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Research Notes

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Development of Habits of Mind Instruments in the Context of Basic Physics Practicum: EFA and Rasch Model

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SVILUPPO DI STRUMENTI PER LE ABITUDINI MENTALI NEL CONTESTO DELLA FISICA DI BASE PRACTICUM: MODELLO EFA E RASCH

Abstract

Assessing the habits of mind among prospective teachers is an essential part of learning. Therefore, this research aims to develop the habits of mind instrument in the context of basic physics practicum. It was conducted using the research and development method

which has three stages namely (1) planning the test, (2) implementing the test, and (3) determining the validity and reliability. The sample consisted of 105 biology teacher candidates taking basic physics courses. The habits of mind instrument developed was in the form of a questionnaire consisting of 52 items and is related to basic physics practicum. Furthermore, exploratory factor analysis and the Rasch model approach were used in developing the instrument. Based on expert judgment using Fleiss Kappa, the content validity was 0.700 and was classified in the good category. The developed instrument was considered reliable based on Cronbach's alpha value of 0.970. The exploratory factor analysis reduced the dimensions of the instrument to 11 factors. The analysis of the Rasch model met the element of unidimensionality. There is no bias on the instrument based on gender and place of residence. However, efforts are needed to overcome the lack of creative thinking habits among prospective biology teachers.

Keywords: Basic physics; Habits of mind; Practicum; Reliability; Validity.

1. Introduction

Habits of mind are intelligent ways to solve problems in certain situations (Goldenberg *et al.*, 2015) and contribute to student success in learning (Abedl-rahman, 2017). Students must have the habit of thinking intelligently in learning physics (Docktor & Mestre, 2014). Habits of mind include integrity, perseverance, curiosity for new ideas, imagination, and exemplify everyday human values needed in scientific activities (Volkmann & Eichinger, 1999; Murray, 2016).

Research on habits of mind have been carried out by those with distinctive characteristics including spatial (Kim & Bednarz, 2013), algebraic (Papadopoulos, 2019), mathematics (Goldenberg *et al.*, 2010; Matsuura *et al.*, 2013; Erşen *et al.*, 2018; Mellawaty *et al.*, 2019), and scientific habits of mind (Saleh & Khine, 2009; Çalik & Coll, 2012; Wiyarsi & Çalik, 2019) as well as integrating habits of mind in science laboratory learning (Volkmann & Eichinger, 1999). Furthermore, the theory of habits of mind is related to the performance of students at various levels of education (Abdelatif & Zaki, 2021). It can be taught directly to students as part of competency achievement (Alexander & Vermette, 2019).

Several investigations have been conducted to evaluate socio-scientific problems through scientific habits of mind, development, and validation of SHOM. Çalik and Coll (2012) developed the SHOM scale using the SSI, which consists of 7 dimensions, including 59 items proposed by Gauld. The SHOM factor include covers mistrust of arguments from authority,

open-mindedness, skepticism, rationality, objectivity, suspension of belief, and curiosity. Meanwhile, the confirmatory factor analysis techniques are used to determine the validity and reliability of the instrument. The results showed that the SHOM instrument can be used in research.

Previous research assessed spatial habits of mind in GIS learning (Kim & Bednarz, 2013) using a valid and reliable instrument. It measures thinking habits, including pattern recognition, spatial description, visualization, as well as spatial concept and tool use (Kim & Bednarz, 2013). Wiyarsi and Çalik (2019) also developed an instrument related to scientific habits of mind for socio-scientific issues. The research involved 658 samples aged 18-68 years including 385 females and 273 males. The habits of mind instrument developed includes the dimensions of distrust of arguments from authority, open-mindedness, skepticism, rationality, objectivity, suspension of belief, and curiosity in the SSI context, also, a confirmatory factor analysis technique was used. The SHOM instrument for socio-scientific issues comprises 36 valid and reliable items. It is considered valid based on theoretical construction and can be used in different contexts (Wiyarsi & Çalik, 2019).

Furthermore, Kreijins *et al.* (2019) investigated the development of the habits of mind inquiry instrument with 13 items using a Likert scale. Exploratory and confirmatory factor analyses were also used. The EFA results obtained three factors by the theory namely (1) value deep understanding, (2) reserve judgment and tolerate ambiguity, and (3) taking a range of perspectives and posing increasingly focused questions. The results show that the habits of mind inquiry instrument has good validity and reliability (Kreijns *et al.*, 2019).

Costa and Kallick define habits of mind into 16 dimensions namely, persisting, listening with understanding and empathy, metacognition, questioning and posing problems, thinking and communicating with clarity and precision, creating, imagining, and innovating, taking responsible risks, thinking interdependently, managing impulsivity, thinking flexibly, striving for accuracy, applying past knowledge to new situations, gathering data through all senses, responding with wonder, finding humor, and remaining open to continuous learning (Costa & Kallick, 2008; 2009).

This research on developing habits of mind in the context of basic physics practicum aims to produce a valid and reliable instrument. Based on the literature review, there is a need to develop an instrument to measure the habits of mind of prospective teachers in physics practicum activities. The instrument development referred to the dimensions of Costa and Kallick (2008).

2. Methods

A research and development model method was used, and the final product is a habit of mind (HoM) questionnaire instrument in the context of basic physics practicum. Instrument development referred to 3 stages, namely (1) planning the test, (2) trying out the test, and (3) determining the validity, and reliability (Oriondo & Dallo-Antonio, 1998; Yanto *et al.*, 2019; Aristiawan & Istiyono, 2020; Winarto *et al.*, 2022). The flow diagram of the research and development instrument is shown in *Figure 1*.

