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Designing Virtual Ethnophysics *Kekehan* on Moment of Inertia and Angular Momentum: Analyzing Students' Creative Thinking Skills

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ABSTRACT

Creative thinking skills are fundamental to education, so a strategy to improve them in line with the current era is needed. Therefore, there needs to be a combination of improving creative thinking skills with learning grounded in culture and humanism. This study aims to describe creative thinking skills, learning needs, media design, and media validity. This study used a development design with a 3D scheme (Define, Design, Development). Data collection was conducted through observation, design, and validity testing. The results showed that students' creative thinking skills were low. Additionally, in physics, students still require visualizations of the concepts presented. Furthermore, the observation results revealed that students support the media development. This posed a challenge for researchers in developing SiVEKa (Simulasi Virtual Ethnophsyics *Kekehan)*. In the media design process, the researcher based the design on student observations and the relevant learning theory. The validity results indicated that the SiVEKa media was highly valid, enabling further testing. In addition, this study contributes to preserving culture through learning. This study hopes to contribute to learning using ethno-integrated technology.

ARTICLE INFORMATION

Keywords:
creative thinking; ethnophysics; physics education; siveka; virtual simulation

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INTRODUCTION

The development of the 21st century has impacted the academic and technological worlds. In the 21st century, students must have 4C academic skills, namely critical, creative, communicative, and collaborative thinking (Khoiri et al., 2021; Waluyo & Wahyuni, 2021). One of the 4C skills needed is creative thinking skills. In the 21st century, education prioritizes creative thinking skills by requiring students to develop abilities beyond academic knowledge (Abustang et al., 2024; Damarsha et al., 2025a; Krisanti et al., 2025; Naufal et al., 2025). In addition, creative thinking skills are important for fostering students' thinking skills (Azeem et al., 2021; Elidemir et al., 2020; Forte-Celaya et al., 2021; Mazla et al., 2020; Thornhill-Miller et al., 2023).

The curriculum in Indonesia emphasizes a community-based approach to learning in the 5.0 era. The 5.0 era focuses on humanism that prioritizes scientific and technological innovation alongside social priorities (Sudibjo et al., 2019; Suprapto et al., 2021). According to Awotunde et al. (2023), this has an impact on education worldwide, especially by improving creative thinking skills. Therefore, it is necessary to incorporate global issues into learning across all subjects in the era of society 5.0 (Hysa

et al., 2021; Xu et al., 2021). In addition, learning in the 21st century should not only focus on global issues but also address social and cultural issues in the era of society 5.0, which reflects technological developments and social interactions (Al-Emran & Al-Sharafi, 2022).

Physics learning is expected to not only focus on understanding the theory by students, but also on the skills to apply physics concepts to solve physics problems in everyday life (Shah, 2019; Yildiz & Guler, 2021). Physics plays a crucial role in learning in today's society, particularly in its application (Nuryadi & Widiatmaka, 2023). In its application to society, especially in the social and cultural fields, physics explains many scientific concepts embedded in surrounding culture (Archer et al., 2020; Avraamidou, 2022). According to Aisah et al. (2024) and Hermawan et al. (2020), culture-based physics learning can improve learners' cognitive understanding skills and benefit development.

In fact, students think physics is too abstract and difficult to learn (Bouchée et al., 2022; Sastradika et al., 2021). According to Mufit et al. (2020), students still find physics difficult, with evidence that their understanding of concepts remains low. According to Gilberti & Organtini (2021), students find it difficult to learn physics because they lack a proper understanding of natural phenomena. According to Puspitasari and Mufit (2021), for learning to proceed well, teachers need to provide learning facilities that align with students' needs and learning objectives, so students can easily understand the concepts.

Previous studies have identified challenges in implementing physics learning (Marsida et al., 2024). Physics learning currently does not optimally utilize technology to develop students' creative thinking skills (Hikmah et al., 2023; Yanti et al., 2023). Meanwhile, the ethnophysics approach, which combines physics with local wisdom, is also rarely applied in the classroom (Warsono et al., 2020). The current education curriculum emphasizes the importance of integrating learning with local wisdom (Sakti et al., 2024; Suprapto et al., 2024; Tohri et al., 2022). As a result, students are not accustomed to applying a more creative, context-based understanding of physics (Lavonen et al., 2021). This indicates a need for learning innovations that combine technology with local wisdom (Kwangmuang et al., 2021; Yusuf, 2023).

Several studies emphasize the need to integrate learning with the demands of the modern era through the use of technology and more contextual learning approaches (Deta et al., 2024; Suprapto et al., 2021). However, efforts to integrate technology learning with an ethnophysical approach in physics education have not been studied in depth. In fact, ethnophysical learning combined with modern technology has great potential to improve the quality of physics learning and creative thinking skills (Yusuf, 2023; Aisah et al., 2024). Therefore, physics learning that combines ethnography with modern technology is needed to support the quality of education and improve creative thinking skills.

One innovation to overcome this is the use of traditional Indonesian games as contextual learning (Zuhri et al., 2023). For example, the game *Kekehan*, short for "*akeh-akehan mumet*," is a traditional spinning-top game from the Lamongan region of East Java (Prasetyo et al., 2022). According to Deta et al. (2024), the physics concept of Kekehan can improve the learning process and student participation. In addition, according to Larasati (2011), the traditional game of *Kekehan* contains important values for physical and mental development. Teachers play a role in physics learning by applying local wisdom (Abril & Aldana, 2023; Hikmawati et al., 2024). However, few teachers apply local wisdom in physics instruction because students are perceived as having difficulty understanding it (Warsono et al., 2020).

