International Journal of Education and Practice
2024 Vol. 12, No. 2, pp. 253-267
ISSN(e): 2310-3868
ISSN(p): 2311-6897
DOI: 10.18488/61.v12i2.3676

Implementation of project-based learning to enhance the creativity of prospective physics teachers in generating learning media viewed from cognitive styles

Ahmad Harjono[1+]
Gunawan[2]
Ahmad Busyairi[3]
Saiful Prayogi[4]

[1,2,3]*Department of Physics Education, University of Mataram, Jl Majapahit 62, Mataram, Indonesia.*
[1]*Email: harjonofkip@unram.ac.id*
[2]*Email: gunawan@unram.ac.id*
[3]*Email: ahmad.busyairi@unram.ac.id*
[4]*Department of Physics Education, Mandalika University of Education, Jl Pemuda 59A, Mataram, Indonesia.*
[4]*Email: saifulprayogi@undikma.ac.id*

(+ Corresponding author)

Article History
Received: 23 June 2023
Revised: 18 September 2023
Accepted: 11 January 2024
Published: 13 March 2024

Keywords
Cognitive style
Creativity
Field dependent
Field independent
Learning media
Project-based learning
Prospective physics teachers.

ABSTRACT

Cognitive style is related to information processing and individual preferences for engaging in the learning process. Therefore, it is crucial to consider the role of cognitive styles - field dependent (FD) and field independent (FI) - as a foundation for implementing a specific learning model in the classroom. This study aims to examining the significant role of cognitive styles, specifically FD and FI, in the context of implementing Project-based Learning (PjBL) for Prospective Physics Teachers (PPT) in generating learning media. The research employed a quantitative approach utilizing an experimental design known as the one-group pretest-posttest design. The study focused on a sample of 40 PPTs from a university located in Mataram City, Indonesia. The two main instruments used in data collection for this research were the Group Embedded Figures Test (GEFT) and the student creativity observation sheet, where the results of both were analyzed descriptively and statistically. The results of the study indicated that the creativity of PPT improves for all cognitive styles after the intervention of the PjBL model. However, the extent of creativity improvement differs for each cognitive style, FD and FI. The PPTs who possess a cognitive style characterized as FD tend to exhibit a more pronounced enhancement in creativity when compared to those who possess an FI cognitive style. The most fundamental finding of the study is that the PjBL model is more suitable for implementation among PPTs with an FD cognitive style in the context of enhancing creativity in generating learning media.

Contribution/Originality: This study contributes to the field by highlighting the significant role of cognitive styles, specifically FD and FI, in the context of implementing PjBL for Prospective Physics Teachers (PPT). The study establishes that PjBL positively impacts the creativity of PPT in generating learning media, with varying degrees of improvement based on cognitive styles.

1. INTRODUCTION

The education sector remains dynamic, characterized by continual development and a multitude of changes in its approaches, strategies, methods, and the utilization of learning media (Bilad, Anwar, & Hayati, 2022). This ongoing evolution in educational practices is a testament to the sector's commitment to adaptability and improvement. Within this transformative landscape, the incorporation of diverse teaching methodologies and innovative learning media becomes pivotal. It is noteworthy that such dynamic transformations in the education sector are not merely superficial but have tangible implications for individuals, fostering the cultivation of creativity. As noted by Fredagsvik (2023) the multifaceted changes in educational approaches and the integration of various learning modalities play a crucial role in providing individuals with the necessary tools and environments to enhance their creative capabilities. This intersection of pedagogical evolution and creativity underscores the intrinsic link between an adaptable education system and the facilitation of individual creativity, ultimately contributing to a more enriched and dynamic learning experience.

Creativity is important for all professions today. Creativity is a key skill and talent that everyone should possess at present (Corazza, 2016). Without creativity, individuals tend to solve problems in ways that may not be suitable for the required conditions, especially for complex problem-solving solutions (Valentine, Belski, & Hamilton, 2017). Similarly, teachers must have creativity to support their professional competence. Creative teachers tend to have better performance and serve as role models for students (Cayirdag, 2017). Creativity is essential for teachers to respond to every challenge they face. One of the challenges mentioned here is often caused by limited school facilities and infrastructure. Teachers who teach in remote areas, for example, are often confronted with limited teaching resources. In such conditions, teachers are expected to be creative in utilizing limited teaching resources. If possible, teachers should be able to develop teaching materials using the available tools and materials. The same applies to teachers who teach in schools with relatively more complete facilities and infrastructure. In such conditions, teachers are expected to design effective and engaging lessons by utilizing the existing media.

Creativity is also important for teachers in responding to every change that occurs. The changes can be caused by technological factors, changes in social conditions, or recently, as a result of the Covid-19 pandemic. The Covid-19 pandemic has demanded schools to make adjustments in delivering education. One of the most substantial adjustments is changing the method of teaching from face-to-face to remote learning. Creative teachers will easily adapt to any changes that occur (Ismayilova & Bolander Laksov, 2023). They can maximize the existing resources and technology. Furthermore, creative teachers will also continue to think about how to combine approaches, methods, strategies, and available learning media to produce combinations that are suitable for the situation and conditions (Wang & Li, 2022).

As an effort to prepare creative teachers, prospective teacher students who are still studying at universities should be accustomed to creative activities (Liu & Lin, 2014). In the learning process, prospective teachers should be given opportunities to argue and express creative ideas, which are then transformed into creative products (Suyidno, Nur, Yuanita, Prahani, & Jatmiko, 2018). These activities can stimulate the emergence of creativity (Wahyudi, Verawati, Ayub, & Prayogi, 2018; Wahyudi, Verawati, Ayub, & Prayogi, 2019). One learning model that can accommodate all of these activities in a single learning experience is the Project-Based Learning (PjBL) model.

Empirical studies on the implementation of the Project-Based Learning (PjBL) model in enhancing creativity have been conducted in several previous studies (Koroh, Lehan, Treesly, & Koro, 2022; Lou, Chou, Shih, & Chung, 2017; Yustina, Syafii, & Vebrianto, 2020). The results show that the PjBL model can improve students' creativity at a moderate level, with varying N-gain scores. Similarly, according to a study conducted by Usmeldi (2019) it was found that the implementation of the PjBL has the potential to significantly boost students' creativity. These studies indicate that the PjBL can enhance students' creativity. However, it is important to emphasize that the extent of creativity improvement varies across studies, even when using the same instructional model. This difference is believed to be influenced by internal factors within the students themselves, such as differences in cognitive styles (Lin, Lu, & Lin, 2018; López-Vargas, Ibáñez-Ibáñez, & Racines-Prada, 2017).