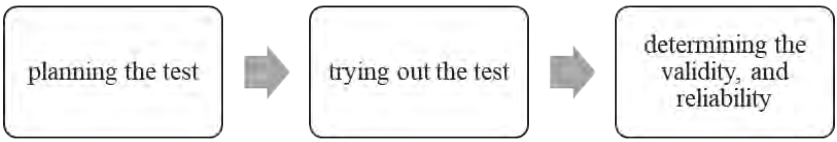

Figure 1. – Flowchart of design research and development instrument.

2.1. *Planning the test*

The test planning stage includes determining the test's purpose and form, preparing the instrument materials, writing test grids and items, as well as making guidelines for filling out the instrument. The purpose of the test is to measure the habits of mind among prospective teachers in the context of basic physics practicum. The HoM instrument used a Likert scale with 4 = strongly agree, 3 = agree, 2 = disagree, and 1 = strongly disagree. The habits of mind instrument consist of 16 dimensions from Costa and Kallick (2008). The instrument developed has 52 items and it was validated by three experts on its language and presentation aspects. Furthermore, the instrument was corrected according to input from the validator, while the results were processed using the Fleiss Kappa equation.

2.2. *Trying out the test*

The research sample consisted of 105 students comprising 20 males and 85 females, aged 19-22 years, 78 domiciled in the village, and 27 in the city. The samples received basic physics lectures along with a practicum. The habits of mind instrument in the form of a questionnaire was distributed to them randomly, then the results were processed and analyzed using explora-

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tory factor analysis. It was found that habits of mind has 11 factors. Meanwhile, item response theory analysis with the Rasch model approach was conducted to determine the validity and reliability of items and responses, unidimensional, scalograms, and items that are difficult to get approval.

2.3. *Determining the validity and reliability*

The construct validity of the habits of mind instrument was measured using Fleiss Kappa. An equation was used to assess the construct validity of the qualitative instrument. Kappa formulates the value of agreement between raters in assessing the instrument's construct validity. The criteria for agreement among raters from Cohen's Kappa ranges from 0.61-0.80 in the good category and 0.81-1.00 in the very good category (Landis & Koch, 1977; Altman, 1990). Moreover, Cronbach's alpha reliability value above 0.60 implies reliable criteria (Cho & Kim, 2015; Setyowati & Chung, 2021).

The Rasch model analysis was performed using Winsteps software, the data were in polytomous form with a rating scale model. The criteria for item response theory referred to the guidelines from Fisher (2007). The criteria for Person and Item Measurement Reliability imply that the 0.67-0.80 criteria are sufficient, while 0.81-0.90 criteria are good. The criteria for Person and Item Strata Separated are as follows; 2-3 sufficient categories, 3-4 good, and 4-5 very good. Unexplained variance accounts for 1-5 of PCA of residuals with a range of 5-10% in the good category, while the variance in data is explained by measures of 50-60% in the sufficient category (Fisher, 2007). Furthermore, the minimum value of the variance in data explained by measures reaching 20% is considered to meet the unidimensionality element (Sumintono & Widhiarso, 2013; Laliyo *et al.*, 2021). Item fit indicators include Outfit Mean square value ($0.5 < MNSQ < 1.5$), Outfit Z-Standard ($-2.0 < ZSTD < +2.0$), Point Measure Correlation ($0.4 < Pt\ Measure\ Corr < 0.85$).

3. Results

3.1. *Planning the test*

The developed instrument aims to collect information related to the habits of mind among prospective teachers in the context of basic physics practi-

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cum. It was developed by adopting the method of Costa and Kallick (2008) which consists of 16 dimensions. The habits of mind instrument grid in the context of basic physics practicum is shown in *Table 1* and *Appendix 1*.

Table 1. – The habits of mind instrument grid in the context of basic physics practicum.

Dimension of habits of mind	Indicator	Item number
Gathering dat through all senses	Collect experimental data involving the senses and motor activities.	1, 2
Questioning and problem posing	Have a questioning attitude; know what data is needed and developed; question strategies to generate the data, and find problems to solve.	3, 4, 5, 6
Thinking about your thinking or learning / metacognition	Be aware of one's own thoughts, strategies, feelings, and actions and their influence on others.	7, 8, 9, 10
Listening with understanding and empathy	Devoting mental energy to appreciating one's thoughts and ideas; restrain one's mind to understand other people's points of view and emotions.	11, 12, 13
Persisting	Persevere in the task to completion; stay focused on practice.	14, 15, 16
Managing impulsivity	Manage impulsivity, think before acting, and remain calm, thoughtful, and consultative.	17, 18, 19, 20
Striving for accuracy and precision	Re-examine every job, accuracy, fidelity, and skill.	21, 22, 23, 24
Thinking and communicating with clarity and precision	Strive to communicate both in written and oral form; avoid overgeneralization, distortion, and deletion.	25, 26, 27, 28
Thinking flexible	Viewing other people's solutions as a point of view; able to change perspectives, generate alternatives.	29, 30, 31
Creating, imagining, and innovating	Creating, imagining, and innovating: try a different way, generate new and new ideas, striving for fluency and originality.	32, 33, 34, 35
Finding humor	Chuckling, finding the odd, inappropriate, and unexpected; can laugh at yourself.	36, 37
Responding with wonderment and awe	Have fun finding out; discover an extraordinary and mysterious world and be curious about phenomena and beauty.	38, 39
Applying past knowledge to novel situations	Applying past knowledge to new situations; accessing prior knowledge; transferring knowledge beyond the situation in which it was learned.	40, 41, 42, 43

Dimension of habits of mind	Indicator	Item number
Taking responsible risk	Exit venture; be adventurous; live on the edge of one's competence.	44, 45, 46
Thinking interdependently	Cooperate; can work with and learn from others in reciprocal situations.	47, 48
Remaining open to continuous learning	Learn from experience; have humility and pride when admitting that we don't know; refuse satisfaction.	49, 50, 51, 52

3.2. *Test result of try-out test*

3.2.1. Content validity

The content validity of the instrument was assessed by 3 experts, approval between them was based on the Fleiss Kappa score and the results are shown in *Table 2*.