To address students' difficulties in learning physics, it is necessary to understand the problems and factors that support students' learning and understanding of physics concepts (Puspitasari & Mufit, 2021). This requires a survey to study further the conditions under which students learn. Thus, to conduct further studies, a preliminary study was conducted to evaluate the implemented learning and students' learning needs (Mufit et al., 2020; Poláková & Klímová, 2021). In addition, the

preliminary study aims to determine the suitability of learning in the current era, taking into account social and cultural factors (Zidny et al., 2020). This study aims to describe the results of media development. The following is the research question: 1) RQ1: What are the creative thinking skill profiles of male and female students? 2) RQ2: How do we need to teach physics to improve creative thinking skills? 3) RQ3: How does SiVEKa media design for learning strategies improve creative thinking skills? 4) RQ4**:** How is the validity of SiVEKa media on expert validators?

METHOD

This study uses an R&D development design with a 3D flow (Define, Design, Development). The research diagram in Figure 1 shows a 3D flow adapted from Damarsha et al. (2025a).

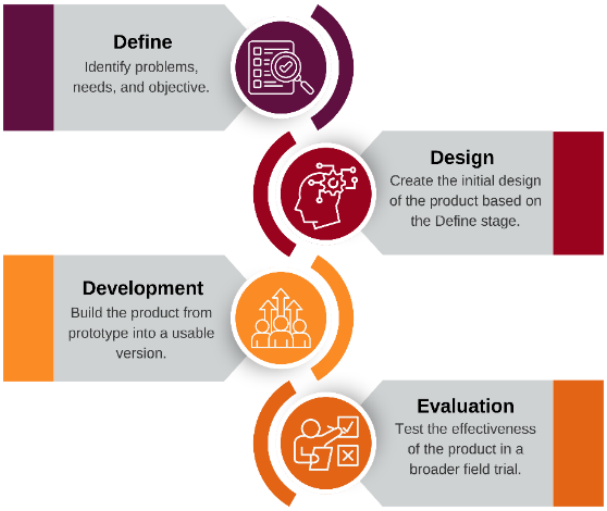


Figure 1. Research flow

Based on Figure 1, this study went through four stages. The first stage was the define stage, during which researchers identified learning problems through observation, literature review, and questionnaire distribution to determine the gap between needs and conditions in the field. The second stage was the design stage, during which researchers developed learning plans for the identified problems. The design includes the selection of the background and objects that can be changed, as well as the creation of a physics concept in the form of angular momentum in the SiVEKa learning media. The third stage is development, which is the process of realizing the learning media design from the previous stage. The realization process needs to be tested for validity in SiVEKa by three validators who are proficient and experts in the process of constructing learning media. The final stage is the evaluation, in which researchers assess all the steps of the research. This research required a lengthy process to develop the SiVEKa media. The media development process took five months. Figure 2 shows the SiVEKa media development process.

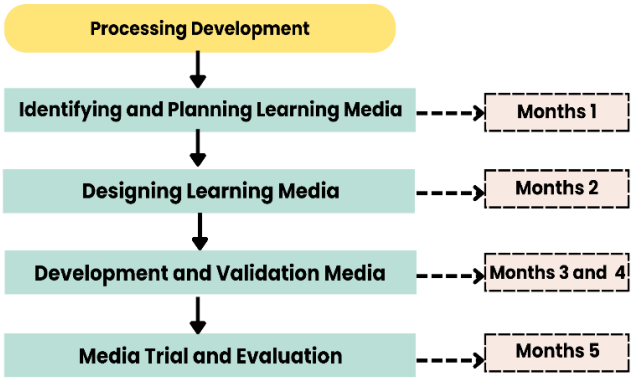


Figure 2. Media development

The development process was carried out in several stages, including identification and planning of learning media, designing learning media, developing and validating media, and testing and evaluating media. The process of identifying and planning media, as adopted by Siagian et al. (2021), follows a development flow: first, problems in physics learning topics are identified; the results of this identification then serve as the basis for planning learning media. In this case, the problem lies in students' understanding of rotational motion, so the learning media focuses on that concept. The design of learning media is carried out after careful planning. The media design used requires a simple shape and dimensions so that the concept can be conveyed to students. In this case, the spinning top becomes the focus of the learning media (Mayer, 2006). The spinning top was chosen for its cultural value in increasing student motivation to learn (Damarsha et al., 2025a).

The next stage involves developing and validating learning media. The development carried out on SiVEKa is aimed at students' creative thinking skills, which are assessed using four indicators (see Table 1). The learning media are validated before testing (Krägeloh et al., 2013). Not only the validation process, but also the testing of the relationship between genders on the four indicators of creative thinking, were carried out using Rasch tests and T-tests. The final step in the fifth month was to test the media and evaluate their performance. This study used test instruments and student response questionnaires. The test instruments were used to determine students' initial creative thinking skills, while the response questionnaires were used to evaluate the SiVEKa media. Table 1 shows the creative thinking skills used based on the reference by Damarsha et al. (2025b).

Table 1. Creative thinking skills indicator

Indicators of creative thinking ability	Creative thinking behavior
Fluency (F)	Providing alternatives/ideas for solving problems through modifications in accordance with the concept of moment of inertia
Elaboration (E)	Evaluate the mass and the moment of inertia of the mass according to the concept.
Flexibility (Fl)	Providing solutions from various perspectives in accordance with the concept of moment of inertia in elasticity
Originality (O)	Developing problem-solving ideas in accordance with the concept of angular momentum in inertia

Before proceeding further, the researchers clustered the data being analyzed. The data were grouped by gender to determine whether there were differences in creative thinking abilities between the two genders. A total of 72 students participated in the study, with 30 male students and 42 female students forming the clusters. All participants were anonymized using pseudonyms. Ethical approval

was obtained from the relevant ethics committee, and written consent was obtained from all participants prior to data collection.

In the first stage, researchers analyzed the data using the Variance Significance Test to ensure data consistency between groups. Next, Rasch model analysis was conducted to assess the reliability of the questions used to evaluate creative thinking skills. The final stage involved overall data validation, which included the results of the analysis of both clusters. According to Aryadoust et al. (2021), the Cronbach's alpha criteria for reliability are as follows (see Table 2). By conducting a reliability test, the research instrument will be determined to be a reliable measure of creative thinking skills.