Cognitive style refers to the unique characteristics of individuals in how they process information (Kozhevnikov, 2007). These individual differences influence their preferences for learning process (Giancola, Palmiero, & D'Amico, 2022). The relationship between cognitive style and creativity enhancement has been explored by Hosseini, Hajizadegan, and Taherifar (2021) including its connection to student intelligence (Giancola et al., 2022). However, there is a lack of sufficient research on how cognitive style serves as a basis for implementing the Project-Based Learning (PjBL) model in classrooms. Specifically, this study aims to examining the significant role of cognitive styles (FD and FI) in the context of implementing Project-based Learning (PjBL) for Prospective Physics Teachers (PPT) in generating learning media.

2. LITERATURE REVIEW

2.1. Creativity

Creativity is widely recognized as a vital component of 21st-century skills (Han & Abdrahim, 2023). It plays a crucial role in enhancing global competitiveness within organizations (Caniëls, de Jong, & Sibbel, 2022) and serves as a fundamental driver of innovation (Valaei, Rezaei, & Ismail, 2017). At the individual level, creativity is considered a crucial skill for personal and professional development (Mi, Bi, & Lu, 2020). Consequently, there has been a growing emphasis on integrating creativity into classroom learning systems, as it is deemed essential for graduates to possess such competencies within the education system (Fan & Cai, 2022). The acquisition of creativity among students holds significant importance, as it equips them with the ability to tackle intricate problems (Tell & Hoveskog, 2022). To nurture creativity in students, it is imperative for teachers to provide support through their educational and instructional practices within the classroom (Vodovnik, 2019).

It is important to highlight that previous research has demonstrated that creativity is specific to particular domains (Baer, 2016). However, the realm of creativity in education continues to encounter significant challenges due to its ever-expanding nature. In order to effectively address these challenges, it is essential to recognize that creativity in education should be approached within its specific context, mirroring the broader concept of creativity itself (Cropley & Patston, 2019). Additionally, to fully comprehend the complexity, value, and significance of creativity in educational settings, it is necessary to adopt more dynamic perspectives (Beghetto & Corazza, 2019). Consequently, it is necessary to justify a specific definition of creativity.

Creativity is the process of associating existing ideas into unusual combinations, ultimately forming new and original ideas (Treffinger, Young, Selby, & Shepardson, 2002). Creativity is identified as an activity to create products that contain elements of originality and effectiveness (Corazza, 2016; Runco & Jaeger, 2012). The definition of creativity is expanded by including aspects such as aesthetics, value, surprise, and appropriateness (Piffer, 2012; Simonton, 2012). From these various definitions, it can be concluded that creativity is a process of generating new ideas or combining existing ideas into something new, effective, valuable, beneficial, appropriate, and considering aesthetic elements. Finally, four standardized indicators of creativity have been developed by previous researchers (Kharkhurin, 2014): novelty, utility, aesthetics, and authenticity.

2.2. Project-Based Learning

Project-Based Learning (PjBL) is a learning model that emphasizes students' activities in working on project tasks by applying their knowledge to produce specific authentic products (Boss, Krauss, & Conery, 2008). In this model, all learning activities revolve around the students. The role of the instructor is to guide the students in completing the assigned project at the beginning of the learning process. Projects are completed collaboratively, allowing students to work together, analyze, and complement each other's opinions or creative ideas that emerge (Maros, Korenkova, Fila, Levicky, & Schoberova, 2021).

According to Duke, Halvorsen, Strachan, Kim, and Konstantopoulos (2021), the PjBL model is highly recommended for learning purposes. Krajcik, Blumenfeld, Marx, and Soloway (1994) have identified several key characteristics of PjBL that establish it as an advanced learning approach. These features include the utilization of authentic and meaningful problems, a focus on developing solutions for real-world issues, and the implementation of a collaborative environment (Krajcik et al., 1994). Consequently, incorporating PBL into educational courses holds the potential to facilitate group collaboration, encourage problem exploration based on individual interests, and foster the creation of tangible solutions for real-world challenges (Kuo, Tseng, & Yang, 2019).

According to Pan, Lai, and Kuo (2023) the constructivist viewpoint highlights the importance of natural learning and encourages creativity. PjBL, as a pedagogical approach, is seen as more beneficial for enhancing student learning outcomes compared to traditional instruction (Barak & Yuan, 2021). Scholars have suggested that PjBL can effectively enhance higher-order thinking skills, as seen in the studies by Putri, Japar, and Bagaskorowati (2019). Notably, PjBL shows promise in fostering student creativity (Pan et al., 2023).

2.3. Cognitive Styles

Cognitive style refers to an individual's characteristics in responding to, processing, storing, thinking, and using information to address a task or various types of environmental situations (Kozhevnikov, 2007). Witkin divided cognitive style into two forms: Field Independent (FI) and Field Dependent (FD) (Onyekuru, 2015). Individuals with a Field-Independent cognitive style tend to think analytically, focus on details, be competitive, individualistic, they place greater emphasis on internal drive and are minimally affected by external circumstances. On the other hand, individuals who possess a cognitive style that leans towards Field-Dependent tend to prioritize group dynamics, adopt a global perspective, exhibit sensitivity towards social interactions, demonstrate openness to criticism, rely on extrinsic motivation, and exhibit susceptibility to external influences (Altun & Cakan, 2006; Ford & Chen, 2001).

The examination of the relationship between FI/FD traits and creativity has received considerable attention in recent research (Lei et al., 2021). This attention stems from the need to better understand the role of FI/FD in both creative potential and output (Zhang, 2017). While previous research did not yield significant results (Niaz, De Núñez, & De Pineda, 2000) others highlighted that individuals with FI characteristics performed better than those with FD traits in tasks involving divergent thinking, particularly in generating novel ideas. For instance, Lei et al. (2021) made an important finding regarding individuals with FI and FD traits. Their research revealed that FI individuals exhibited notably higher scores in novelty and fluency, in contrast to FD individuals. Furthermore, they observed that the significance of these differences diminished when environmental cues were introduced. Multiple studies have also emphasized the influence of FI on convergent production, highlighting the relationship between FI/FD traits and convergent thinking (Noppe & Gallagher, 1977) while the study by Ohnmacht and McMorris (1971) found no significant difference. In the context of creative output, previous study found that FI individuals were more proficient in creating imaginative collages compared to FD individuals (Miller, 2007).

