Pre-print

Hayat Bilgisi Öğretiminde Öğrenci Merkezli Öğretim Yöntem ve Tekniklerinin Akademik Başarı Üzerindeki Etkisi: Bir Meta Analiz Çalışması

*Yetiş KURT **Beycan DOĞANAY ***Saliha SOYER ****Mehmet Behiç ŞAHİN

***Öz*:** Bu araştırmada hayat bilgisi öğretiminde öğrenci merkezli öğretimin öğrencilerin akademik başarıları üzerindeki genel etkisinin belirlenmesi amaçlanmıştır. Bu amaç doğrultusunda YÖK Tez Merkezinde taranan, açık erişim izni olan, yöntemsel olarak meta analize dahil edilme kriterlerini karşılayan 25 lisanüstü tez bu çalışmanın verilerini oluşturmuştur. 25 tez çalışmasından meta analiz yöntemiyle 26 etki değeri hesaplanmıştır. Etki değerlerinin belirlenebilmesi için Cohen'nin g değeri kullanılmıştır. Meta analize dahil edilen araştırmalar Rosenthal yöntemi ve huni grafiği kullanılarak öncelikle yayın yanlılığı açısından sınanmıştır. Ayrıca meta analiz modeline karar vermek için Z değeri, Z değerinin anlamlılığı, Q değeri ve 25 serbestlik derecesinde ki-kare dağılım değerleri kullanılmıştır. Meta analize dahil edilen araştırmaların yayın yanlılığı göstermediği ve heterojen dağıldığı saptanmıştır. Bu doğrultuda rastgele etkiler modeline göre meta analiz gerçekleştirilmiştir. Araştırmada elde edilen bulgulara göre analize dâhil edilen her bir araştırmanın bağımsız olarak öğrencilerin akademik başarılarını olumlu etkilediği görülmüştür. Rastgele etkiler modeline göre bütünleştirilen araştırmaların genel etki büyüklüğünün 1.028 olduğu belirlenmiştir. Bundan hareketle hayat bilgisi öğretiminde öğrenci merkezli öğretim yöntem ve tekniklerinin öğrencilerin akademik başarılarını geniş ölçüde olumlu etkilediği sonucuna ulaşılmıştır.
Anahtar Kelimeler: Hayat bilgisi, öğrenci merkezli öğretim, ilkokul, meta analiz, akademik başarı.

The Effect of Student-Centered Teaching Methods and Techniques on Academic Achievement in Life Sciences Teaching: A Meta-Analysis Study

***Abstract*:** In this study, it was aimed to determine the general effect of student-centered teaching on students' academic achievement in life science teaching. For this purpose, 25 theses scanned in YÖK Thesis Center, having open access permission and methodologically meeting the criteria for inclusion in meta-analysis constituted the data of this study. From 25 thesis studies, 26 effect values were calculated by meta-analysis method. Cohen's g value was used to determine the effect values. The studies included in the meta-analysis were first tested for publication bias using the Rosenthal method and funnel plot. In addition, Z value, significance of Z value, Q value and chi-square distribution values at 25 degrees of freedom were used to decide the meta-analysis model. It was found that the studies included in the meta-analysis did not show publication bias and were heterogeneously distributed. Accordingly, meta-analysis was conducted according to the random effects model. According to the findings obtained in the study, it was seen that each study included in the analysis independently positively affected students' academic achievement. It was determined that the overall effect size of the studies integrated according to the random effects model was 1.028. From this point of view, it was concluded that student-centered teaching methods and techniques in life science teaching have a large positive effect on students' academic achievement.
Keywords: Life science, student-centered teaching, primary school, meta-analysis, academic achievement.

* Teacher, Ministry of The National Education, 0009-0005-4715-8037, yetiskurt@gmail.com
** Teacher , Ministry of The National Education, 0009-0002-7308-9205, beycandoganay@gmail.com
*** Teacher, Ministry of The National Education, 0009-0009-7577-6309, salihasoyer38@gmail.com
**** Teacher, Ministry of The National Education, 0009-0007-7674-7708, sahinmehmetbehic@gmail.com