Table 2. Cronbach's alpha reliability score

Value of Cronbach's Alpha	Description
$\alpha < 0.50$	Weak
$0.50 < \alpha \leq 0.60$	Enough
$0.60 < \alpha \leq 0.70$	Good
$0.70 < \alpha \leq 0.80$	Very good
$\alpha > 0.80$	Excellent

After conducting reliability tests, researchers conducted T-tests to determine differences in creative thinking skills between genders. The T-test results were supported by Rasch model analysis, which strengthened the assessment of creative thinking skills for each individual (Chicco et al., 2025). The use of the Rasch model in research involves the unidimensionality value of the measurement. Measurement unidimensionality is measured using an eigenvalue scale with unidimensionality criteria of more than 2 and a percentage of more than the raw variance explained by measures (RVEM) 40%. Furthermore, the Rasch model analyses item fit through the Outfit Mean Square (MNSQ) and Z-Standard (ZSTD) values. An item is declared fit if it meets the criteria of 0.5 < MNSQ < 1.5 and -2.0 < ZSTD < +2.0. Items that do not fit will be corrected or deleted (Nisa et al., 2024).

RESULTS AND DISCUSSION

The reliability test yielded a Cronbach's alpha of 0.773, which is very good. This means that the instrument tested can be used to measure creative thinking skills. The findings show that both male and female students have the same initial skills. To reinforce the research results on significant differences, it is necessary to use Rasch model analysis. The results of the Rasch model analysis are shown in Figures 3, 4(a), and 5(b).

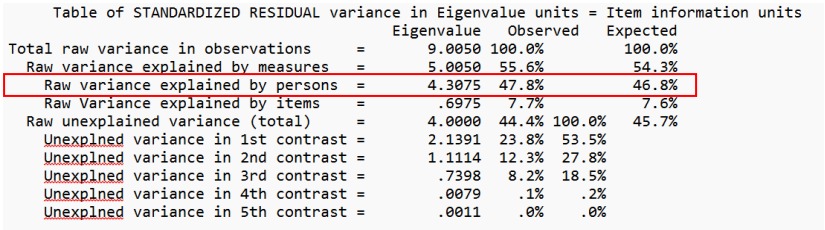
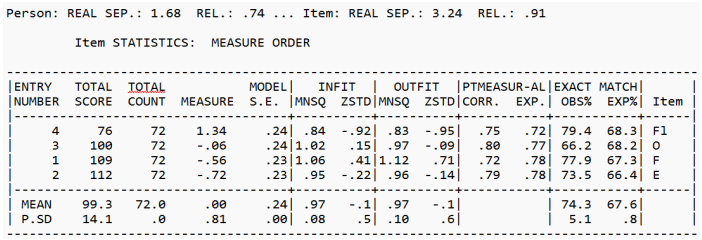


Table of STANDARDIZED RESIDUAL variance in Eigenvalue units = Item information units

	Eigenvalue	Observed	Expected
Total raw variance in observations =	9.0050	100.0%	100.0%
Raw variance explained by measures =	5.0050	55.6%	54.3%
Raw variance explained by persons =	4.3075	47.8%	46.8%
Raw Variance explained by items =	.6975	7.7%	7.6%
Raw unexplained variance (total) =	4.0000	44.4% 100.0%	45.7%
Unexplned variance in 1st contrast =	2.1391	23.8% 53.5%	
Unexplned variance in 2nd contrast =	1.1114	12.3% 27.8%	
Unexplned variance in 3rd contrast =	.7398	8.2% 18.5%	
Unexplned variance in 4th contrast =	.0079	.1% .2%	
Unexplned variance in 5th contrast =	.0011	.0% .0%	