Building upon the foundation of existing literature, the present study shedding light on the paramount significance of cognitive styles, specifically focusing on Field Dependent (FD) and Field Independent (FI) styles. This exploration unfolds within the context of implementing Project-based Learning (PjBL), a dynamic and participatory approach to education, tailored for Prospective Physics Teachers (PPT). The study's focal point is the pivotal role that cognitive styles play in shaping the outcomes of PjBL initiatives, particularly in the domain of generating learning media. By examining the interplay between cognitive styles and the pedagogical framework of PjBL, the research aims to unravel nuanced insights into how these cognitive preferences influence the effectiveness of educational strategies designed for aspiring physics educators. This investigation not only contributes to the ongoing discourse on cognitive styles and their impact on learning but also provides practical implications for educators and educational institutions seeking to optimize PjBL experiences for prospective physics teachers.

3. METHOD

3.1. Research Design

The study employed a quantitative approach utilizing an experimental design known as the one-group pretest-posttest design (Fraenkel, Wallen, & Hyun, 2012). The experiment did not use a comparison group, and the pretest

(O_1) - posttest (O_2) scheme was employed in one treatment group to determine the exact effect of the Project Based Learning (PjBL) model on improving the creativity of prospective physics teachers. The research design is presented in Table 1.

Table 1. Study design.

Pre-test	Treatment	Post-test
O_1	Project-based learning (PjBL) model	O_2

Pretest (O_1) is the initial observation of the creativity of prospective physics teachers (PPT) before the implementation of PjBL. Posttest (O_2) is the final observation of the creativity of PPT after the implementation of PjBL. Prior to employing this design, the cognitive styles of each PPT were identified to categorize them into FD and FI.

The syntax of PjBL model in current studies adopts the stages initiated by "The George Lucas Educational Foundation 2007" (Gunawan, Sahidu, Harjono, & Suranti, 2017) as presented in Table 2.

Table 2. Syntax of project-based learning.

Learning stages	Learning objectives
1. Start with the essential question	• Providing stimulation to prospective teachers to generate creative ideas in response to given questions as a form of solution.
2. Design a plan for the project	• Train prospective teachers to collaboratively create product designs while considering the elements of novelty, utility, aesthetics, and authenticity.
3. Create a schedule	• Train prospective teachers to create creative, innovative, and effective work plans.
4. Monitor the students and the progress of the project	• Provide guidance throughout the project implementation process.
5. Assess the outcome	• Providing assessment as the basis for improving products that have been successfully developed by prospective teachers.
6. Evaluate the experience	• Encourage prospective teachers to reflect on their entire experience during the project implementation process.

3.2. Participants

The study was carried out at a university located in the city of Mataram, West Nusa Tenggara, Indonesia. The participants consisted of 40 physics education undergraduate students who were taking the general physics course. In terms of demographics, the number of male and female participants was balanced, and they were aged between 17-18 years.

3.3. Data Collection and Analysis

The two main instruments used in data collection for this research were the Group Embedded Figures Test (GEFT) and the student creativity observation sheet. The GEFT, a standardized test, was created by Witkin and Goodenough (1981). A standard GEFT test instrument consists of 25 patterned picture items divided into 3 sections. The first section consists of 7 items with very simple patterned pictures, while the second and third sections consist of 9 items each. In this test, prospective teachers must find simple pictures hidden within complex pictures. The purpose of administering this test is to identify and classify the cognitive styles of prospective teachers into two cognitive styles: Field Independent (FI) and Field Dependent (FD). The observation sheet is used to assess the creativity of prospective physics teachers in producing learning media products. The creativity indicators in this study include novelty, utility, aesthetics, and authenticity (Kharkhurin, 2014).

Descriptive data analysis of the research used the calculation of N-gain (normalized gain) to determine the increase in creativity of prospective physics teachers as a result of implementing the PjBL model in each cognitive style. The N-gain is determined by comparing the average actual improvement (gain) with the average potential improvement that students could attain. The average normalized gain <g> follows Hake's formulation (Hake, 1999). The interpretation for the value of <g> is as follows: < 0.30 (low); $0.30 \leq g \leq 0.70$ (moderate); and > 0.70 (high).

To determine the difference in the creativity enhancement of prospective physics teachers with Field Independent (FI) and Field Dependent (FD) cognitive styles, a comparative statistical test was conducted. This employed the t-test. To further clarify the effect of Project-based Learning (PjBL) intervention on creativity in the FI/FD cognitive style group, effect size calculations were performed. This is based on the standardized difference in means (d) using the formulation by Cohen (2013). The criteria are as follows: $0.0 < d < 0.20$ (small effect); $0.20 \leq d \leq 0.80$ (medium effect); and $d \geq 0.80$ (large effect).

4. RESULTS

A study has been conducted which aims to examine the significant role of Field Dependent (FD) and Field Independent (FI) cognitive styles in the context of implementing Project-based Learning (PjBL) for Prospective Physics Teachers (PPT) in generating learning media. The initial phase involves identifying the specific cognitive style of each PPT, followed by a comprehensive analysis of their creativity, with a focus on discerning variations arising from their respective cognitive styles. The results of the identification of cognitive styles of each PPT using the GEFT instrument show that 20 students belong to the FD cognitive style and the other 20 belong to the FI cognitive style. This means that within the participant group (n = 40) involved in this study, there is a balance between those who have the FD and FI cognitive styles. Furthermore, the findings of this study outline the results of analyzing the creativity of PPT in general based on parameters (mean scores of pre-posttest and n-gain), and specifically based on the difference in cognitive styles (FD/FI) using the same parameters.

Data on the analysis of the creativity of PPT based on the mean scores of pretest, posttest, and n-gain are presented in Table 3.

Table 3. Analysis results of creativity based on average scores of pre-posttest and n-gain.

Variable	Pretest scores	Posttest scores	N-gain	Score range	Category
Creativity	41.50	80.75	0.67	$0.30 \leq g \leq 0.70$	Moderate

The pretest and posttest results in Table 3 indicate an increase in creativity scores among prospective physics teachers after the implementation of the PjBL learning model. Calculating the N-gain reveals that the increase in creativity falls into the moderate category (N-gain = 0.67). Furthermore, for further analysis purposes, N-gain calculations were performed for each creativity indicator. Table 4 presents the N-gain results for each creativity indicator.