Table 2. – Content validity.

Aspect	Overall agreement
Kappa	0.700
Standard Error	0.204
Sig.	0.001
Asymptotic 95% confidence interval lower bound	0.687
Asymptotic 95% confidence interval upper bound	0.713

The Kappa value indicates agreement between raters, the result showed a value of 0.700 which can be classified in the good category. Fleiss Kappa coefficient value 0.61-0.80 is considered to be in the good category (Landis & Koch, 1977; Altman, 1990). Based on the result, the habits of mind instrument have good construct validity. After three experts assessed the instrument, the items were corrected based on individual input, then a trial was conducted to determine the empirical validity. The habits of mind questionnaire instrument was tested on 105 prospective teachers.

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3.2.2. Instrument reliability

Cronbach's alpha value showed a strong internal item consistency correlation with a value of 0.970. This value indicates that the habits of mind questionnaire instrument is reliable. The cut-off value of the Cronbach alpha > 0.7 is considered reliable (Cho & Kim, 2015; Setyowati & Chung, 2021) (*Tab. 3*).

Table 3. – Instrument reliability.

Cronbach's alpha	No of items
0.970	52

3.2.3. Exploratory factor analysis

The habits of mind instrument development was carried out using exploratory factor analysis to determine the number of influencing factors. The results are presented in *Table 4*.

Table 4. – The result of KMO and Bartlett's tests.

Kaiser-meyer-olkin measure of sampling adequacy		0.877
Bartlett's test of sphericity	Approx. Chi-Square	4114.734
	df	1326
	Sig.	0.000

The KMO value is acceptable when it is more than 0.6 (Kaiser, 1960; Siddiquei & Kathpal, 2021). *Table 3* shows that the KMO value of 0.877 > 0.6, while the significance value of Bartlett's test of sphericity was 0.000. It shows a strong relationship between the test item data sets and indicates that the factor analysis can be continued (Aburezeq & Kasik, 2021; Alabdulkarim, 2022).

Communalities

Table 5. – Communalities extraction.

Item	Extraction	Item	Extraction	Item	Extraction	Item	Extraction
Item 1	0.697	Item 14	0.749	Item 27	0.755	Item 40	0.711
Item 2	0.615	Item 15	0.767	Item 28	0.732	Item 41	0.725

Item	Extraction	Item	Extraction	Item	Extraction	Item	Extraction
Item 3	0.801	Item 16	0.793	Item 29	0.709	Item 42	0.686
Item 4	0.628	Item 17	0.698	Item 30	0.637	Item 43	0.783
Item 5	0.699	Item 18	0.532	Item 31	0.702	Item 44	0.772
Item 6	0.725	Item 19	0.558	Item 32	0.663	Item 45	0.786
Item 7	0.813	Item 20	0.719	Item 33	0.753	Item 46	0.807
Item 8	0.730	Item 21	0.770	Item 34	0.769	Item 47	0.698
Item 9	0.774	Item 22	0.657	Item 35	0.765	Item 48	0.730
Item 10	0.706	Item 23	0.703	Item 36	0.705	Item 49	0.775
Item 11	0.784	Item 24	0.696	Item 37	0.684	Item 50	0.707
Item 12	0.729	Item 25	0.691	Item 38	0.702	Item 51	0.680
Item 13	0.716	Item 26	0.630	Item 39	0.685	Item 52	0.707

Table 5 shows the value of the item indicator and its ability to explain the factor or not. When the extraction value is greater than 0.05, then the item can explain the factor (Sarah *et al.*, 2019). For samples ranging from 100 to 200, the communalities value must be above 0.5 (Mooi *et al.*, 2018). Values close to 1 indicate that the extracted factors explain most individual item variances (Schreiber, 2020). *Table 4* shows that the communalities extraction value is more than 0.05, which implies that the item can explain the factor.

Eigenvalue and screen plot

Table 6. – Eigenvalues for habits of mind test.

Component	Initial eigenvalues		
	Total	% of variance	Comulative %
1	21.651	41.637	41.637
2	2.855	5.491	47.128
3	2.146	4.128	51.255
4	1.866	3.588	54.843
5	1.464	2.815	57.658
6	1.368	2.631	60.289
7	1.364	2.622	62.912

Component	Initial eigenvalues		
	Total	% of variance	Comulative %
8	1.234	2.373	65.285
9	1.144	2.200	67.485
10	1.107	2.128	69.613
11	1.011	1.944	71.557

The total variance explanation had 11 components and their eigenvalues ranged from 21.651 to 1.001, with a maximum variance percentage value of 41.637%. The eigenvalue of component 1 was 21.651, indicating that the proportion of the first factor which explains the data variation was 41.637%. The screen plot results presented in *Figure 2* show the number of factors formed from the habits of mind instrument namely 11.

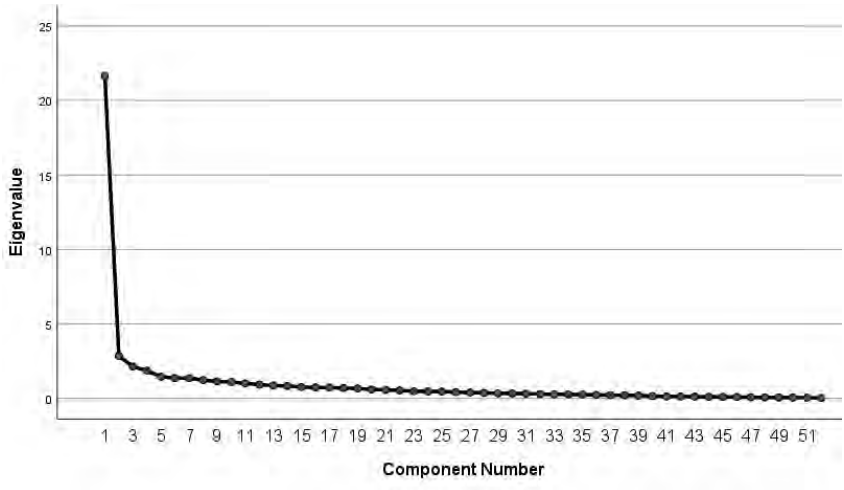

Figure 2. – Screen plot.