Figure 3. Unidimensionality measurement result

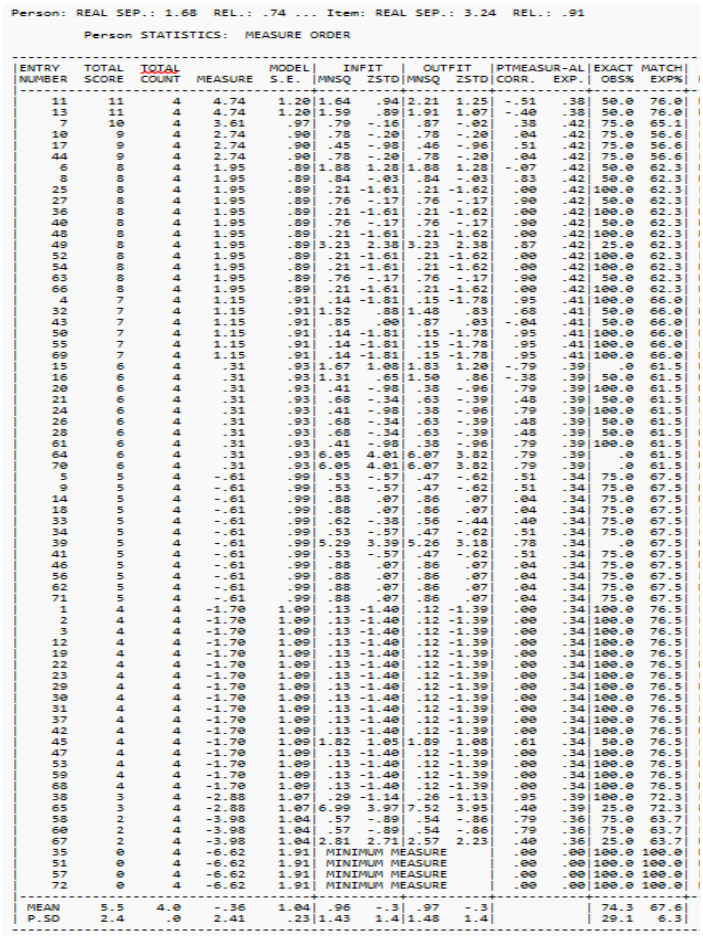


Person: REAL SEP.: 1.68 REL.: .74 ... Item: REAL SEP.: 3.24 REL.: .91

Item STATISTICS: MEASURE ORDER

ENTRY NUMBER	TOTAL SCORE	TOTAL COUNT	MODEL MEASURE	MODEL S.E.	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD	PTMEASUR-AL CORR.	PTMEASUR-AL EXP.	EXACT MATCH OBS%	EXACT MATCH EXP%	Item
4	76	72	1.34	.24	.84	-.92	.83	-.95	.75	.72	79.4	68.3	F1
3	100	72	-.06	.24	1.02	.15	.97	-.09	.80	.77	66.2	68.2	O
1	109	72	-.56	.23	1.06	.41	1.12	.71	.72	.78	77.9	67.3	F
2	112	72	-.72	.23	.95	-.22	.96	-.14	.79	.78	73.5	66.4	E
MEAN	99.3	72.0	.00	.24	.97	-.1	.97	-.1			74.3	67.6	
P.SD	14.1	.0	.81	.00	.08	.5	.10	.6			5.1	.8	

(a)



Person: REAL SEP.: 1.68 REL.: .74 ... Item: REAL SEP.: 3.24 REL.: .91

Person STATISTICS: MEASURE ORDER

ENTRY NUMBER	TOTAL SCORE	TOTAL COUNT	MEASURE	MODEL S.E.	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD	PTMEASUR-AL CORR.	PTMEASUR-AL EXP.	EXACT MATCH OBS%	EXACT MATCH EXP%
11	11	4	4.74	1.20	1.64	.94	2.21	1.25	-.51	.38	50.0	76.0
13	11	4	4.74	1.20	1.59	.89	1.91	1.07	-.40	.38	50.0	76.0
7	10	4	3.61	.97	.79	-.16	.87	-.02	.38	.42	75.0	65.1
10	9	4	2.74	.90	.78	-.20	.78	-.20	.04	.42	75.0	56.6
17	9	4	2.74	.90	.45	-.98	.46	-.96	.51	.42	75.0	56.6
44	9	4	2.74	.90	.78	-.20	.78	-.20	.04	.42	75.0	56.6
6	8	4	1.95	.89	1.88	1.28	1.88	1.28	-.07	.42	50.0	62.3
8	8	4	1.95	.89	.84	-.03	.84	-.03	.83	.42	50.0	62.3
25	8	4	1.95	.89	.21	-1.61	.21	-1.62	.00	.42	100.0	62.3
27	8	4	1.95	.89	.76	-.17	.76	-.17	.90	.42	50.0	62.3
36	8	4	1.95	.89	.21	-1.61	.21	-1.62	.00	.42	100.0	62.3
40	8	4	1.95	.89	.76	-.17	.76	-.17	.90	.42	50.0	62.3
48	8	4	1.95	.89	.21	-1.61	.21	-1.62	.00	.42	100.0	62.3
49	8	4	1.95	.89	3.23	2.38	3.23	2.38	.87	.42	25.0	62.3
52	8	4	1.95	.89	.21	-1.61	.21	-1.62	.00	.42	100.0	62.3
54	8	4	1.95	.89	.21	-1.61	.21	-1.62	.00	.42	100.0	62.3
63	8	4	1.95	.89	.76	-.17	.76	-.17	.90	.42	50.0	62.3
66	8	4	1.95	.89	.21	-1.61	.21	-1.62	.00	.42	100.0	62.3
4	7	4	1.15	.91	.14	-1.81	.15	-1.78	.95	.41	100.0	66.0
32	7	4	1.15	.91	1.52	.88	1.48	.83	.68	.41	50.0	66.0
43	7	4	1.15	.91	.85	.00	.87	.03	-.04	.41	50.0	66.0
50	7	4	1.15	.91	.14	-1.81	.15	-1.78	.95	.41	100.0	66.0
55	7	4	1.15	.91	.14	-1.81	.15	-1.78	.95	.41	100.0	66.0
69	7	4	1.15	.91	.14	-1.81	.15	-1.78	.95	.41	100.0	66.0
15	6	4	.31	.93	1.67	1.08	1.83	1.20	-.79	.39	.0	61.5
16	6	4	.31	.93	1.31	.65	1.50	.86	-.38	.39	50.0	61.5
20	6	4	.31	.93	.41	-.98	.38	-.96	.79	.39	100.0	61.5
21	6	4	.31	.93	.68	-.34	.63	-.39	.48	.39	50.0	61.5
