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Development of Computational Thinking Skill Instruments on Prospective Physics Teachers

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Abstract. Computing thinking is a specialized skill related to computer science. However, nowadays almost everyone is expected to have basic computing skills that are in line with current technological developments. This research aims to develop an instrument for computational thinking skills in physics education at a university level. The Computational Thinking Instrument was designed to include items related to decomposition, pattern recognition, abstraction, and algorithms. The development of the instrument resulted in 14 valid items. The sample for this study consisted of 104 students majoring in physics education at the Department of Physics Education, UIN Walisongo Semarang, Indonesia. The instrument used in this research employed a modified Likert scale. The validity of the instrument was assessed using content validity and construct validity. Content validity was measured using Aiken's index, while construct validity was assessed using Exploratory Factor Analysis (EFA). The reliability estimation using the Cronbach Alpha formula yielded a value of 0.94, indicating that the assessment instrument for students' computational thinking skills in physics education is reliable. The results of the rotated component matrix revealed that the 14 developed items could be divided into only 2 factor.

Keywords: Instruments; computational thinking skills; physics

INTRODUCTION

Computing thinking is a specialized skill related to computer science. However, nowadays almost everyone is expected to have basic computing skills that are in line with current technological developments (Abtokhi et al., 2021; Berry & Fagerjord, 2017; Felix et al., 2020; Haseski et al., 2018; Ilic et al., 2018; Kusaka, 2021; Lachney, 2017; Pöllänen & Pöllänen, 2019). Among these skills, computational thinking is believed to be an important skill to enable future generations (Eguchi, 2016; HUANG & SHIH, 2020; Karakasis & Xinogalos, 2020; Threekunprapa & Yasri, 2020; Winter & Sherwin, 2020; Yadav et al., 2016) but how to apply these skills requires further investigation.

Computational thinking defines as an approach to problem-solving, systems design, and understanding of human behavior based on computer-based concepts (Aksit, 2020; Bers, 2018; Fessakis & Prantsoudi, 2019; Hutchins, 2020; Lachney, 2017; Snow et al., 2019), considers CT as a skill that requires the use of computational systems to solve problems in all fields of study (Garneli & Chorianopoulos, 2018; Kwon et al., 2021; Rehmat et al., 2020). Thus, research has mostly focused on the ability to think computational thinking.

Developing computational thinking skills makes coding more interesting (Gero & Levin, 2019; Tran, 2019). In particular, studies on computational thinking have presented different ideas about the definition and development of CT skills (Ertugrul-Akyol, 2019; Tsai et al., 2021; Yin et al., 2020), These differences revealed in the understanding of computational thinking have also been reflected. in interventions for measurement and related skills development. It also prevents an understanding of how computational thinking is developed (Aksit & Wiebe, 2020; Garneli & Chorianopoulos, 2018; Kwon et al., 2021; Ma et al., 2021), and even different strategic approaches to the development of computational thinking. used. There is diversity among countries, regions, schools

Computational Thinking Skills development needs to be developed by designing instruments used to test consists of decomposition. pattern recognition, abstraction, and algorithms (B. Gopinath, R. Santhi, 2020; Yue Yin &d Roxana Hadad & Xiaodan Tang & Qiao Lin ; 2019). Instrument development has been designed by producing 19 items that are valid in computer learning from 5 aspects of Computational Thinking Skills (Tsai et al., 2021). In this research the development and modification of the instrument developed by (Tsai et al., 2021) and used in physics education students.

METHODS

The type of research used for research and Development, with use ADDIE approach R and D method will produce a certain product that can be used to produce products and test the effectiveness of a product. The population in this study were students of the physics education study program in UIN Walisongo. The sample of this research is students, totaling 104 students. The sampling technique, the researcher chooses the sample because it is willing to be studied.

Something instrument said well if it meets the validity requirements and reliability. Something instruments said to be valid if it can measure what it should be measured and reliability means if it has the consistent measurement results

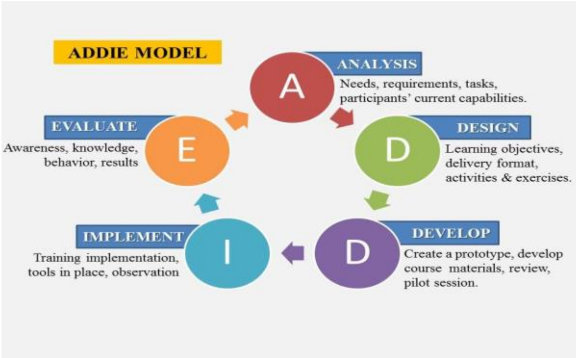

Figure 1. ADDIE R & D research cycle

The instrument used follows consists of Decomposition. Pattern recognition, abstraction, and algorithms (B. Gopinath, R. Santhi, 2020; Yue Yin & Roxana Hadad & Xiaodan Tang & Qiao Lin ; 2019). From the 4 aspects of computational thinking skills, they are reduced to indicators and indicator statements so that they become 14 statement items. The results were tested on 104 students in one of the majors in the Physics education study program in Semarang.