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Rotated matrix factor

Table 7. – Rotated matrix factor.

Item	Component										
	1	2	3	4	5	6	7	8	9	10	11
Item 23	0.704										
Item 24	0.682										
Item 28	0.659										
Item 19	0.594										
Item 27	0.594										
Item 16	0.569										
Item 4	0.535										
Item 17	0.523										
Item 30	0.489										
Item 18	0.482										
Item 26	0.462										
Item 33		0.758									
Item 29		0.710									
Item 32		0.679									
Item 6		0.660									
Item 22		0.531									
Item 25		0.522									
Item 7		0.519									
Item 34		0.513									
Item 20		0.490									
Item 14		0.489									
Item 42		0.439									
Item 1			0.764								
Item 2			0.566								
Item 44			0.561								

Item	Component										
	1	2	3	4	5	6	7	8	9	10	11
Item 50			0.464								
Item 46				0.698							
Item 41				0.637							
Item 21				0.563							
Item 38				0.495							
Item 15				0.440							
Item 40				0.389							
Item 3					0.769						
Item 13					0.574						
Item 31					0.505						
Item 48					0.484						
Item 52					0.417						
Item 45						0.665					
Item 47						0.658					
Item 36						0.645					
Item 49						0.565					
Item 43						0.417					
Item 39						0.396					
Item 12							0.760				
Item 11							0.521				
Item 35								0.739			
Item 9									0.836		
Item 8									0.451		
Item 10										0.587	
Item 36										0.545	
Item 51											0.588
Item 5											0.407

The loading factor value for each item is eligible as their values were above 0.300. The habits of mind component are formed from the respondents' answers to about 11 factors. Meanwhile, the instrument based on Costa and Kallick's theory consist of 16 factors, hence, there was a reduction from 16 factors to 11 factors.

3.2.4. Item response theory

Person and item reliability

The person reliability value was 0.91, equivalent to the Pearson separation index value of 3.27. Pearson's reliability value is categorized as very good (Fisher, 2007). The value of the item separation index was 3.27, which is in a good category, this shows that the consistency of student responses to the habits of mind test was very good. The Cronbach alpha coefficient (KR-20) value of 0.97 indicates a good interaction between students and the habits of mind questionnaire. This shows a strong correlation between student responses and items, where student knowledge tends not to be fragmented and can be measured (Adams & Wieman, 2011). The instrument is reliable in distinguishing the habits of mind of prospective teachers (*Tab. 8*).

Table 8. – Reliability of person and item.

	Person (105)	Item (52)
Reliability	0.91	0.88
Separation	3.27	2.68
Measure (SD)	2.47 (1.85)	0.00 (.56)
INFIT MNSQ	1.02	0.99
INFIT ZSTD	-.2	-.2
OUTFIT MNSQ	1.04	1.04
OUTFOT ZSTD	-.2	0.0
KR (20) = 0.97		

The value of the item separation index was 2.68 which is in the sufficient category with a reliability value of 0.88 (good). This shows that the item has good consistency. Furthermore, the items can qualify for unidimensionality and define well-measured variables. Person measure value +2.47 logit shows the average value of respondents in the habits of mind instrument. The average logit value of more than 0.0 indicates the tendency of respondents to agree with statements on various items (Sumintono &

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Widhiarso, 2013). The value of the Pearson separation index was 3.27 logit with a good category, and the item separation index value was 2.68 with a sufficient category (Fisher, 2007). These two values indicate that the habits of mind questionnaire test distribution is quite good for students and items. This criterion shows that the instrument is arranged accordingly and can be relied upon to measure the habits of students' minds.

3.2.5. *Unidimensionality*

Figure 3 which shows unidimensionality indicates the extent to which the diversity of the instrument measures what it is designed to measure (Sumintono & Widhiarso, 2013). The value of raw variance explained by measures was 40.5%, indicating that the unidimensionality requirement is quite good. The minimum value that must be met for this requirement is 20%. Raw unexplained variance value namely variance that cannot be explained by the instrument was below 10%, meaning that the instrument can effectively measure the habits of mind (Fisher, 2007).

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

	Eigenvalue	Observed		Expected
Total raw variance in observations =	87.3238	100.0%		100.0%
Raw variance explained by measures =	35.3238	40.5%		40.6%
Raw variance explained by persons =	20.3334	23.3%		23.4%
Raw Variance explained by items =	14.9904	17.2%		17.2%
Raw unexplained variance (total) =	52.0000	59.5%	100.0%	59.4%
Unexplned variance in 1st contrast =	4.2199	4.8%	8.1%	
Unexplned variance in 2nd contrast =	3.4108	3.9%	6.6%	
Unexplned variance in 3rd contrast =	2.8012	3.2%	5.4%	
Unexplned variance in 4th contrast =	2.5808	3.0%	5.0%	
Unexplned variance in 5th contrast =	2.3038	2.6%	4.4%	

Figure 3. – Unidimensionality.

Rating scale test

The rating scale test aims to determine whether the HoM questionnaire scale assessment criteria or ranking can be used or not. The habits of mind instrument was given 4 answer choices in the form of a Likert rating for each item.