24	6	4	.31	.93	.41	-.98	.38	-.96	.79	.39	100.0	61.5
26	6	4	.31	.93	.68	-.34	.63	-.39	.48	.39	50.0	61.5
28	6	4	.31	.93	.68	-.34	.63	-.39	.48	.39	50.0	61.5
61	6	4	.31	.93	.41	-.98	.38	-.96	.79	.39	100.0	61.5
64	6	4	.31	.93	6.05	4.01	6.07	3.82	.79	.39	.0	61.5
70	6	4	.31	.93	6.05	4.01	6.07	3.82	.79	.39	.0	61.5
5	5	4	-.61	.99	.53	-.57	.47	-.62	.51	.34	75.0	67.5
9	5	4	-.61	.99	.53	-.57	.47	-.62	.51	.34	75.0	67.5
14	5	4	-.61	.99	.88	.07	.86	.07	.04	.34	75.0	67.5
18	5	4	-.61	.99	.88	.07	.86	.07	.04	.34	75.0	67.5
33	5	4	-.61	.99	.62	-.38	.56	-.44	.40	.34	75.0	67.5
34	5	4	-.61	.99	.53	-.57	.47	-.62	.51	.34	75.0	67.5
39	5	4	-.61	.99	5.29	3.39	5.26	3.18	.78	.34	.0	67.5
41	5	4	-.61	.99	.53	-.57	.47	-.62	.51	.34	75.0	67.5
46	5	4	-.61	.99	.88	.07	.86	.07	.04	.34	75.0	67.5
56	5	4	-.61	.99	.88	.07	.86	.07	.04	.34	75.0	67.5
62	5	4	-.61	.99	.88	.07	.86	.07	.04	.34	75.0	67.5
71	5	4	-.61	.99	.88	.07	.86	.07	.04	.34	75.0	67.5
1	4	4	-1.70	1.09	.13	-1.40	.12	-1.39	.00	.34	100.0	76.5
2	4	4	-1.70	1.09	.13	-1.40	.12	-1.39	.00	.34	100.0	76.5
3	4	4	-1.70	1.09	.13	-1.40	.12	-1.39	.00	.34	100.0	76.5
12	4	4	-1.70	1.09	.13	-1.40	.12	-1.39	.00	.34	100.0	76.5
19	4	4	-1.70	1.09	.13	-1.40	.12	-1.39	.00	.34	100.0	76.5
22	4	4	-1.70	1.09	.13	-1.40	.12	-1.39	.00	.34	100.0	76.5
23	4	4	-1.70	1.09	.13	-1.40	.12	-1.39	.00	.34	100.0	76.5
29	4	4	-1.70	1.09	.13	-1.40	.12	-1.39	.00	.34	100.0	76.5
30	4	4	-1.70	1.09	.13	-1.40	.12	-1.39	.00	.34	100.0	76.5
31	4	4	-1.70	1.09	.13	-1.40	.12	-1.39	.00	.34	100.0	76.5
37	4	4	-1.70	1.09	.13	-1.40	.12	-1.39	.00	.34	100.0	76.5
42	4	4	-1.70	1.09	.13	-1.40	.12	-1.39	.00	.34	100.0	76.5
45	4	4	-1.70	1.09	1.82	1.05	1.89	1.08	.61	.34	50.0	76.5
47	4	4	-1.70	1.09	.13	-1.40	.12	-1.39	.00	.34	100.0	76.5
53	4	4	-1.70	1.09	.13	-1.40	.12	-1.39	.00	.34	100.0	76.5
59	4	4	-1.70	1.09	.13	-1.40	.12	-1.39	.00	.34	100.0	76.5
68	4	4	-1.70	1.09	.13	-1.40	.12	-1.39	.00	.34	100.0	76.5
38	3	4	-2.88	1.07	.29	-1.14	.26	-1.13	.95	.39	100.0	72.3
65	3	4	-2.88	1.07	6.99	3.97	7.52	3.95	.40	.39	25.0	72.3
58	2	4	-3.98	1.04	.57	-.89	.54	-.86	.79	.36	75.0	63.7
60	2	4	-3.98	1.04	.57	-.89	.54	-.86	.79	.36	75.0	63.7
67	2	4	-3.98	1.04	2.81	2.71	2.57	2.23	.40	.36	25.0	63.7
35	0	4	-6.62	1.91	MINIMUM MEASURE				.00	.00	100.0	100.0
51	0	4	-6.62	1.91	MINIMUM MEASURE				.00	.00	100.0	100.0
57	0	4	-6.62	1.91	MINIMUM MEASURE				.00	.00	100.0	100.0
72	0	4	-6.62	1.91	MINIMUM MEASURE				.00	.00	100.0	100.0
MEAN	5.5	4.0	-.36	1.04	.96	-.3	.97	-.3			74.3	67.6
P.SD	2.4	.0	2.41	.23	1.43	1.4	1.48	1.4			29.1	6.3