Table 4. Results of the creativity analysis for each creativity indicator.

Indicator	Average scores		<g>	Score range	Category
	Pretest	Posttest			
Novelty	28	83	0.76	> 0.70	High
Utility	57	81	0.57	$0.30 \leq g \leq 0.70$	Moderate
Aesthetic	56	82	0.60	$0.30 \leq g \leq 0.70$	Moderate
Authenticity	25	77	0.69	$0.30 \leq g \leq 0.70$	Moderate

The data in Table 4 shows the average of prospective physics teachers' creativity has increased in all aspects of creativity. For the novelty aspect, there was a high increase (N-gain = 0.76), indicating that prospective physics teachers' ability to produce different learning media products from existing ones has improved. Novelty can be observed in the level of innovation in its form, materials used, or how it is used. The utility aspect experienced a moderate increase (N-gain = 0.57), indicating that prospective teachers' ability to develop instructional media has improved in terms of the utility level of the produced media, which is considered moderate.

Utility emphasizes that the produced media can clarify the concepts conveyed by the teacher, represent real-world phenomena, facilitate the teacher in delivering the teaching materials, stimulate and motivate students, and serve as a medium for conveying messages between teachers and students. The aesthetics aspect improved moderately (N-gain = 0.60), meaning that prospective physics teachers have taken into account factors such as neatness, attractiveness, suitability, ease of operation, and color harmony in creating instructional media. As for the authenticity aspect, it improved moderately (N-gain = 0.69). The authenticity aspect relates to whether the produced media products are truly authentic and represent ideas that originate from within the students themselves.

Furthermore, an assessment of creativity improvement was conducted based on the differences in cognitive styles between prospective physics teachers. This was done to determine whether there were significant differences in creativity improvement between prospective physics teachers with FD and FI cognitive styles. The results from the pre- and post-test for each cognitive style of prospective physics teachers are presented in Table 5.

Table 5. The results of creativity analysis based on pre-posttest scores for each cognitive style.

Variable	Field dependent (n = 20)				Field independent (n = 20)			
	Min.	Max.	Average	SD	Min.	Max.	Average	SD
Pretest	32	56	44	7.29	32	56	38	6.65
Posttest	79	92	87	3.99	70	85	75	4.45

The data in Table 5 strongly indicate that the average pretest and posttest scores of prospective physics teachers' creativity for both cognitive styles groups (FD/FI) showed improvement. Descriptively, this is evident in the difference between the average pretest and posttest scores for each cognitive styles group (FD/FI). The results of the N-gain analysis for each cognitive styles are presented in Table 6.

Table 6. The calculation results of N-gain for each cognitive style.

Cognitive style	Average scores		<g>	Score range	Category
	Pretest	Posttest			
Field dependent	44	87	0.76	> 0.70	High
Field independent	38	75	0.59	$0.30 \leq g \leq 0.70$	Moderate

Based on the N-gain calculations, it was found that the creativity of prospective physics teachers with FD cognitive style has significantly increased (N-gain = 0.76) in the high category. On the other hand, the creativity of prospective physics teachers with FI cognitive style has moderately increased (N-gain = 0.59) in the moderate category. To determine if the increase is significantly different, a comparative statistical test using the t-test was conducted. The results of the t-test with a significance level of 0.05 indicate a significant difference in the increase of creativity between prospective physics teachers with FD and FI cognitive styles, with t_{cal} (2.21) > t_{tab} (1.68). Furthermore, the analysis of the impact of implementing the PjBL model on the enhancement of creativity in prospective physics teachers, considering their cognitive styles, is presented in Table 7.

Table 7. The calculation results of effect size.

Cognitive style	N	<g>	SD	d	Criteria
Field dependent	20	0.76	0.085	2.00	Large
Field independent	20	0.59	0.085		

The calculation of the effect size in Table 7 indicates that the difference in cognitive style has a significant impact on the improvement of creativity among prospective physics teachers, with a large effect size (d = 2.00). For a more in-depth analysis, the data on the difference in creativity improvement among prospective physics teachers with FD and FI cognitive styles for each creativity indicator are presented in Table 8.

Table 8. Differences in creativity improvement (based on indicators) in each cognitive style.

Indicator	Group	Average scores		N-gain	Category
		Pretest	Posttest		
Novelty	Field dependent	51	87	0.81	High
	Field independent	25	79	0.72	High
Utility	Field dependent	58	92	0.80	High
	Field independent	56	71	0.34	Moderate
Aesthetic	Field dependent	62	88	0.69	Moderate
	Field independent	50	76	0.53	Moderate
Authenticity	Field dependent	27	80	0.73	High
	Field independent	23	74	0.62	Moderate

Table 8 shows that the increase in creativity of prospective physics teachers with the cognitive style of FD is always greater, compared to the cognitive style of FI for all creativity indicators. To determine whether the differences in improvement for each creativity indicator are significantly different, a significance test (t-test) was conducted at a significance level of 0.05, with the reference value of t_{tab} (1.68). The results are displayed in Table 9.

Table 9. Results of t-test for each creativity indicator.

Indicator	Group	n	Gain average	t-test	Interpretation
Novelty	Field dependence	20	56.50	0.75	Not significantly different
	Field independence	20	54.00		
Utility	Field dependence	20	34.07	5.15	Significantly different
	Field independence	20	15.07		
Aesthetic	Field dependence	20	26.50	0.03	Not significantly different
	Field independence	20	26.65		
Authenticity	Field dependence	20	53.00	0.42	Not significantly different
	Field independence	20	51.00		

The analysis results in Table 9 indicate that there is no significant difference in the improvement of creativity among prospective physics teachers with FD and FI cognitive styles for the aspects of novelty, aesthetic, and authentic. However, for the aspect of utility, there is a significant difference in improvement between those with FD and FI cognitive styles. The increase in creativity for the utility aspect is greater in the group with FD cognitive style compared to the FI cognitive style.

5. DISCUSSION

Project Based Learning (PjBL) is a learning model that emphasizes students' activities in working on project tasks to produce specific authentic products (Boss et al., 2008). Project tasks are completed collaboratively, allowing students to discuss, contribute numerous ideas, thoughts, critiques, and suggestions in order to generate creative products.