Giriş

While the concept of learning is defined in various ways according to different theories and approaches, the learner itself is at the core of learning (Gültekin & Burak, 2021). On the other hand, instruction is a formal approach aimed at the realization of learning through formal means. The primary goal of instruction is to impart desired knowledge, skills, and values to the student. However, achieving the acquisition of desired knowledge, skills, and values becomes difficult without considering the learner's interests, desires, and needs, in other words, without placing the learner at the center of the instructional process (Jonassen & Grabowski, 1993; Riding & Rayner, 2012). Therefore, adopting and employing an instructional approach that centers on the learner is crucial for providing effective and efficient instruction. Learner-centered instruction is largely explained through the social constructivist approach, emphasizing that learning is a social phenomenon (Yaşar et al., 2015). Within this context, learner-centered instruction can be thought to be based on views advocating for the learner to construct their own meaning through gaining experiences and interacting and communicating with others (Deboer, 2002). In other words, teacher-centered instruction primarily provides guidance and organization, while learner-centered instruction involves students actively participating in and experiencing instructional activities.

Social Studies is a central subject aimed at preparing primary school students for life and future learnings. Social Studies can be expressed as knowledge of life that focuses on learning by doing and experiencing (Burak & Topkaya, 2018). However, it seems quite challenging for the goals of Social Studies regarding life to be achieved without adopting an approach that prioritizes the student expected to be prepared for life in the instruction of this subject. In this regard, the findings of a study conducted by Taneri and Engin Demir (2013) on Social Studies instruction with students are noteworthy. In the mentioned study, primary school students expressed that they enjoyed and were more engaged and learned when their teachers conducted activities such as drama and collaborative learning in Social Studies classes.

The paradigm shift in education since 2005 emphasizes student-centered instruction. It cannot be assumed that Social Studies, whose main aim is to acquire life-oriented competencies, would be exempt from this. Indeed, the 2018 Primary School Social Studies Curriculum emphasizes student-centered activities, providing instruction tailored to students' interests, desires, and needs, particularly highlighting experiential learning or processes where students are actively engaged. The program articulates these orientations and recommendations as follows:

> "In the conduct of the course, care should be taken to carry out both in-school and out-of-school applications. Especially, out-of-school applications such as oral history, local history, museum visits, environmental education, recognition of official and private institutions and organizations should be valued, and student-centered activities pre-planned in this direction should be implemented." (Ministry of National Education-MoNE, 2018, p. 9).

MoNE explicitly expects teachers in Social Studies instruction to embrace a student-centered instructional approach and design their instruction accordingly. Therefore, teachers are expected to utilize methods and techniques that prioritize students in the learning-teaching process, such as game-based learning, collaborative learning, project-based learning, problem-solving, scenario-based learning, active learning, utilizing case studies, brainstorming, multiple intelligences, differentiated instruction practices, experiments, drama, creative drama, role-playing, research-based learning, learning through the 5E model, multiple intelligence practices, differentiated instruction, station technique, utilization of social media and information technologies (Yağan, 2022). Despite the recommendation in the current curriculum and the potential for providing student-centered instruction through various methods and techniques, it is observed that classroom teachers encounter challenges in implementing student-centered instruction. Karaman (2019) revealed in a study with classroom teachers that while teachers

acknowledge that the Social Studies curriculum is student-centered, they face difficulties in instructional design and evaluation processes. Therefore, it can be speculated that one reason for classroom teachers' inability to create a student-centered instructional design in Social Studies is the lack of sufficient evidence on the general impact of various methods and techniques and their specific effects in Social Studies education. Although there are some meta-analytical studies in the literature demonstrating the positive effects of student-centered instruction methods and techniques, such as the meta-analysis conducted by Yağan (2022) indicating the overall positive effect of student-centered instruction on students' attitudes towards learning, Yaşar et al., (2015) showing the positive effect of student-centered instruction on academic achievement in social studies, Ulubey and Toraman (2015) and Yılmaz, Yüksel, and Toy (2023) demonstrating the positive effect of creative drama from student-centered instruction activities on academic achievement, Can and Gerşil (2021) on the positive effect of project-based learning on academic achievement, Camnalbur and Mutlu Bayraktar (2018) demonstrating the positive effect of collaborative learning on academic achievement, Camnalbur and Erdoğan (2008) and Dikmen and Tuncer (2018) on the positive effect of computer-assisted instruction on academic achievement, Toraman, Çelik, and Çakmak (2018) showing the positive effect of gamification on academic achievement, it can be said that there is a need for studies revealing the impact of student-centered instruction on students' academic achievement specifically in Social Studies. Therefore, the present study aims to examine the effect of student-centered instruction in primary school Social Studies on students' academic achievement. In line with this aim, the study sought to answer the research question:

"What is the effect of student-centered instruction on academic achievement in Social Studies instruction?" It is expected that the findings of the current study will contribute to teachers and researchers in the field of Social Studies instruction.