Figure 4 shows that the Observed Average starts from logit -1.00, for rank 1 (strongly disagree) to logit +0.44 for rank 2 (disagree), logit +1.70 for rank 3 (agree), and logit +2.97 for rank 4 (strongly agree). This shows a consistent transition of the rating scale category (Linacre, 2020). Furthermore, the Andrich Threshold value table shows whether the polytomy has been used correctly or not. It shows that the options given are valid for respondents and sequentially (Sumintono & Widhiarso, 2013).

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SUMMARY OF CATEGORY STRUCTURE. Model="R"

CATEGORY LABEL	SCORE	OBSERVED COUNT	%	OBSVD AVRGE	SAMPLE EXPECT	INFIT MNSQ	OUTFIT MNSQ	ANDRICH THRESHOLD	CATEGORY MEASURE	
1	1	104	2	-1.00	-1.50	1.43	1.74	NONE	(-2.98)	1
2	2	374	7	.44	.58	.99	1.00	-1.68	-1.20	2
3	3	2403	44	1.70	1.73	.91	1.01	-.65	.91	3
4	4	2579	47	2.97	2.94	.98	.97	2.34	(3.47)	4

OBSERVED AVERAGE is mean of measures in category. It is not a parameter estimate.

Figure 4. – Rating scale test.

Item 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%	Item
32	313	105	1.27	.17	1.34	2.07	1.40	2.25	.56	.64	53.5	61.6	Q32
33	321	105	1.05	.17	.88	-.75	.91	-.48	.62	.63	69.7	62.6	Q33
29	323	105	.99	.17	.73	-1.85	.77	-1.48	.67	.62	75.8	62.7	Q29
18	327	105	.87	.17	1.15	.97	1.08	.53	.56	.62	63.6	63.4	Q18
37	327	105	.87	.17	1.90	4.66	1.93	4.48	.46	.62	45.5	63.4	Q37
7	329	105	.82	.17	.99	.01	1.01	.13	.62	.61	58.6	63.5	Q7
6	334	105	.66	.18	1.13	.85	1.12	.72	.55	.60	57.6	63.7	Q6
25	335	105	.63	.18	1.02	.17	1.00	.06	.60	.60	57.6	63.7	Q25
36	336	105	.60	.18	1.49	2.81	1.50	2.63	.48	.60	54.5	63.8	Q36
45	336	105	.60	.18	1.07	.52	1.05	.33	.59	.60	61.6	63.8	Q45
42	338	105	.54	.18	.74	-1.83	.74	-1.63	.66	.60	71.7	63.9	Q42
12	339	105	.51	.18	1.85	4.53	2.08	4.87	.45	.59	56.6	63.9	Q12
21	341	105	.44	.18	.85	-.99	.84	-.93	.61	.59	68.7	63.8	Q21
46	342	105	.41	.18	.64	-2.70	.62	-2.48	.67	.59	77.8	63.9	Q46
41	343	105	.38	.18	.64	-2.68	.64	-2.32	.66	.59	76.8	63.9	Q41
30	344	105	.35	.18	.80	-1.40	.75	-1.53	.61	.58	76.8	63.8	Q30
10	345	105	.31	.18	1.26	1.64	1.32	1.69	.49	.58	56.6	63.8	Q10
8	346	105	.28	.18	1.02	.20	1.00	.05	.56	.58	56.6	63.7	Q8
47	347	105	.25	.18	1.25	1.60	1.22	1.20	.51	.58	57.6	63.6	Q47
14	348	105	.21	.18	.82	-1.21	.80	-1.12	.63	.58	75.8	63.8	Q14
22	352	105	.08	.19	.73	-1.95	.69	-1.88	.64	.57	68.7	63.6	Q22
35	352	105	.08	.19	1.35	2.20	1.33	1.71	.46	.57	53.5	63.6	Q35
38	353	105	.05	.19	.83	-1.17	.80	-1.09	.62	.56	70.7	63.5	Q38
43	353	105	.05	.19	.81	-1.30	.76	-1.35	.63	.56	72.7	63.5	Q43
28	354	105	.01	.19	.71	-2.16	.71	-1.70	.65	.56	75.8	63.7	Q28
34	356	105	-.06	.19	1.07	.50	1.06	.37	.55	.56	59.6	63.8	Q34
40	356	105	-.06	.19	.57	-3.51	.55	-2.84	.67	.56	77.8	63.8	Q40
3	357	105	-.09	.19	1.14	.96	1.38	1.84	.51	.55	58.6	63.8	Q3
4	357	105	-.09	.19	.78	-1.58	.81	-1.03	.59	.55	64.6	63.8	Q4
23	358	105	-.13	.19	.97	-.15	.89	-.54	.58	.55	71.7	63.8	Q23
50	359	105	-.17	.19	1.00	.02	.96	-.17	.57	.55	66.7	63.7	Q50
51	359	105	-.17	.19	1.03	.28	.94	-.23	.54	.55	65.7	63.7	Q51
15	363	105	-.31	.19	.58	-3.50	.55	-2.65	.66	.54	72.7	64.3	Q15
31	364	105	-.35	.19	1.01	.14	.95	-.18	.53	.53	64.6	64.4	Q31
48	364	105	-.35	.19	1.08	.62	1.19	.95	.52	.53	62.6	64.4	Q48
26	365	105	-.39	.19	.91	-.62	.85	-.70	.56	.53	66.7	64.6	Q26
27	365	105	-.39	.19	.94	-.36	.85	-.68	.56	.53	69.7	64.6	Q27
44	365	105	-.39	.19	.87	-.96	.81	-.90	.60	.53	76.8	64.6	Q44
19	366	105	-.42	.19	1.06	.50	1.20	.95	.48	.53	63.6	64.6	Q19
49	368	105	-.50	.20	.75	-1.92	.77	-1.09	.58	.52	74.7	65.2	Q49
1	369	105	-.54	.20	1.91	5.20	3.38	6.95	.38	.52	64.6	65.4	Q1
5	369	105	-.54	.20	.87	-.89	.86	-.60	.55	.52	72.7	65.4	Q5
39	370	105	-.58	.20	.82	-1.31	.78	-1.01	.60	.52	71.7	65.7	Q39
2	371	105	-.62	.20	.87	-.89	.93	-.25	.53	.51	72.7	66.1	Q2
17	372	105	-.66	.20	.83	-1.24	.79	-.90	.57	.51	69.7	66.3	Q17
28	372	105	-.66	.20	.93	-.49	.88	-.47	.55	.51	69.7	66.3	Q28
52	372	105	-.66	.20	.99	-.05	.95	-.15	.53	.51	65.7	66.3	Q52
9	373	105	-.70	.20	1.23	1.59	2.37	4.39	.35	.51	58.6	66.7	Q9
24	374	105	-.74	.20	.72	-2.16	.67	-1.51	.59	.50	75.8	67.0	Q24
16	376	105	-.82	.21	.81	-1.41	.70	-1.30	.57	.50	77.8	67.8	Q16
13	378	105	-.91	.21	.89	-.77	.95	-.11	.52	.49	66.7	68.5	Q13
11	381	105	-1.04	.21	.89	-.78	.89	-.33	.53	.48	71.7	69.8	Q11
MEAN	353.4	105.0	.00	.19	.99	-.2	1.04	.0			66.7	64.5	
P.SD	16.4	.0	.56	.01	.30	1.9	.48	1.9			7.8	1.5	