(b)

Figure 4. *(a)* Item factor analysis result; *(b)* person factor analysis result

Figure 3 shows the unidimensionality test for the measurement instrument, both at the item and person (participant) levels. The eigenvalue obtained in the measurement, at the raw variance level, is 5.0050, corresponding to 55.6%. The measured data show that the measurement is unidimensional. According to several references, the upper limit for eigenvalues and percentage values is 2, with a minimum percentage of 40% (Nisa et al., 2024; Han, 2022). This showed that the findings in this study, which were reinforced using Rasch model analysis, indicate that the instrument used is highly valid for measuring creative thinking skills.

Furthermore, Figures 4(a) and 5(b) show the measures on items and persons to reinforce the results. Figure 4(a) shows that the MNSQ is 0.97 and the ZSTD is -1, indicating that the items are suitable for measuring creative thinking skills. Figure 4(b) shows that the MNSQ is 0.96, while the ZSTD is -3, indicating that the person responded to the items in accordance with their skills. This

shows that each person needs to be evaluated to improve their creative thinking skills. Furthermore, Figure 5 shows students' creative thinking skills across genders.

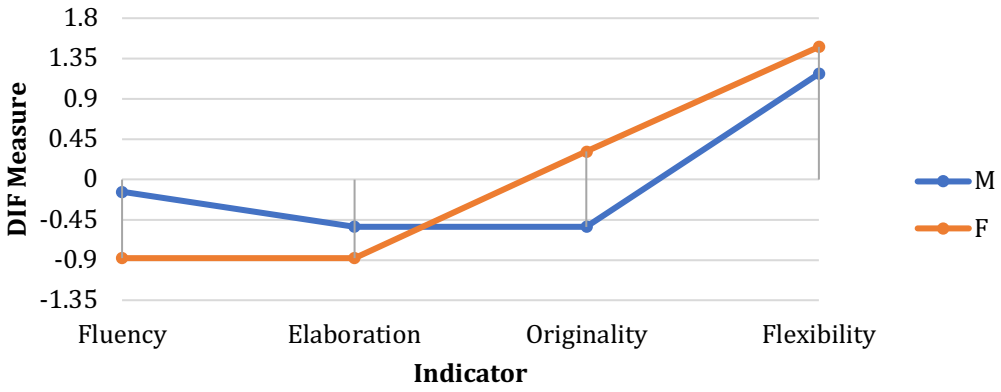


Figure 5. DIF Measure

Figure 5 illustrates the DIF Measure values across 4 indicators of creative thinking skills. Revealed that both of them (female & male) get a difficult-to-solve flexibility indicator. However, a gender-based disparity was observed in the other indicators: male students successfully solved three indicators with ease, whereas female students found only two to be easily solvable. This pattern suggests that gender may play a pivotal role in shaping the development and manifestation of creative thinking skills in this context. Furthermore, a strategy is needed to improve students' creative thinking skills. To explore the strategy to be implemented, the researcher conducted a survey using a student questionnaire (see Table 3).

Table 3. Student's option statement survey results

Question	Option Statement	Frequency
What difficulties do you experience when learning physics?	Lack of practical activities	7
	Lack of visualization of the material provided	30
	Teachers rely more on formulas	12
	The teacher does not give examples of daily life	4
Does the teacher often use problems or phenomena before explaining physics material?	Almost every learning activity	17
	Every time you start a new material	21
	Once or twice only	14
	Never	1
What does your teacher do to make learning physics fun?	Display video or animation	15
	Conducting virtual lab practicum	9
	Doing learning while playing games	26
	None	3
Does your teacher always relate physics problems to local wisdom around you?	Always	6
	Often	20
	Rare	25
	Never	2

Table 5 shows that 30 students reported that the material presented was difficult to understand because it lacked media that illustrated physics concepts in real-world contexts. Learning through visualization can help students understand the material and motivate them to learn (Tarradas et al.,

2022). In the second statement, 21 students stated that real phenomena or problems were used only when introducing new material. According to Akkas and Eker (2021), learning with a real-phenomenon-based approach is still rarely used, even though it helps improve creative thinking skills. Furthermore, in the third statement, 26 students stated that the learning process felt more enjoyable when applying games while learning. According to Hartt et al. (2020), game-based learning could establish joyful learning. Meanwhile, 25 student responses stated that teachers rarely integrate local wisdom into physics learning. The integration of local wisdom into learning can foster student creativity by encouraging observation of phenomena in students' environments (Suprapto et al., 2024; Aisah et al., 2024).

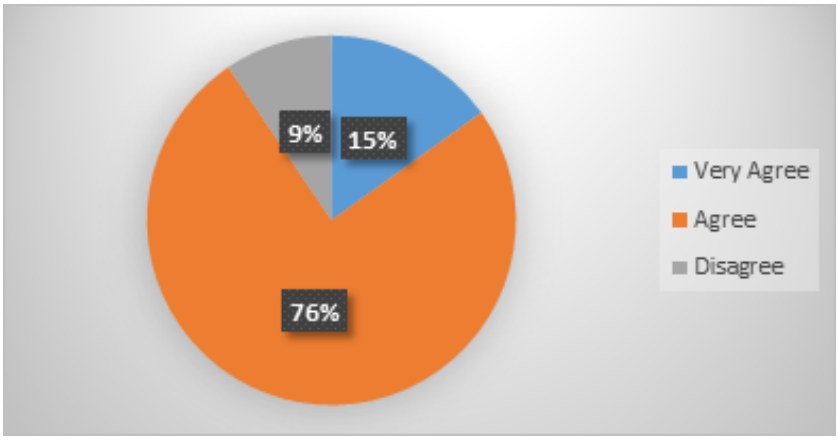


Figure 6. Questionnaires answers

Based on the survey results presented, 76% of students agreed, while 15% strongly agreed that SiVEKa helped them understand physics material more easily and interestingly. Meanwhile, only 9% of students disagreed with the effectiveness of this media. The dominance of "agree" and "strongly agree" responses indicates that SiVEKa has successfully met students' learning needs, particularly through visual presentations and interactivity that support conceptual understanding. This aligns with Damarsha et al. (2025a) and Rachmavita (2020), who state that the application of virtual simulations based on local wisdom can increase learning motivation and facilitate the development of creative thinking through visualization media.

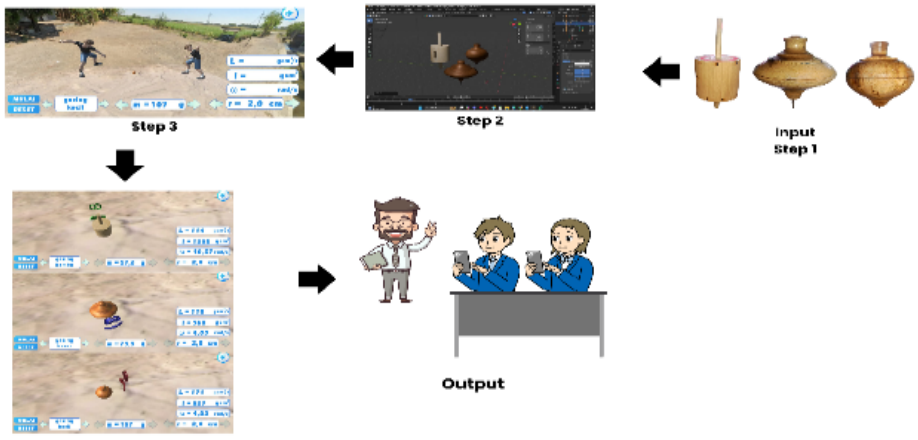


Figure 7. SiVEKa development flowchart

The development of SiVEKa involves sequential stages from design to application in learning. The spinning top model was chosen to easily stimulate students' perceptions of interpreting equations because of its simple geometry. In this context, the constant of an object is its shape, while its density

is its material. Spinning tops have three shapes and are made of two different materials, each of which affects their inertia and angular momentum. In this context, this affects the rules of the game regarding how long they spin, so it is necessary to know their inertia and angular momentum. The three models from step 1 were selected, and modeling continued in step 2 using software to simulate the spinning top in 3D. The spinning top is used as an observation object in SiVEKa. After the modeling session is complete, the third stage involves adding the background, the spinning top game players, and the measurement parameters (angular momentum, moment of inertia, spinning top radius, angular velocity, and spinning top mass). Trials were conducted before the implementation stage in physics learning. The testing aimed to validate the theory of angular momentum conservation, enabling physics learning to be integrated with the SiVEKa learning media.