Method

This study aims to examine the effect of student-centered instruction in primary school Social Studies on students' academic achievement. In line with this aim, the scope of the current study has constituted experimental studies where student-centered instructional activities, technologies, or materials defined as student-centered instruction in Social Studies education are utilized as independent variables, and academic achievement is considered as the dependent variable. A thorough literature review revealed numerous studies, hence the current research was conducted using the meta-analysis method. Meta-analysis is a research process where findings of multiple studies with a common focus are reanalyzed (Dinçer, 2014).

In meta-analysis studies, the first step involves accessing studies with a specific focus, followed by descriptive classification of these studies, and finally, statistical integration, analysis, and interpretation of the findings (Dinçer, 2014; Burak, 2023). Therefore, to conduct the current study, the initial focus was on graduate theses containing student-centered instructional practices in Social Studies education. Studies conducted in an experimental model and examining the effect of student-centered instruction in Social Studies education on academic achievement were identified from these theses. The identified studies were then meticulously examined in terms of methodology (sample, data analysis, etc.), and finally, based on the findings of these studies, the overall effect of student-centered instruction on academic achievement was statistically determined.

Data Collection

The data for this study were sourced from graduate education theses scanned in the National Thesis Center of the Council of Higher Education (YÖK). The study data were accessed by periodically scanning the thesis center with specific keywords until February 01, 2024. In this context, keywords such as "Hayat Bilgisi" (Life Science), "Akademik Başarı"

(Academic Achievement), and their English equivalents "Life Science" and "Academic Achievement" were utilized. As a result of the scans, 299 master's and doctoral theses were retrieved from the system. The inclusion criteria for the studies to be included in the meta-analysis were determined based on inclusion criteria, and among the 299 theses, those eligible for meta-analysis formed the research data. The inclusion criteria used in this study are as follows:

i) The thesis should be openly accessible (focused on the last 20 years),

ii) The research should be conducted in an experimental research model,

iii) There should be control groups in the experimental process,

iv) Data should be obtained using pre-test and post-test,

v) There should be no significant difference in pre-test academic achievement scores between the experimental and control groups,

vi) The research findings should include arithmetic mean, standard deviation, and/or t-value.

Accordingly, 25 graduate theses constituted the data for the current study, yielding 26 effect sizes. The theses used in the meta-analyses of the current study were first saved to a computer in PDF format and then coded using a form. During the coding process, the characteristic features of the studies (author, year, type, sample size, student-centered method used, etc.) and statistical findings (arithmetic mean, standard deviation, t-value, etc.) were entered into the form. The characteristic features of the theses that constituted the data for the current study are presented in Table 1.

Tablo 1

Characteristic Features of Theses

Variables	**Sub-variables**	**n**
Year	2003	1
	2004	2
	2005	2
	2008	1
	2009	1
	2010	1
	2011	2
	2012	2
	2013	1
	2014	1
	2015	1
	2017	1
	2019	1
	2020	1
	2021	1
	2022	1
	2023	5
Thesis	Master Education	22
	Dissertation	3
Clases	2. Grade	5
	3. Grade	20
Teaching Methods and Techniques	Scenario Based Learning	1
	Learning Style Model (Dunn and Dunn)	1
	Flipped Learning	1
	Augmented Reality	1
	Multiple Intelligence Theory	2
	Drama-Dramatization-Creative Drama	4
	Analytical Story Method	1
	Brain Based Learning	1
	Technology Supported Learning	1

Educational Game-Digital Game-Gamification	4
Collaborative Learning	1
Cartoon	2
Media Supported Teaching	1
Learning Package (Slides, Video, etc.)	1
Project Based Learning	1
Station Technique	1
Problem Based Learning	1

Data Analysis

The Comprehensive Meta-Analysis (CMA) package program was employed for analyzing the data of this research. In the analysis, effect sizes for each examined study were determined. Hedge's g was utilized for determining effect sizes. Cohen's (1988) suggested criteria intervals were considered in evaluating the determined effect sizes:

- -0.15 to 0.15: negligible level
- 0.15 to 0.40: small level
- 0.40 to 0.75: medium level
- 0.75 to 1.10: large level
- 1.10 to 1.45: very large level
- 1.45 and above: excellent level

Once the effect size for each individual study was determined independently, the overall effect size of studies in different models was calculated. In this context, the overall effect size can be examined in two different models: fixed or random effect models (Burak, 2023). To decide on the interpretation of the overall effect size, whether a fixed or random model should be used, the obtained Z value, significance level of the Z value, Q value, and degrees of freedom were used in comparison with the critical value of the $\chi 2$ (chi-square) distribution. If the Q value is smaller than the critical value, the fixed effects model should be preferred; if it is larger, the random effects model should be preferred (Dinçer, 2014). To determine which model to use in this study, the Q value obtained in the homogeneity test and the critical value of the $\chi 2$ distribution at 25 degrees of freedom with a 95% confidence interval were compared.

To demonstrate the reliability of the meta-analyses conducted in the present study, the scope of the research was examined in terms of publication bias. Various methods and techniques exist to determine whether publication bias is present in meta-analysis studies. In the current research, publication bias was examined using the Rosenthal method and funnel plot. The Rosenthal method indicates how many studies opposite to the effect size obtained in the research scope should be included in the analysis to nullify the effect size (Burak, 2023; Özcan, 2008). In this study, 25 studies were selected and included according to the inclusion criteria, and a meta-analysis was conducted. According to the Rosenthal method, for the effect size obtained in the present study to be considered biased, another 1859 studies opposite to these studies would need to be found. Hence, it can be said that the current study is free from publication bias. Additionally, funnel plots can also be utilized to determine whether publication bias is present. The funnel plot presents the dispersion of each independent study's effect size around the overall effect size. If the independent studies scatter within the funnel and show symmetry, it indicates the absence of publication bias (Dinçer, 2014). Figure 1 presents the funnel plot of the current study.

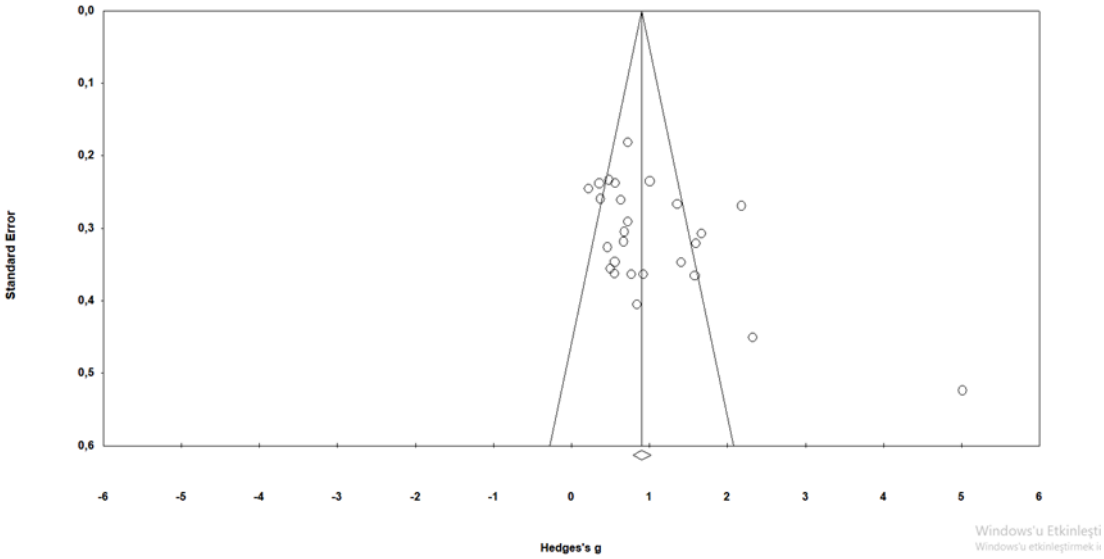

Figure 1. Funnel plot

Based on the graph in Figure 1, it can be observed that the majority of the studies examined through meta-analysis are scattered within the funnel. Therefore, it can be concluded that there is no publication bias in the current study according to both the Rosenthal method and the funnel plot.