Table 1. Aspects of computational thinking and instrument numbers

Decomposition			Pattern Recognition			Abstraction				Algorithmic thinking			
E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	E14

RESULTS AND DISCUSSION

Validity refers to the accuracy and precision of a measuring instrument (est). Content validity show correspondence between the measured pa and the instrument that exists. This validity indicates the process that determines how far is the process relevant test.

Table 2. Content validity assessment

No	V	Category	No	V	Category
1	0.75	high	8	0.68	medium
2	0.75	high	9	0.74	high
3	0.75	high	10	0.73	high
4	0.67	medium	11	0.73	high
5	0.75	high	12	0.75	high
6	0.74	high	13	0.63	high
7	0.69	medium	14	0.75	high

Based on the results of the content validity calculation, no items were discarded because 14 items were in the medium and high categories. A good instrument shows consistency if a test can generate measurement which stable and steady. The reliability test using Cronbach's alpha formula using SPSS found that the Cronbach'S Alpha value was 0.94 very good.

Table 3. Reliability with Cronbach's alpha

Reliability Statistics

Cronbach's Alpha	N of Items
.940	14

Instrument which compiled is a development of the Tsai which is operated on computer students, in this study the existing instruments were developed and modified for physics students. To ensure that it is correct, the researcher uses the approach

Exploratory factor analysis using oblimin rotation method is applied to clarify the dimensions of the items on the computational thinking skills questionnaire.Oblimin rotation method has been widely used in social science research when factors or dimensions in one questionnaire are correlated with each other. When applying the noblemen rotation method, all items that must be greater than 0.4 will be retained.

Results from testing with EFA analysis obtained The Kaiser Meyer Olkin Measure of Sampling (KMO) factor is an index of the distance comparison between the correlation coefficient and its partial correlation coefficient. If the sum of the squares of the partial correlation coefficients among all pairs of variables is small compared to the sum of the squares of the correlation coefficients, it will produce a KMO value close to 1. The KMO value is considered sufficient if it is more than 0.5. The results of this study indicate that the Kaiser Meyer Olkin Measure of Sampling value is 0.928. Thus the KMO requirements meet the requirements because they have a value above 0.5

Table 4. KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.928
Bartlett's Test of Sphericity	Approx. Chi-Square	1007.569
	Df	91
	Sig.	.000

The second is anti-image. Some variables are analyzed based on an anti-image table. If you look at the anti-image correlation, you can see a number marked 'a'. The sign indicates the MSA of a variable. Of the 14 numbers, all show that the anti-image value is > 0.5 so all values are used.

Table 5. Anti-image correlation table

Anti-image Matrices

Anti-image Correlation	E1	.948[a]	-.079	-245	-.018	-.099	-.077	-.217	-.198	.099	.085	.143	-.130	-.082	-.062
	E2	-.079	.961[a]	.074	-.230	-.144	-.003	-.209	-.041	-.080	-.113	-.046	-.064	-.161	.058
	E3	-.245	.074	.913[a]	-.428	-.133	-.010	.047	.054	.137	-.077	-.078	-.056	-.050	-.137
	E4	-.018	-.230	-.428	.908[a]	-.178	-.031	.171	-.038	-.145	-.124	.076	.157	-.051	-.149
	E5	-.099	-.144	-.133	-.178	.930[a]	-.275	.030	-.302	.060	.039	-.158	-.022	.002	.202
	E6	-.077	-.003	-.010	-.031	-275	.920[a]	-.278	.122	-.383	.131	-.081	-.011	-.056	.022
	E7	-.217	-.209	.047	.171	.030	-.278	.918[a]	-.116	-.288	.126	-.186	.097	-.057	-.032
	E8	-.198	-.041	.054	-.038	-.302	.122	-.116	.926[a]	-.145	-.279	.169	-.039	-.084	-.258
	E9	.099	-.080	.137	-.145	.060	-.383	-.288	-.145	.923[a]	-.120	-.003	-.103	-.093	.041
	E10	.085	-.113	-.077	-.124	.039	.131	.126	-.279	-.120	.916[a]	-.084	-.055	-.030	.019
	E11	.143	-.046	-.078	.076	-.158	-.081	-.186	.169	-.003	-.084	.890[a]	-.300	.104	-.396
	E12	-.130	-.064	-.056	.157	-.022	-.011	.097	-.039	-.103	-.055	-.300	.942[a]	-.178	-.175
	E13	-.082	-.161	-.050	-.051	.002	-.056	-.057	-.084	-.093	-.030	.104	-.178	.966[a]	-.233
	E14	-.062	.058	-.137	-.149	.202	.022	-.032	-.258	.041	.019	-.396	-.175	-.233	.913[a]