The media design in the development of SiVEKa involved 3D animation to upload motivation and a persuasive game atmosphere for students. The development of SiVEKa is based on a cultural (ethno) foundation integrated with science, especially physics, and uses spinning tops in the SiVEKa game. The SiVEKa game displays indicators of rotational motion of a spinning top, including the spinning top's radius and moment of inertia, which are interrelated. Furthermore, before implementing the stages to be tested, media validation needs to be carried out to determine the suitability of the media for application. Validation was carried out by three expert validators in the fields of learning media, creative thinking skills, and ethnophysics. The results of media validation are shown in Table 4.

Table 4. Validity test result by validators

Validity Test					
Aspect	**Validator 1**	**Validator 2**	**Validator 3**	**Average**	**Criteria**
Attractiveness	87.5%	81.25%	87.5%	85.41%	Very Valid
Content suitability	83.3%	75%	91.67%	83.32%	Very Valid
Media quality	100%	83%	91.67%	91.55%	Very Valid
Construction	75%	91.66%	100%	88.67%	Very Valid

The results of the SiVEKa media validity test by three validators in Table 4 show that all aspects are categorized as highly valid, with an average of 87.24%. According to Sugiono (2019), learning media with a validity score above 80% is categorized as highly valid. In terms of media quality, it obtained the highest validity score of 91.55%. This shows that the SiVEKa media has a clear visual appearance and smooth technical functionality, indicating that it meets learning quality standards. According to Rachmavita (2020), learning media with an attractive, interactive visual design can enhance students' motivation to learn. Conversely, the content suitability aspect received the lowest average score of 83.32%. Even though the material content is relevant, content suitability does not depend solely on its accuracy, but also on how effectively the media can encourage student engagement in learning (El-Sabagh, 2021). In terms of construction and content suitability, the validators gave a score of 75%, indicating that some considered the flow of the concept presentation and the material relevance to be less than optimal. This was due to the development focus, which emphasized interactive displays rather than in-depth concepts. Figure 5b, where the ZSTD value exceeds the standardization, which means that each person has difficulty answering the questions given. Therefore, a strategy is needed to improve creative thinking skills, as these skills are highly needed in the 21st century (Krisanti et al., 2025; Naufal et al., 2025).

To address this issue, it is necessary to understand the actual field conditions, which requires conducting a field survey. Students have difficulty understanding physics because the concepts are not well visualized. This is supported by Mufit et al. (2020), who state that physics learning requires visualization to help students understand the material. To make these adjustments, further

observation of the application of the curriculum and the current era is needed. This aims to ensure that the learning process aligns with current needs. In the observation solution, the researcher proposes developing SiVEKa media to improve creative thinking skills. Figure 5 shows the students' response to the offer to develop SiVEKa media. The response is positive, indicating that SiVEKa media can be accepted in development. Before further development, the researcher outlines creative thinking skills through the required framework and learning theory, as shown in Figure 8.

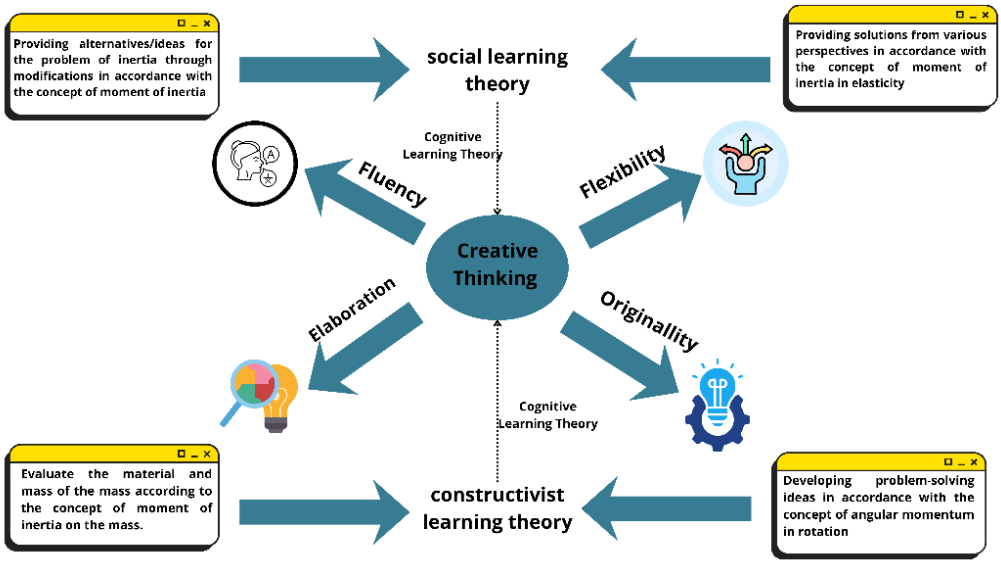


Figure 8. Creative thinking dimensions framework and involving learning theory

The development of the framework reveals the relationship between flexibility and fluency within the social learning theory framework. Based on a review by Schönfeld et al. (2019), students' cognitive recognition and adaptation processes can be accommodated through interactions and demonstrations that enable the identification of event patterns. Patterns of event sequences provide information for an individual to act in accordance with what is happening or even improvise on certain ideas (De Felice et al., 2023; Olsson et al., 2020). Thus, the process of transforming information into cognitive reflexes and adding substance to create a certain impression reflects students' fluency and flexibility. Furthermore, the framework also reveals the relationship between originality and elaboration in the context of constructivist theory. An individual's creative thinking ability can be initiated by observing real problems. According to Almulla (2023), creative thinking abilities are influenced by the complexity of the problems faced, with diverse and different solutions for each individual. Thus, the ability to be original in obtaining authentic solutions, as well as the ability to elaborate by combining understood concepts into a solution, shows how constructivist theory can explain this connection (Rodriguez & Towns, 2021).

