposed that the government sponsor the design of a public reading service emblem and promote it via television and the Internet in order to increase public awareness of reading facilities. The identification of a public reading service might be a logo displayed in a prominent location; it is also recommended to unify the pattern and color of the appearance of public reading facilities to make local public libraries or reading services easily recognizable. In order to encourage students to visit and read in the library, community librarians can also be dispatched to schools to deliver lectures on the regular services of the public library and the specifics of library use, such as the library's location, appropriate opening hours for elementary and secondary school students, book borrowing procedures, etc.

Hao (2020) recommended that the government coordinate all types of digital resources and compel local libraries to enlist the aid of digital platforms such as portal websites, WeChat, and QQ in order to offer specialized services to elementary and secondary school students. Big data analytics can be used to push personalized digital resources to students of different ages, and online library use helps students improve their ability to search for useful digital information, thus improving their digital literacy. With the support of online platforms, students can access extensive reading materials relevant to classroom teaching content.

Recommendations on School-Level Efforts

The present study on basic education student reading indicates that there is great room for improvement in the classroom reading environment. The majority of studies underline the need for schools to spend more money on library conditions and for teachers to provide students with greater guidance for their substantial reading.

He (2020) stated that modern Chinese reading instruction requires new teaching strategies from Chinese language instructors. In the age of information explosion, people are exposed to a vast array of information and have multiple means of acquiring knowledge. With so many options for reading, students frequently struggle to decide what to read. To guarantee that students are immersed in excellent works, teachers should carefully choose the reading material for reading sessions. They should also teach students practical reading strategies so that they can read effectively and efficiently.

Yu (2007) underlined the importance of the school library in guiding students' in-depth reading. The school library should take the initiative to inform students about the most recent publications, invite experts and scholars to compile reading lists of highly recommended books for students based on their knowledge and perspectives in the relevant fields, and assist students in locating educational reading materials to increase their scientific and cultural literacy.

The improvement of student reading literacy has been hampered, according to Liu's (2020) study, by a shortage of high-quality reading courses, insufficient school library resources, and other factors. The school library should try to attract more student readers by improving the reading rooms and the online reading platform. Both in-class and inter-class reading-related interaction should be encouraged to foster the sharing of reading resources and experiences. Schools should work to establish long-term mechanisms for reading instructions, update student reading lists on a regular basis, and assist students in creating reading plans.

In light of the impact of digital reading on student reading behavior, Gu, Li, and Chang (2020) asserted that schools must regulate students' use of electronic devices on campus but can encourage teachers to utilize the benefits of digital media to broaden students' reading experiences, such as reading multiple texts and engaging in cross-cultural reflection and evaluation. In addition to specialized digital literacy instruction, the development of students' digital reading skills is aided by such training.

Suggestions for Parents

Studies suggest that family socioeconomic situation, parental education level, and the size of the family's book collection have a substantial effect on the reading motivation of elementary and secondary school students. Parents with a high level of education typically spend a great deal of money on books and periodicals as long as the family's financial situation allows. A reading-friendly family environment can promote students' interest in reading organically (Liu, 2012).

Yuqi Zhang (2019) stressed that parental reading habits have a significant impact on children's reading behavior and recommended that parents foster the ideal family reading environment by acting as role models for their kids when it comes to free reading. Additionally, he discovered that the majority of children's reading materials were owned by their parents and that the quantity of books in the home was a reliable indicator of kids' reading interests. To meet their children's various reading needs, parents should make an effort to amass a large book collection.

In her paper, Liu (2012) recommended that parents use rewards like praise and cash gifts to encourage their children's reading motivation. High-self-efficacy kids are more willing to take on obstacles and are more tenacious while working on long-term projects. As a result, parents should provide children with timely feedback and motivation to increase their reading self-efficacy.

Advice to Students

Researchers generally agree that improving students' reading competency and results depends on their awareness of reading, engagement with reading, and use of effective reading strategies. In his study, Wu (2011) emphasizes the need for students to create personalized reading schedules that are tailored to their unique reading abilities and are continually modified to ensure that their limited reading time is spent on carefully cho-

sen, insightful books. According to Liu (2022), children should set a long-term objective for free reading while understanding that reading is about long-term spiritual development rather than instant rewards. Students must understand that reading is a way to get a greater understanding of life and the world, not just a “job” to accomplish or a way to boost academic performance. The ideal reading engagement, according to Xiao (2019), is “talking through the reading substance.” To increase their worry about their reading development and sustain a constant interest in reading, students can talk with their peers about a story’s storyline or their own knowledge and sentiments during any time that is not class time, such as before and after class, during lunch, etc.

Conclusion

Reading is more than a simple pastime. In actuality, reading helps us increase our knowledge and skills while also gaining useful experience from others. People establish the habit of reading as early as childhood. Education in primary and secondary schools is setting the groundwork for students’ development and lifetime learning. Their reading consciousness, interest, and techniques must therefore be well developed during the basic education stage. Communities, schools, and families should collaborate to create conducive reading environments and provide young people with an abundance of high-quality reading materials in order to maximize their reading literacy development, which not only serves as a foundation for success in other academic areas across the board but also as a requirement for successful adult participation in society.

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