Table 5 shows the number of factors formed from the items analyzed. A total of 14 items were extracted into 2 factors. The amount of variance in the question can be explained by the formed factors, for example, the second factor, then the factor is 60.59 percent while the rest is explained by factors not examined

Table 6. Total Variance explained

	Initial Eigenvalues			Extraction Sums of Squared Loading			Rotation Sums of Squared Loadings		
Factor	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	8.052	57.515	57.515	7.649	54.638	54.638	4.250	30.356	30.356
2	1.167	8.336	65.851	.834	5.956	60.593	4.233	30.237	60.593
3	.892	6.370	72.221						
4	.727	5.196	77.416						
5	.538	3.845	81.261						
6	.430	3.074	84.336						
7	.384	2.746	87.082						
8	.361	2.581	89.663						
9	.345	2.463	92.126						
10	.289	2.062	94.188						
11	.237	1.695	95.883						
12	.212	1.515	97.399						
13	.192	1.372	98.771						
14	.172	1.229	100.000						

The number of factors in the instrument can be seen from the scree plot. Factor analysis always tries to produce fewer factors than the number of variables processed. The approach is used to determine the number of factors obtained by using the eigenvalue approach. The scree plot results can be seen in Figure 2.

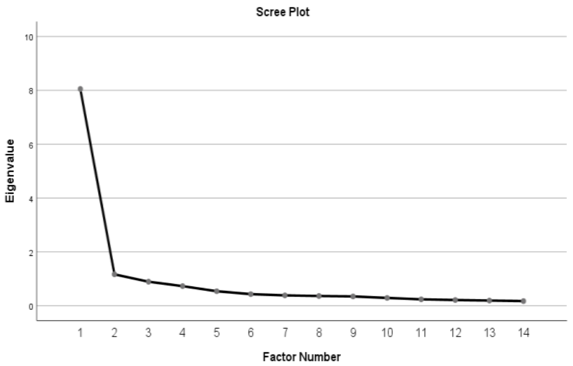

Figure 2 Rotated factor Matrix

Table 7. Rotated Component Matrix

Rotated Component Matrix		
	Component	
Number	1	2
E1	.574	.545
E2	.651	
E3		.794
E4		.776
E5	.590	.533
E6	.862	
E7	.885	
E8	.528	.646
E9	.816	
E10		.733
E11	.596	
E12	.562	
E13	.601	.555
E14		.632

From table 7 it can be explained that there are two factors, namely:

Factor 1: E1, E2, E5, E6, E7, E8, E9, E11, E12, E13 and factor 2 : E1, E3, E4, E5, E8, E10, E13, E14.

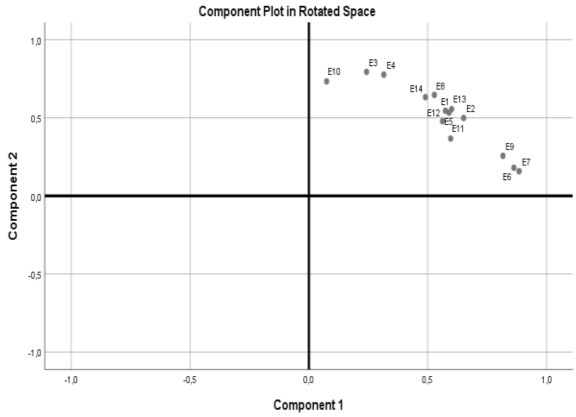

Figure 3. Component plot in rotated Space

From the graph of the plot in rotated space, it can be seen that the 14 questions are divided into two factors (components). That the value of the plotting results allows the existence of these 2 factors, namely in physics learning. This research is divided into 4 factors in computer learning but it is possible that in physics learning it is divided into 2 because in physics learning a simple problem description of the application of physics can consist of decomposition, abstraction, and interrelated algorithmic thinking.

CONCLUSION

This research aims to develop instrument computational thinking skills in learning Physics in Higher Education. The sample in this study was

104 physics education students in the Department of Physics Education at UIN Walisongo Semarang Indonesia. The instrument in this study used a modified Likert Scale. The validity test used in this research is content validity and construct validity. Content validity with Aiken value and construct validity was measured using EFA (Exploratory Factor Analysis). By using SPSS, the reliability estimate is obtained with the Cronbach Alpha formula of 0.94 and it can be stated that the instrument for evaluating-computational thinking skills of physics students in learning physics is reliable. The result of a rotated component matrix is that the 14 questions are divided into 2 factors.

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