Figure 5. – Item measure.

Item measure

Item measure shows the difficulty level of the statement item, and the difficulty of the items is ordered from the most difficult to the easiest. Item number 32 proved to be the most difficult to agree on indicating a problem in relation to the habits of mind instrument. Meanwhile, item 11 was the item most easily approved by the participants. This shows that the habits of mind following the statement of item 11 have appeared in physics practicum. Item fit indicators include Outfit Mean square value (0.5 < MNSQ < 1.5), Outfit Z-Standard (-2.0 < ZSTD < +2.0), and Point Measure Correlation (0.4 < Pt Measure Corr < 0.85) (*Fig. 5*).

Wright map

The Wright map shows the item's difficulty level regarding the questionnaire instrument. Items which are difficult to agree on indicate that there is a problem to be solved based on the information. Meanwhile, items easily approved describe the habits of mind that have been embedded in the respondents. The results of the item and person mapping are shown in *Figure 6*.

As shown in *Figure 6*, the statements considered difficult for the respondents included items 32, 29, and 33. Meanwhile, the items that were easily agreed upon were 11, and 13. The statement for item 32 is «I have a different way of solving physics problems», item 33 «I express ideas in physics learning activities», and item 29 «I am able to change my perspective on physics problems». There is a tendency for respondents to find it difficult to agree with item 32 which shows an indicator of creativity. Therefore, there is a need to develop methods for growing activity skills in solving physics problems. The habit of thinking creatively needs to be designed in physics learning. Item 11 which stated that «I respect other people's opinions even though they have different views» is the easiest for respondents to agree with. This shows that the respondents empathy attitude have emerged in learning. The habit of respecting others is part of the habit of thinking intelligently.

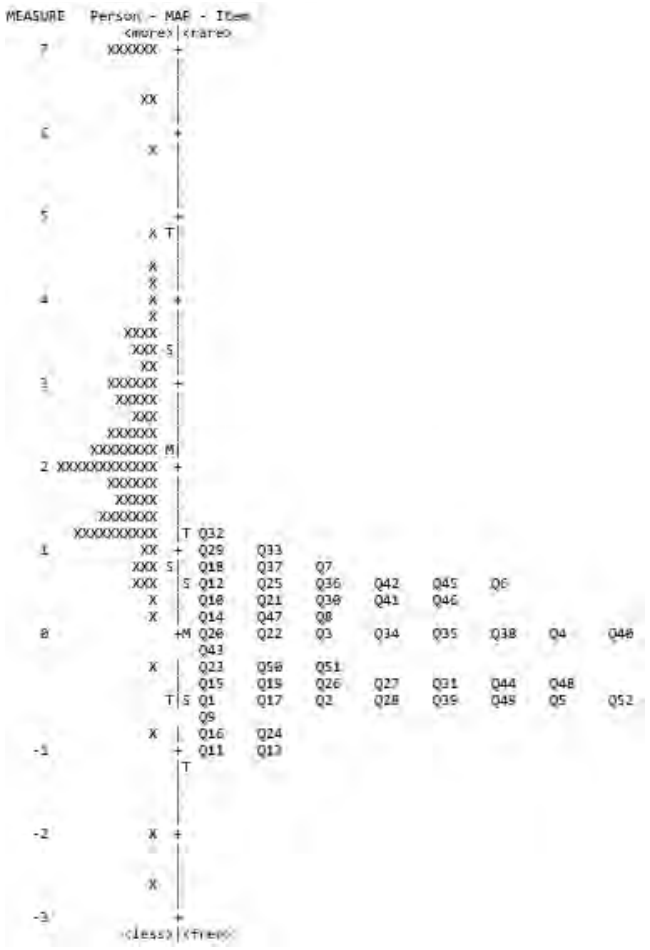

Figure 6. – Wright map.

Differential item functioning

Differential Item Functioning test was performed to determine item bias from the aspect of gender and student residence (City/Village). Prob values less than 5% (0.05) indicate a biased item based on gender and location of residence in the city/rural area. Based on the results, no prob value was below 0.05, this indicates that there were no biased items regarding gender and location. The results of the Winstep DIF output are shown in *Figure 7*.