The findings of this study strongly indicate that the PjBL model can enhance the creativity of PPT across all cognitive styles. In other words, the PjBL model is suitable for application both among students with a Field-Independent (FI) cognitive style and those with a Field-Dependent (FD) cognitive style. These research findings are supported by previous studies (Koroh et al., 2022; Lou et al., 2017; Usmeldi, 2019; Yustina et al., 2020) that found the PjBL model can enhance students' creativity. In this current study, the creativity of both cognitive style groups (FD/FI) experienced improvement (based on average pre-test-post-test parameters). However, after conducting a t-test for the analysis, the results indicate that the average creativity improvement between the two groups differs significantly. The increase in creativity among PPT with a Field-Dependent (FD) cognitive style is greater than those with a Field-Independent (FI) cognitive style.

One of the factors indicated as a cause of differences in the increase of creativity in both cognitive style groups is the different preferences for the implementation of PjBL (Project-based Learning) of each cognitive style. In the PjBL model, the learning process is more oriented towards collaborative project completion. Group cooperation plays a significant role in the learning process with the PjBL model. Each group member exchanges thoughts, ideas, suggestions, solutions, and other creative ideas. Therefore, the active participation of each group member is crucial for the learning process to run optimally. On the one hand, prospective teachers with the FI cognitive style prefer individual learning compared to group learning (Alomyan, 2004; Chen & Macredie, 2002; Chou, 2001; López-Vargas et al., 2017). They are not influenced by criticism, suggestions, and motivation from fellow group members or teachers. As a result, prospective teachers with the FI cognitive style tend to be passive and individualistic, even within a group. This statement is reinforced by previous findings (Lin et al., 2018) that only 31% of students with the FI cognitive style are active in learning activities with group discussion methods. Therefore, prospective physics teachers with the FI cognitive style are less facilitated in the PjBL learning process compared to prospective physics teachers with the FD cognitive style.

In contrast, PPT with a Field Dependent (FD) cognitive style prefer collaborative learning and group work. Within the group, they assist other students and motivate each other, thus improving learning outcomes (Lee, Cheng, Rai, & Depickere, 2005). Furthermore, López-Vargas et al. (2017) argue that learners with an FD cognitive style prefer planned exploration activities, can work in groups, and even if guided by an external agent (facilitator or teacher). Consistent with this statement, Boss et al. (2008) state that in the Project-based Learning (PjBL) model, the project process is guided and monitored by a mentor, and the learning activities are designed accordingly at the stage of creating a schedule. Therefore, in a group project, PPT with an FD cognitive style can perform better compared to PPT with an FI cognitive style (Lu & Lin, 2018).

Another factor that causes an increase in creativity among prospective teachers with a cognitive style of FD compared to FI is the characteristic factor of each cognitive style. The individuals exhibiting an FI cognitive style possesses a tendency towards an objective perspective (impersonal orientation), chooses a profession that is individualistic, prioritizes analytical and systematic thinking (convergent thinking), and emphasizes self-motivation. Individuals who possess a convergent thinking mindset exhibit heightened critical thinking skills, analytical prowess, and superior problem-solving capabilities in contrast to those with a divergent thinking. This statement is supported by previous research findings (Evendi et al., 2022) that students with an FI cognitive style have better problem-solving abilities compared to students with an FD cognitive style.

An individual with an FD cognitive style is someone who thinks globally and comprehensively (divergent), has a social orientation, chooses a profession that involves social skills, tends to follow existing goals and information, and tends to prioritize external motivation. Arguments from previous studies (Doron, 2016; Kousoulas, 2010; Runco & Acar, 2012) state that a key characteristic of creative individuals is the ability to think divergently. Divergent thinking activities are characterized by thinking processes that are global, comprehensive, considering all aspects (novelty, utility, and aesthetics), thinking of many possibilities, being varied, unusual, and detailed to enrich possibilities. Divergent thinkers not only think from their own perspective but also consider the perspectives of others. They consider what others need, what already exists to satisfy those needs, and what innovations can be made when viewed from utility and aesthetics. This is what causes an increase in creativity among prospective teachers, especially for the utility aspect, which differs significantly between the two groups. The increase in creativity among prospective physics teachers with an FD cognitive style is greater than for FI, particularly in terms of utility.

Furthermore, when considering all creativity indicators, it can be observed that the increase in creativity of prospective teachers with a cognitive style of FD tends to be greater than that of FI for all aspects of creativity (novelty, utility, aesthetics, and authenticity). However, further testing indicates that the increase in creativity for both cognitive style groups, particularly in the aspects of novelty, aesthetics, and authenticity, is not significantly different. This means that the differences in creativity improvement for the aspects of novelty, aesthetics, and authenticity cannot be generalized to describe the state of the population. This appears rational because even though prospective physics teachers with an FI cognitive style are less facilitated in group discussions in the PjBL model, their independent characteristics, difficulty in being influenced by the environment, tendency to be confident, and ability to think critically and analytically, result in their products during learning activities still having originality (novelty) and authenticity. As for the utility aspect, the improvement in both groups is significantly different. Looking at the characteristics of both cognitive style groups, it appears that someone with an FI cognitive style tends to be closed-minded, resistant to criticism, and overly confident, always viewing problems from their own perspective. In contrast, those with FD tend to be more open to criticism, suggestions, and other people's perspectives, resulting in products that are more universally suited to the needs of many people (utility). Therefore, the increase in creativity, particularly in the utility aspect, is greater for prospective physics teachers with an FD cognitive style compared to FI.

6. CONCLUSION AND SUGGESTIONS

The implementation of the Project Based Learning (PjBL) model can enhance the creativity of prospective physics teachers, whether they have a FI or FD cognitive style, in producing instructional media. The increase in creativity among prospective physics teachers with an FD cognitive style is greater than among those with an FI cognitive style. The results of the effect size analysis strongly indicate that the difference in cognitive styles has an impact on enhancing the creativity of prospective physics teachers. When specifically focusing on creativity indicators, it is evident that the increase in creativity among prospective physics teachers with an FD cognitive style tends to be greater than among those with an FI cognitive style for all indicators (novelty, utility, aesthetics, and authenticity). However, the statistical analysis results indicate that there is no significant difference in the enhancement of creativity between prospective physics teachers with an FD cognitive style and those with an FI cognitive style in terms of novelty, aesthetics, and authenticity; significant differences are only found in terms of utility. Overall, the most fundamental finding of the current study is that the PjBL model is more suitable for implementation among prospective physics teachers with an FD cognitive style in the context of enhancing their creativity.