The four indicators of creative thinking show interrelationships in students' cognitive processes. Creative thinking is the result of an individual's cognitive processing of raw information into reflexes or memories (Stolte et al., 2024). In this context, Krüger and Bodemer (2022) explain that visual media is one of the steps in accommodating the learning theories that have been put forward, particularly in individual cognitive construction. The integration of visuals with cultural values (ethno) facilitates students' interpretation of real events they observe, thereby supporting their cognitive processes (Septyan & Kuswanto, 2025). Thus, theoretical studies on the development of SiVEKa as an animation-based learning medium and on the visualization of cultural values can facilitate students' creative thinking in physics learning.

The results obtained show that SiVEKa media was designed based on students' learning difficulties and adjustments to the society curriculum. In this context, SiVEKa media can improve creative thinking skills because each indicator of these skills is present in the media. Furthermore, SiVEKa media can manipulate various variables in the concepts of moment of inertia and angular momentum. This leads to many different variants and perspectives among students when developing ideas. This differs from Deta et al. (2024) and Deta et al. (2026), which were based solely on concepts and had not been tested at the learning media stage for improving creative thinking skills. The development process of the SiVEKa media took 5 months, indicating that it underwent multiple stages. In the final stage of development, researchers conducted validity tests. The validity test results showed that the SiVEKa media met the criteria for further testing. This refers to current learning needs, so that SiVEKa media can be considered very valid for further use. To conduct further discussion, it is necessary to map the SiVEKa learning media as they develop. The framework used to develop SiVEKa media was adapted from the theoretical framework of Rizki et al. (2025), as shown in Figure 9.

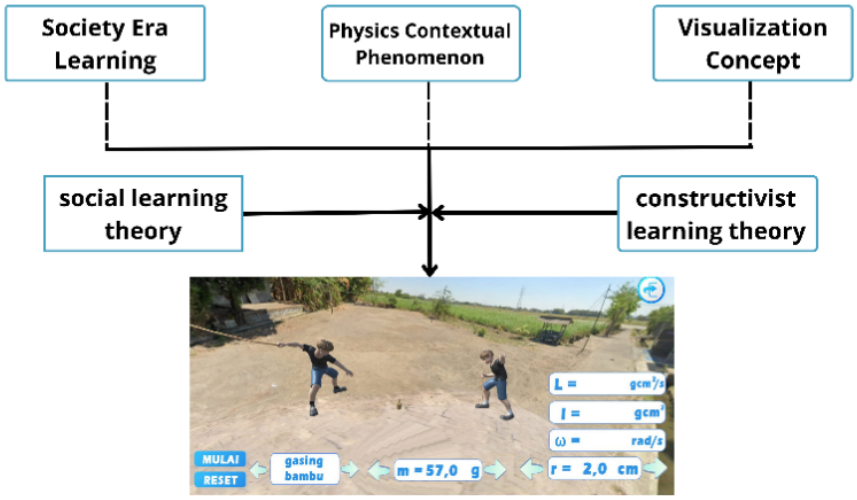


Figure 9. SiVEKA development framework and involving fundamental theory

Figure 9 shows that SiVEKa media is based on the era, societal context, and the visualization of concepts. This is based on the needs and conditions of learning in the 21st century, as well as on surveys conducted by researchers. This foundation is reinforced by a theoretical framework for creative thinking improvement solutions, enabling SiVEKa media to enhance creative thinking skills. SiVEKa provides visualizations that serve as a basis for improving creative thinking skills. In this context, visualization is important for creative thinking skills because it helps students gain multiple perspectives on the physics concept (Badmus & Jilta, 2022). Therefore, SiVEKa is designed to provide visualizations by changing the experiment variables. Therefore, further implementation is needed to support the quality of education. This implementation is necessary to demonstrate that SiVEKa media can improve creative thinking skills through ethnophysics learning. This is because this stage of development is still theoretical and lacks empirical support. This study is expected to have an impact on human resource development, particularly Sustainable Development Goal (SDG) 4. In this context, incentive assistance is needed to improve the quality of SDG 4 through a community-oriented curriculum. In addition, this study is expected to impact cultural preservation through the learning process.

CONCLUSION

Based on this study, it can be concluded that students' creative thinking skills remain relatively low for both males and females. This is evidenced by the Rasch model analysis, which shows a ZSTD value higher than the standardization. These findings indicate the need for a strategy to improve creative thinking skills. Observations show that students need SiVEKa media, so further development is needed. The process of designing SiVEKa media involves several stages, from the real spinning top to its virtual form. In addition, SiVEKa media was developed using creative thinking skills in line with learning theory. The validity results indicate that SiVEKa media is highly valid, so it can be used to further improve creative thinking skills. This study aims to improve the quality of education. In addition, this study also aims to help students preserve their culture through this learning experience. This study is limited to the development stage, up to the point of validity. Additionally, this study has not been tested on a larger scale to support its generalization in education. Further research is recommended to conduct larger-scale tests so that the results can be generalized.

DECLARATION OF GENERATIVE AI

The authors declare that no generative AI or AI-assisted technologies were used in the writing process of this manuscript.

CONFLICTING INTEREST STATEMENT

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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