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DIF class/group specification is: DIF=$S4W2

Person CLASSES	SUMMARY DIF CHI-SQUARED	D.F.	PROB.	BETWEEN-CLASS/GROUP UNWTD MNSQ	ZSTD	Item Number	Name
4	3.1461	3	.3684	1.3811	.69	1	Q1
4	1.5788	3	.6637	.7918	.00	2	Q2
4	1.7441	3	.6263	.7839	-.01	3	Q3
4	3.0634	3	.3807	1.1426	.44	4	Q4
4	.9631	3	.8100	.5915	-.32	5	Q5
4	.1991	3	.9779	.0802	-1.82	6	Q6
4	2.6897	3	.4408	1.7857	1.06	7	Q7
4	4.4853	3	.2125	1.7651	1.04	8	Q8
4	5.0092	3	.1702	2.4022	1.52	9	Q9
4	3.4236	3	.3296	1.2127	.52	10	Q10
4	3.7692	3	.2863	2.4944	1.58	11	Q11
4	1.3108	3	.7261	1.1003	.39	12	Q12
4	1.3156	3	.7249	.4914	-.58	13	Q13
4	1.4091	3	.7028	.4985	-.49	14	Q14
4	.2069	3	.9767	.0713	-1.88	15	Q15
4	1.2615	3	.7378	.4707	-.54	16	Q16
4	2.1075	3	.5494	1.3227	.63	17	Q17
4	3.1625	3	.3660	1.1145	.41	18	Q18
4	7.7456	3	.0512	3.4649	2.16	19	Q19
4	1.1871	3	.7557	.4879	-.68	20	Q20
4	2.2598	3	.5192	.8147	.03	21	Q21
4	2.6442	3	.4486	.9376	.19	22	Q22
4	4.7983	3	.1862	1.8215	1.09	23	Q23
4	.9179	3	.8210	.5394	-.41	24	Q24
4	3.9160	3	.2695	1.4121	.72	25	Q25
4	2.1189	3	.5471	1.0847	.37	26	Q26
4	3.6117	3	.3054	1.6341	.93	27	Q27
4	2.5798	3	.4599	.9488	.21	28	Q28
4	.2436	3	.9705	.0825	-1.80	29	Q29
4	3.2549	3	.3527	1.1812	.48	30	Q30
4	2.3354	3	.5047	1.1288	.42	31	Q31
4	2.5641	3	.4626	.9724	.24	32	Q32
4	.4926	3	.9207	.1691	-1.37	33	Q33
4	5.7872	3	.1217	2.2774	1.43	34	Q34
4	1.4121	3	.7021	.5024	-.48	35	Q35
4	5.1411	3	.1608	1.8771	1.13	36	Q36
4	1.4736	3	.6879	.6013	-.30	37	Q37
4	1.1448	3	.7661	.5187	-.45	38	Q38
4	3.7681	3	.2864	1.5742	.87	39	Q39
4	3.1792	3	.3636	1.1944	.50	40	Q40
4	.3825	3	.9441	.1489	-1.45	41	Q41
4	.3263	3	.9552	.1437	-1.48	42	Q42
4	1.9494	3	.5828	.6854	-.16	43	Q43
4	.1945	3	.9786	.0688	-1.90	44	Q44
4	.6943	3	.8746	.2526	-1.08	45	Q45
4	2.4165	3	.4894	.8803	.12	46	Q46
4	1.5421	3	.6719	.5394	-.41	47	Q47
4	1.1179	3	.7724	.3891	-.72	48	Q48
4	.6374	3	.8879	.2266	-1.16	49	Q49
4	5.9105	3	.1153	2.1239	1.32	50	Q50
4	1.6128	3	.6559	.5638	-.37	51	Q51
4	1.6177	3	.6546	.8055	.02	52	Q52

Figure 7. – Output differential item functioning.

4. Discussion

The habits of mind instrument in the context of basic physics practice fulfills the elements of validity and reliability. The construct validity includes aspects of language, content, and appearance. Based on the results of expert approval analyzed by Fleiss Kappa, an inter-rater agreement was obtained at 0.700. This indicates that the instrument meets the elements of good construct validity (Landis & Koch, 1977; Altman, 1990). Moreover, the habits of mind instrument fulfill the element of reliability with a Cronbach's alpha value of 0.970. An instrument is considered reliable when it has a reliability value above 0.6 (Cho & Kim, 2015; Setyowati & Chung, 2021). The instrument was developed based on the dimensions of the habits of mind by Costa and Kallick (2008) comprising a total of 16. After exploratory factor analysis, 11 dimensions were obtained. In other words, the habits of mind dimensions were reduced from 16 to 11 factors.

Based on the item difficulty level analysis, some items are difficult and easy to agree with. Items 32, 33, and 29 are statements difficult for the respondents to agree with. Meanwhile, items 11, and 13 are statements that are easily approved by respondents. Item 32 states that «I have different ways of solving physics problems». This item shows the respondent's problem related to creativity in solving physics problems. Item 32 states that «I am able to change my perspective on physics problems» while Item 33 is as follows «I express ideas in physics learning activities». Based on the results, Item 33 was difficult for students to agree with indicating that the creative thinking aspect of students still needs to be improved. Similarly, item 29 was difficult for respondents to agree with meaning that students are less flexible in solving problems related to physics. Item 11 was easily approved by the respondents, it states that «I respect other people's opinions even though they have different views». This shows that the habit of respecting others has grown in the respondents. Item 13 states that «I pay attention to other people when speaking» this shows that the nature of empathy in students has developed.