Based on the conclusions of the study, future research could explore the specific factors within the Project Based Learning (PjBL) model that contribute to the greater enhancement of creativity among prospective physics teachers with an FD cognitive style compared to those with an FI cognitive style. This could involve investigating the types of tasks, instructional strategies, or project structures that are particularly effective in stimulating creativity in different cognitive styles. Additionally, it would be valuable to explore the long-term impact of enhanced creativity on the teaching practices and outcomes of physics teachers, as well as how to adapt the PjBL model to support the creativity development of teachers with different cognitive styles.

7. LIMITATIONS AND IMPLICATIONS

The limitations in this study are: (a) The study was conducted on a relatively small sample size of 40 prospective physics teachers (PPT) from a specific university in Mataram City, Indonesia. This limits the generalizability of the findings to a broader population of PPT or other educational contexts; (b) The study utilized a one-group pretest-posttest design, which lacks a control group. The absence of a control group limits the ability to establish causal relationships between the implementation of the PjBL and the observed improvements in creativity. Other confounding variables or alternative explanations could account for the observed changes; and (c) While the study employed a quantitative approach, focusing on numerical measurements of creativity and cognitive styles, it may overlook qualitative aspects that could provide a deeper understanding of the participants' experiences and perceptions.

Future implications of the study are: (a) Future research should aim to replicate the study with larger and more diverse samples of PPT, as well as educators from different subject areas and cultural backgrounds. This would enhance the generalizability of the findings and provide a broader understanding of the relationship between cognitive styles, PjBL, and creativity; (b) Conducting longitudinal studies that follow PPT over an extended period would enable researchers to examine the long-term effects of the PjBL model on creativity and cognitive styles. This could provide insights into the sustainability of the observed improvements and any potential changes or fluctuations over time; (c) Complementing quantitative approaches with qualitative methods, such as interviews or focus groups, could provide a more comprehensive understanding of how cognitive styles and the PjBL model interact to enhance creativity. Qualitative data can capture nuances and contextual factors that quantitative measures may overlook, allowing for a richer analysis of participants' experiences; and (d) Comparing the effectiveness of the PjBL model with other instructional approaches, such as traditional lecture-based instruction or problem-solving exercises, could help determine the unique contributions and benefits of PjBL in fostering creativity among PPT. Such comparative studies could inform educators and policymakers about the most effective instructional strategies for different cognitive styles.

Funding: This research is supported by the University of Mataram, Indonesia (Grant number: 2649/UN18.L1/2020).
Institutional Review Board Statement: The Ethical Committee of the University of Mataram, Indonesia has granted approval for this study (Ref. No. 2649/UN18.L1/ETIK/2020).
Transparency: The authors state that the manuscript is honest, truthful, and transparent, that no key aspects of the investigation have been omitted, and that any differences from the study as planned have been clarified. This study followed all writing ethics.
Data Availability Statement: The corresponding author can provide the supporting data of this study upon a reasonable request.
Competing Interests: The authors declare that they have no competing interests.
Authors' Contributions: All authors contributed equally to the conception and design of the study. All authors have read and agreed to the published version of the manuscript.

REFERENCES

Alomyan, H. (2004). Individual differences: Implications for web-based learning design. *International Education Journal, 4*(4), 188-196.

Altun, A., & Cakan, M. (2006). Undergraduate students' academic achievement, field dependent/independent cognitive styles and attitude toward computers. *Journal of Educational Technology & Society, 9*(1), 289-297.

Baer, J. (2016). Creativity doesn't develop in a vacuum. *New Directions for Child and Adolescent Development, 2016*(151), 9-20. https://doi.org/10.1002/cad.20151

Barak, M., & Yuan, S. (2021). A cultural perspective to project-based learning and the cultivation of innovative thinking. *Thinking Skills and Creativity, 39*, 100766. https://doi.org/10.1016/j.tsc.2020.100766

Beghetto, R. A., & Corazza, G. E. (2019). *Dynamic perspectives on creativity: New directions for theory, research, and practice in education*. New York: Springer International Publishing.

Bilad, M. R., Anwar, K., & Hayati, S. (2022). Nurturing prospective STEM teachers' critical thinking skill through virtual simulation-assisted remote inquiry in fourier transform courses. *International Journal of Essential Competencies in Education, 1*(1), 1-10. https://doi.org/10.36312/ijece.v1i1.728

Boss, S., Krauss, J., & Conery, L. (2008). *Reinventing project-based learning: Your field guide to real-world projects in the digital age* (1st ed.). Washington DC: International Society for Technology in Education.

Caniëls, M. C., de Jong, J. P., & Sibbel, H. (2022). The curvilinear relation between work predictability and creativity. *Creativity Research Journal, 34*(3), 308-323. https://doi.org/10.1080/10400419.2021.1994204

Cayirdag, N. (2017). Creativity fostering teaching: Impact of creative self-efficacy and teacher efficacy. *Educational Sciences: Theory & Practice, 17*(6), 1959–1975.

Chen, S. Y., & Macredie, R. D. (2002). Cognitive styles and hypermedia navigation: Development of a learning model. *Journal of the American Society for Information Science and Technology, 53*(1), 3-15. https://doi.org/10.1002/asi.10023

Chou, H.-W. (2001). Influences of cognitive style and training method on training effectiveness. *Computers & Education, 37*(1), 11-25. https://doi.org/10.1016/s0360-1315(01)00028-8

Cohen, J. (2013). *Statistical power analysis for the behavioral sciences*. New York: Routledge.

Corazza, G. E. (2016). Potential originality and effectiveness: The dynamic definition of creativity. *Creativity Research Journal, 28*(3), 258-267.