Results

The effect sizes produced from 25 experimental studies testing the impact of student-centered teaching methods and techniques in life science education on students' academic achievements in life science, along with their confidence intervals and findings regarding the study weights within the meta-analysis, are presented in Table 2.

Tablo 2
Effect Sizes, Confidence Interval ve Weights of Studies

Study	Etki Büyüklüğü	Confidence Interval		Study Weights (Fixed Effect)	Study Weights (Random Effects)
		Lower	Upper		
Aslan, 2004	0.463	-0.177	1.102	3.06	3.80
Bilek, 2009	1.598	0.969	2.227	3.16	3.87
Bütün, 2015	0.768	0.056	1.480	2.47	3.67
Çakmak, 2023	0.840	0.046	1.634	1.99	3.42
Çalışır, 2011	1.406	0.725	2.087	2.70	3.70
Çetin, 2011	1.670	1.068	2.273	3.45	3.89
Çokçalışkan, 2013	0.372	-0.136	0.881	4.83	4.11
Demir, 2008	0.478	0.021	0.936	5.98	4.22
Dinçer Çengeloğlu, 2005	0.678	0.080	1.276	3.50	3.90
Dündar, 2003	0.561	0.094	1.028	5.74	4.20
Gazioğlu, 2023	0.724	0.153	1.295	3.83	3.96
Gündüz, 2014	0.557	-0.122	1.237	2.71	3.70
Güneş, 2021	5.013	3.986	6.039	1.19	2.87
Karaoğlan, 2019	2.183	1.655	2.711	4.49	4.07
*Kaynar, 2020a	0.920	0.207	1.634	2.46	3.62
*Kaynar, 2020b	0.555	-0.155	1.265	2.48	3.62

Kılıç Özün, 2010	0.359	-0.109	0.826	5.73	4.20
Oğuz, 2023	2.324	1.441	3.207	1.60	3.20
Özdemir, 2023	0.219	-0.263	0.701	5.38	4.17
Palavan, 2012	0.721	0.365	1.077	9.87	4.43
Selanik Ay, 2005	1.358	0.835	1.881	4.57	4.08
Temur, 2004	0.667	0.042	1.292	3.20	3.83
Tengilimiloğlu, 2013	0.634	0.121	1.146	4.77	4.10
Ütkür, 2012	1.008	0.547	1.469	5.88	4.22
Yavuz, 2017	1.583	0.866	2.300	2.56	1.98
Yıldız, 2022	0.499	-0.199	1.196	2.57	3.66

The 26 effect sizes generated from the 25 studies presented in Table 2 are distributed between 0.219 and 5.013. Thus, it has been observed that each study independently exhibits a positive effect size. Based on this, in experimental studies where student-centered methods and techniques are tested against traditional teaching methods in life science education, it is evident that academic achievement significantly differs in favor of the experimental group. Therefore, it can be said that the use of student-centered methods and techniques in life science education positively impacts academic achievement. Findings related to the evaluation of the magnitude of each study's independent effect sizes are presented in Table 3.

Tablo 3
Size of Independent Effect Values of Studies

Effect Size Interval	**Level of Effect Size**	**n**
-0.15-0.15	Negligible	0
0.15-0.40	Small	2
0.40 -0.75	Medium	12
0.75 -1.10	Large	4
1.10 -1.45	Very Large	2
1.45 -	Excellent	5

According to the findings presented in Table 3, it has been determined that 2 studies have small effect sizes, 12 studies have medium effect sizes, 4 studies have large effect sizes, 2 studies have very large effect sizes, and 5 studies have excellent effect sizes. In this context, it can be stated that each study independently exhibits at least a medium level of effect size. The combined effect sizes of the relevant studies according to different models are presented in Table 4.

Tablo 4
Combined Effect Sizes of Studies According to Different Models

Model	n	*Z*	*p*	*Q*	$\chi 2$ Değeri	Effect Size	Confidence Interval	
							Lower	Upper
Fixed Effects	26	15.769	0.000	144.896	37.652	0.900	0.788	1.011
Random Effects	26	7.342	0.000	144.896	37.652	1.028	0.754	1.302

As observed in Table 4, the Z values are statistically significant in different models (15.769; 7.342, $p < 0.05$). Therefore, overall, the combined effect size of the studies included in the meta-analysis holds a significant value. To decide which of the two different models to use for interpreting the overall effect size, the Q value presented in Table 4 was considered. In this regard, it was found that the Q value was 144.896. It was observed that the critical value of the $\chi 2$ distribution at 5% alpha level with 25 degrees of freedom was 37.652. Thus, it was determined that the $\chi 2$ value was smaller than the Q value, indicating that the effect sizes of the independent studies exhibited a heterogeneous distribution. Therefore, the combined overall effect size of the studies was interpreted according to the random effects model.