The habits of mind instrument developed did not contain bias on gender and origin of residence (City/Village) as demonstrated by the DIF prob values which were above 0.0500. This shows that the developed instrument can measure the habits of mind among prospective teachers without differentiating gender and place of residence. This shows that habits of mind are not influenced by gender and place of residence. This study is consistent with previous research, which states that habits of mind are not influenced by gender (Çalik & Karatas, 2019).

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Nevertheless, habits of mind need to be developed, especially in the aspect of creative thinking. Lecturers have a central role in developing the habits of mind among prospective teachers. They need to apply practical learning methods that can develop creative thinking skills. This is because creative thinking is needed by prospective teachers to face future problems (Ismail *et al.*, 2019). Besides, creative thinking is a 21st-century skill that must be possessed by students (Koray & Köksal, 2009; Ku & Kuo, 2016; Nasir, 2018; Wahyudi *et al.*, 2019) and it can be developed through practice (Capraro *et al.*, 2013; Malik & Ubaidillah, 2020).

5. Conclusion

The results showed that the habits of mind instrument in the context of basic physics practicum was valid and reliable. The content validity according to the agreement of the experts was 0.700. The instrument is also considered reliable based on the reliability value of Cronbach's alpha of 0.970. Furthermore, it consists of 52 items and did not contain elements of bias regarding gender and the place of residence. Based on the results, lecturers need to apply appropriate learning methods to increase student creativity in practical learning.

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APPENDIX 1

Instrument of habits of minds in the context of basics physics practicum

Item	Statement	Response			
		4	3	2	1
1	I measure physical quantities by involving the sense of sight				
2	I involve motor activities (touching the practicum tools) when doing physics experiments				
3	I ask other people things that I don't understand when I get data from physics experiments				
4	I question the strategies used in obtaining experimental physics data				
5	I use available data/information to solve physics problems				
6	I found a strategy to solve physics problems				
7	I used to think deeply when solving physics problems				
8	I apply thought-provoking actions to the situation I find myself in				
9	I take action considering the effect it has on other people.				

Item	Statement	Response			
		4	3	2	1
10	I prioritize thoughts over feelings when solving physics problems				
11	I respect other people's opinions even though they have different views				
12	I hold myself back when a peer interrupts the conversation in a discussion				
13	I pay attention to other people when I speak				
14	I try to solve physics problems diligently				
15	I stay focused when taking physics lessons				
16	I obey the rules in physics class				
17	I think before taking action.				
18	I stay calm when facing physics-related questions				
19	I consult with other people when I have difficulty solving physics problems				
20	I respond wisely to every problem I face				
21	I apply high standards (careful, thorough) in solving physics problems				
22	I try to apply the right strategy in solving physics problems				
23	I check back every completed work				
24	I try to improve myself continuously				
25	I communicate ideas orally in physics learning clearly				
26	I communicate the experimental results by making a practicum report				
27	I conclude natural phenomena based on data and facts.				
28	I cite valid references in support of the findings in the experiment				
29	I am able to change my perspective on physics problems				
30	I am able to weigh the choices from several of the best options				
31	I appreciate it if there is a different way with me in solving physics problems				
32	I have a different way of solving physics problems				
33	I express ideas in physics learning activities				
34	I create a pleasant atmosphere when doing physics experiments				
35	I involve my imagination in solving abstract physics problems				

Item	Statement	Response			
		4	3	2	1
36	I try to create humor when I get stuck in learning				
37	I chuckle (laugh at myself) for what I did wrong				
38	I have curiosity when given physics problems				
39	I feel amazed by natural phenomena that can be solved through physics				
40	I use the knowledge I already have to help understand new material				
41	I apply my knowledge of physics to solve everyday problems				
42	I can relate knowledge of physics with other related sciences				
43	I always check (review) my work and improve it				
44	I am responsible for every action I take				
45	I am challenged by new things I know				
46	I try to improve my competence in the midst of competition				
47	I work with others to achieve goals				
48	I can learn from the experiences of others				
49	I enjoy every process of learning physics by constantly improving myself				
50	I try to reflect on my achievements				
51	I don't feel satisfied with what I get				
52	I am aware of my abilities				

Note: 4 = strongly agree, 3 = agree, 2 = disagree, and 1 = strongly disagree.

Riassunto

Valutare le abitudini mentali tra i futuri insegnanti è una parte essenziale dell'apprendimento. Pertanto, questa ricerca mira a sviluppare le abitudini dello strumento mentale nel contesto del praticantato di fisica di base. È stato condotto utilizzando il metodo di ricerca e sviluppo che prevede tre fasi: (1) pianificazione del test, (2) attuazione del test e (3) determinazione della validità e affidabilità. Il campione era composto da 105 candidati insegnanti di biologia che seguivano corsi di fisica di base. Lo strumento delle abitudini della mente sviluppato era sotto forma di un questionario composto da 52 item ed è relativo alla pratica di fisica di base. Inoltre, nello sviluppo dello strumento sono stati utilizzati l'analisi fattoriale esplorativa e l'approccio del modello Rasch. Sulla base del giudizio di esperti utilizzando Fleiss Kappa, la validità del contenuto era 0,700 ed è

stata classificata nella categoria buona. Lo strumento sviluppato è stato considerato affidabile sulla base del valore alpha di Cronbach di 0,970. L'analisi fattoriale esplorativa ha ridotto le dimensioni dello strumento a 11 fattori. L'analisi del modello di Rasch ha incontrato l'elemento di unidimensionalità. Non vi è alcun pregiudizio sullo strumento in base al sesso e al luogo di residenza. Tuttavia, sono necessari sforzi per superare la mancanza di abitudini di pensiero creativo tra i futuri insegnanti di biologia.

Parole chiave: Abitudini mentali; Affidabilità; Fisica di base; Pratica; Validità.

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