Cropley, D. H., & Patston, T. J. (2019). Supporting creative teaching and learning in the classroom: Myths, models, and measures. *Creativity under Duress in Education? Resistive Theories, Practices, and Actions*, 267-288. https://doi.org/10.1007/978-3-319-90272-2_15

Doron, E. (2016). Short term intervention model for enhancing divergent thinking among school aged children. *Creativity Research Journal, 28*(3), 372-378. https://doi.org/10.1080/10400419.2016.1195616

Duke, N. K., Halvorsen, A.-L., Strachan, S. L., Kim, J., & Konstantopoulos, S. (2021). Putting PjBL to the test: The impact of project-based learning on second graders' social studies and literacy learning and motivation in low-SES school settings. *American Educational Research Journal, 58*(1), 160-200. https://doi.org/10.3102/0002831220929638

Evendi, E., Kusaeri, A., Kusaeri, A., Pardi, M., Sucipto, L., Bayani, F., & Prayogi, S. (2022). Assessing students' critical thinking skills viewed from cognitive style: Study on implementation of problem-based e-learning model in mathematics courses. *Eurasia Journal of Mathematics, Science and Technology Education, 18*(7), 1-15. https://doi.org/10.29333/ejmste/12161

Fan, M., & Cai, W. (2022). How does a creative learning environment foster student creativity? An examination on multiple explanatory mechanisms. *Current Psychology, 41*(7), 4667-4676. https://doi.org/10.1007/s12144-020-00974-z

Ford, N., & Chen, S. Y. (2001). Matching/mismatching revisited: An empirical study of learning and teaching styles. *British Journal of Educational Technology, 32*(1), 5-22. https://doi.org/10.1111/1467-8535.00173

Fraenkel, J. R., Wallen, N. E., & Hyun, H. H. (2012). *How to design and evaluate research* (8th ed.). New York: Mc Graw Hill.

Fredagsvik, M. S. (2023). The challenge of supporting creativity in problem-solving projects in science: A study of teachers' conversational practices with students. *Research in Science & Technological Education, 41*(1), 289-305. https://doi.org/10.1080/02635143.2021.1898359

Giancola, M., Palmiero, M., & D'Amico, S. (2022). Exploring the interplay between fluid intelligence and creativity: The mediating role of the field-dependent-independent cognitive style. *Thinking Skills and Creativity, 45*, 101047. https://doi.org/10.1016/j.tsc.2022.101047

Gunawan, G., Sahidu, H., Harjono, A., & Suranti, N. M. Y. (2017). Efektivitas penerapan model project based learning berbantuan media virtual terhadap kreativitas fisika peserta didik. *Jurnal Cakrawala Pendidikan, 36*(2). https://doi.org/10.21831/cp.v36i2.13514

Hake, R., R. (1999). *Analyzing change/gain scores Indiana university*. USA: Woodland Hills, CA.

Han, W., & Abdrahim, N. A. (2023). The role of teachers' creativity in higher education: A systematic literature review and guidance for future research. *Thinking Skills and Creativity, 48*, 101302. https://doi.org/10.1016/j.tsc.2023.101302

Hosseini, M. S., Hajizadegan, M., & Taherifar, Z. (2021). The mediating role of thinking styles in the relationship between intelligence and creativity. *Journal of Applied Psychological Research, 11*(4), 227-243. https://doi.org/10.22059/japr.2021.295897.643418

Ismayilova, K., & Bolander Laksov, K. (2023). Teaching creatively in higher education: The roles of personal attributes and environment. *Scandinavian Journal of Educational Research*, *67*(4), 536-548. https://doi.org/10.1080/00313831.2022.2042732

Kharkhurin, A. V. (2014). Creativity. 4in1: Four-criterion construct of creativity. *Creativity Research Journal*, *26*(3), 338-352. https://doi.org/10.1080/10400419.2014.929424

Koroh, T. R., Lehan, A. A. D., Treesly, Y., & Koro, M. (2022). The effects of project based learning model toward students' creative thinking skill on civics subject. *Journal of Teaching and Learning in Elementary Education*, *5*(2), 233-242.

Kousoulas, F. (2010). The interplay of creative behavior, divergent thinking, and knowledge base in students' creative expression during learning activity. *Creativity Research Journal*, *22*(4), 387-396. https://doi.org/10.1080/10400419.2010.523404

Kozhevnikov, M. (2007). Cognitive styles in the context of modern psychology: Toward an integrated framework of cognitive style. *Psychological Bulletin*, *133*(3), 464-481. https://doi.org/10.1037/0033-2909.133.3.464

Krajcik, J. S., Blumenfeld, P. C., Marx, R. W., & Soloway, E. (1994). A collaborative model for helping middle grade science teachers learn project-based instruction. *The Elementary School Journal*, *94*(5), 483-497. https://doi.org/10.1086/461779

Kuo, H.-C., Tseng, Y.-C., & Yang, Y.-T. C. (2019). Promoting college student's learning motivation and creativity through a STEM interdisciplinary PBL human-computer interaction system design and development course. *Thinking Skills and Creativity*, *31*, 1-10. https://doi.org/10.1016/j.tsc.2018.09.001

Lee, C. H. M., Cheng, Y. W., Rai, S., & Depickere, A. (2005). What affect student cognitive style in the development of hypermedia learning system? *Computers & Education*, *45*(1), 1-19. https://doi.org/10.1016/j.compedu.2004.04.006

Lei, W., Deng, W., Zhu, R., Runco, M. A., Dai, D. Y., & Hu, W. (2021). Does cognitive style moderate expected evaluation and adolescents' creative performance: An empirical study. *The Journal of Creative Behavior*, *55*(1), 120-129. https://doi.org/10.1002/jocb.439

Lin, P.-C., Lu, H.-K., & Lin, Y.-C. (2018). A study of knowledge dimension and cognitive process pattern of cognitive style differences in stem cooperative learning environment. *International Journal of Information and Education Technology*, *8*(10), 720-724. https://doi.org/10.18178/ijiet.2018.8.10.1128

Liu, S.-C., & Lin, H.-s. (2014). Primary teachers' beliefs about scientific creativity in the classroom context. *International Journal of Science Education*, *36*(10), 1551-1567. https://doi.org/10.1080/09500693.2013.868619

López-Vargas, O., Ibáñez-Ibáñez, J., & Racines-Prada, O. (2017). Students' metacognition and cognitive style and their effect on cognitive load and learning achievement. *Journal of Educational Technology & Society*, *20*(3), 145-157.