According to the random effects model presented in Table 4, it was found that the lower limit of the overall effect size at a 95% confidence interval was 0.754, and the upper limit was 1.302. The combined overall effect size of the studies was calculated as 1.028. Based on these values, it was determined that student-centered teaching methods and techniques have a substantial impact on academic achievement in life science education.

Discussion and Conclusion

This study aimed to determine the effect of student-centered teaching on academic achievement in life science education. To reach this aim, 25 postgraduate education theses meeting the inclusion criteria for meta-analysis methodology and available from the Higher Education Council (YÖK) Thesis Center, and with open access permission, conducted between 2003 and 2023 were examined. During the meta-analysis process, the effect sizes produced from the 25 thesis studies were independently examined, then combined to establish and interpret the overall effect size. According to the findings of the research, it was revealed that the student-centered teaching process in life science education has a statistically significant effect on academic achievement. It was found that this effect favored the experimental group where student-centered teaching was conducted over the control groups using traditional teacher-centered teaching methods. In this context, it can be inferred that student-centered teaching in life science education positively affects academic achievement more favorably compared to traditional teaching.

According to the findings of the current research, each study conducted independently with student-centered teaching in life science education positively affected students' academic achievements. However, when the effect sizes of each study were examined independently, it was found that the experimental study conducted by Güneş (2021), based on the Dunn and Dunn learning styles, significantly differed from other studies and demonstrated the most excellent effect size. Therefore, designing student-centered teaching in life science education to provide instruction tailored to the learning characteristics of students, as demonstrated by learning styles, appears to be an effective approach. Providing instruction according to learning style not only positively affects students' academic achievement but also enables students to develop positive attitudes towards the course. Despite the existence of many factors affecting academic achievement, students' affective characteristics such as attitudes and interests significantly influence academic achievement to a greater extent than cognitive characteristics like learning style. Therefore, providing instruction according to learning style in life science education also positively affects these affective aspects, supporting the remarkable positive effect observed in academic achievement.

The findings of the current research revealed that the studies included in the meta-analysis showed a heterogeneous distribution. Therefore, the general effect of student-centered teaching in life science education on academic achievement was interpreted according to the random effects model of meta-analysis. According to the random effects model, it was concluded that student-centered teaching in life science education has a broad impact. Previous studies in the literature have also generally indicated that student-centered teaching has a moderate effect on students' attitudes towards the course (Yağan, 2022) and significantly positively influences academic achievement in social studies (Yaşar et al., 2015). Furthermore, some studies have shown that student-centered teaching methods such as creative drama (Ulubey & Toraman, 2015; Yılmaz et al., 2023), project-based learning (Can & Gerşil), collaborative learning (Camnalbur & Mutlu Bayraktar, 2018) have a broad impact on academic achievement in life science education. Additionally, computer-supported instruction has a broad impact on students' academic achievements (Camnalbur & Erdoğan, 2008; Dikmen & Tuncer, 2018), while gamification has been found to have an excellent effect (Toraman et al., 2018). In this context, it can be said that the positive effect of student-centered teaching, along with the independent methods and techniques used in this teaching, is consistent with and supports the literature.

In conclusion, it is understood that implementing student-centered teaching in life science education significantly enhances students' academic achievements. Academic achievement is considered as an indicator of the effectiveness of methods and techniques used in the education system (Rodríguez et al., 2017) and is accepted as a criterion by stakeholders (Burak & Gültekin, 2021). Therefore, the findings obtained in the current study are highly significant in terms of life science education. In this regard, teachers in life science education should frequently utilize student-centered teaching methods, techniques, and materials such as collaborative learning, station technique, drama, computer-supported instruction, augmented reality, brain-based learning, educational digital or non-digital games, project-based learning, learning environments organized according to learning styles, cartoons, and media-supported instruction based on the available resources, student characteristics, and their own competencies

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