Lou, S.-J., Chou, Y.-C., Shih, R.-C., & Chung, C.-C. (2017). A study of creativity in CaC2 steamship-derived STEM project-based learning. *Eurasia Journal of Mathematics, Science and Technology Education*, *13*(6), 2387-2404. https://doi.org/10.12973/eurasia.2017.01231a

Lu, H.-K., & Lin, P.-C. (2018). A study on the effect of cognitive style in the field of STEM on collaborative learning outcome. *International Journal of Information and Education Technology*, *8*(3), 194-198. https://doi.org/10.18178/ijiet.2018.8.3.1032

Maros, M., Korenkova, M., Fila, M., Levicky, M., & Schoberova, M. (2021). Project-based learning and its effectiveness: Evidence from Slovakia. *Interactive Learning Environments*, 1-9. https://doi.org/10.1080/10494820.2021.1954036

Mi, S., Bi, H., & Lu, S. (2020). Trends and foundations of creativity research in education: A method based on text mining. *Creativity Research Journal*, *32*(3), 215-227. https://doi.org/10.1080/10400419.2020.1821554

Miller, A. L. (2007). Creativity and cognitive style: The relationship between field-dependence-independence, expected evaluation, and creative performance. *Psychology of Aesthetics, Creativity, and the Arts*, *1*(4), 243-246. https://doi.org/10.1037/1931-3896.1.4.243

Niaz, M., De Núñez, G. S., & De Pineda, I. R. (2000). Academic performance of high school students as a function of mental capacity, cognitive style, mobility-fixity dimension, and creativity. *The Journal of Creative Behavior*, *34*(1), 18-29. https://doi.org/10.1002/j.2162-6057.2000.tb01200.x

Noppe, L. D., & Gallagher, J. M. (1977). A cognitive style approach to creative thought. *Journal of Personality Assessment*, *41*(1), 85-90. https://doi.org/10.1207/s15327752jpa4101_14

Ohnmacht, F. W., & McMorris, R. F. (1971). Creativity as a function of field independence and dogmatism. *The Journal of Psychology*, *79*(2), 165-168. https://doi.org/10.1080/00223980.1971.9921307

Onyekuru, B. U. (2015). Field dependence-field independence cognitive style, gender, career choice and academic achievement of secondary school students in emohua local government area of rivers state. *Journal of Education and Practice*, *6*(10), 76-85.

Pan, A.-J., Lai, C.-F., & Kuo, H.-C. (2023). Investigating the impact of a possibility-thinking integrated project-based learning history course on high school students' creativity, learning motivation, and history knowledge. *Thinking Skills and Creativity*, *47*, 101214. https://doi.org/10.1016/j.tsc.2022.101214

Piffer, D. (2012). Can creativity be measured? An attempt to clarify the notion of creativity and general directions for future research. *Thinking Skills and Creativity*, *7*(3), 258-264. https://doi.org/10.1016/j.tsc.2012.04.009

Putri, S. S., Japar, M., & Bagaskorowati, R. (2019). Increasing ecoliteracy and student creativity in waste utilization. *International Journal of Evaluation and Research in Education*, *8*(2), 255-264. https://doi.org/10.11591/ijere.v8i2.18901

Runco, M. A., & Acar, S. (2012). Divergent thinking as an indicator of creative potential. *Creativity Research Journal*, *24*(1), 66-75. https://doi.org/10.1080/10400419.2012.652929

Runco, M. A., & Jaeger, G. J. (2012). The standard definition of creativity. *Creativity Research Journal*, *24*(1), 92-96. https://doi.org/10.1080/10400419.2012.650092

Simonton, D. K. (2012). Taking the US patent office criteria seriously: A quantitative three-criterion creativity definition and its implications. *Creativity Research Journal*, *24*(2-3), 97-106. https://doi.org/10.1080/10400419.2012.676974

Suyidno, S., Nur, M., Yuanita, L., Prahani, B. K., & Jatmiko, B. (2018). Effectiveness of creative responsibility based teaching model on basic physics learning to increase student's scientific creativity and responsibility. *Journal of Baltic Science Education*, *17*(1), 136-151.

Tell, J., & Hoveskog, M. (2022). Applied engineering education for soft skills in the context of sustainability and mobility. *International Journal of Sustainability in Higher Education*, *23*(8), 324-336. https://doi.org/10.1108/ijshe-07-2022-0202

Treffinger, D. J., Young, G. C., Selby, E. C., & Shepardson, C. (2002). *Assessing creativity: A guide for educators in national research center on the gifted and talented*. Washington DC: National Research Center on the Gifted and Talented.

Usmeldi, U. (2019). *The effect of project-based learning and creativity on the students' competence at vocational high schools*. Paper presented at the Proceedings of the 5th UPI International Conference on Technical and Vocational Education and Training (ICTVET 2018). Proceedings of the 5th UPI International Conference on Technical and Vocational Education and Training (ICTVET 2018), Bandung, Indonesia.

Valaei, N., Rezaei, S., & Ismail, W. K. W. (2017). Examining learning strategies, creativity, and innovation at SMEs using fuzzy set qualitative comparative analysis and PLS path modeling. *Journal of Business Research*, *70*, 224-233. https://doi.org/10.1016/j.jbusres.2016.08.016

Valentine, A., Belski, I., & Hamilton, M. (2017). Developing creativity and problem-solving skills of engineering students: A comparison of web-and pen-and-paper-based approaches. *European Journal of Engineering Education*, *42*(6), 1309-1329. https://doi.org/10.1080/03043797.2017.1291584

Vodovnik, Z. (2019). The Bologna reform and its impact on the motivation and activities of the academics-a national case study: Slovenia. *International Journal of Innovation and Learning*, *25*(4), 349-362. https://doi.org/10.1504/ijil.2019.10021079

Wahyudi, P., Verawati, N. N. S., Ayub, S., & Prayogi, S. (2018). Development of inquiry-creative-process learning model to promote critical thinking ability of physics prospective teachers. *Journal of Physics: Conference Series*, *1108*, 2-7. https://doi.org/10.1088/1742-6596/1108/1/012005

Wahyudi, W., Verawati, N., Ayub, S., & Prayogi, S. (2019). The effect of scientific creativity in inquiry learning to promote critical thinking ability of prospective teachers. *International Journal of Emerging Technologies in Learning*, *14*(14), 122-131. https://doi.org/10.3991/ijet.v14i14.9532

Wang, B., & Li, P. (2022). Digital creativity in STEM education: The impact of digital tools and pedagogical learning models on the students' creative thinking skills development. *Interactive Learning Environments*, 1–14. https://doi.org/10.1080/10494820.2022.2155839

Witkin, H. A., & Goodenough, D. R. (1981). Cognitive styles: Essence and origins field dependence and field independence. *Psychological Issues*, 51, 1-141.

Yustina, Y., Syafii, W., & Vebrianto, R. (2020). The effects of blended learning and project-based learning on pre-service biology teachersâ€™ creative thinking through online learning in the Covid-19 pandemic. *Jurnal Pendidikan IPA Indonesia*, *9*(3), 408-420. https://doi.org/10.15294/jpii.v9i3.24706

Zhang, L. (2017). *The value of intellectual styles* (1st ed.). Cambridge: Cambridge University Press.