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Development of Questionnaire on Students' Perceptions of STEM and Problem-solving (SPSP): a Rasch Modelling Approach

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Abstract

This study aims to prove empirically the validity and reliability of Questionnaire on Students' Perceptions of STEM and Problem-solving (SPSP) in learning physics using Rasch model. The questionnaire was disseminated to 59 (N=59) students class XI MIPA in one of Senior High School in Kuningan Regency. Development of SPSP Questionnaire using procedure of product development model 4-D. The stages that will be used consists of four stages, namely: a) define, b) design, c) development, and disseminate. The data obtained were analyzed by means of the Rasch Model. Based on the result of the study, it shows that the SPSP questionnaire had high reliability that 0.90. So, it can be concluded that SPSP questionnaire is reliable and acceptable. While the item validity analysis shows that there are 8 valid items and 1 item does not match the MNSQ benchmark. Outfit value lies between 0.5 <MNSQ <1.5 and also does not meet the ZSTD Outfit criteria (-2.0 <ZSTD <2, 0). Meanwhile, the students' responses indicate that learning in school has not supported STEM activities and problem solving. So it is necessary to develop learning in schools that can support STEM activities and students' problem solving abilities.

Keyword: *STEM, Problem Solving, Rasch Model, Model 4-D*

Abstrak

Penelitian ini bertujuan untuk menghasilkan bukti empiris mengenai validitas dan reliabilitas kuisioner Students' Perceptions of STEM and Problem-solving (SPSP) dalam pembelajaran fisika dengan menggunakan Rasch model. Kuisioner disebarkan kepada 59 (N=59) orang siswa kelas XI MIPA di salah satu SMA Negeri di Kabupaten Kuningan. Pengembangan SPSP kuisioner menggunakan prosedur model pengembangan produk 4-D. Adapun tahapan yang akan dilakukan terdiri dari empat tahap, yaitu: a) define, b) design, c) development, dan disseminate. Data yang diperoleh dianalisis dengan Rasch Model. Berdasarkan hasil penelitian, menunjukkan bahwa kuisioner SPSP memiliki reliabilitas yang tinggi yaitu 0.9 dan dapat diterima. Sedangkan analisis validitas item menunjukkan bahwa terdapat 8 item valid dan 1 item tidak sesuai dengan nilai standar MNSQ Outfit yaitu 0,5 < MNSQ < 1,5 dan juga tidak sesuai dengan nilai standar ZSTD Outfit yaitu -2,0 < ZSTD < 2,0. Sementara respon siswa menunjukkan bahwa pembelajaran disekolah belum mendukung kegiatan STEM dan pemecahan masalah. Maka perlu dikembangkan pembelajaran di sekolah yang dapat mendukung kegiatan STEM dan kemampuan pemecahan amsalah siswa.

Kata kunci: *STEM, Pemecahan Masalah, Rasch Model, Model 4-D*

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1. Introduction

The study presented in this article is an concentrated on perception students about integrated STEM in class. The central reputation of Science, Technology, Engineering and Mathematics (STEM) is broadly acknowledged internationally [1], there are serious problems in standings of skills shortages in STEM professions and reduced acceptances in secondary and tertiary STEM subjects, gender inequity in participation in STEM careers and admissions [2] and and difficulty achieving levels in science and mathematics in schools in many countries with PISA [3]. To relieve these hitches, at present there is converted international momentum in STEM school education, expressly classes which integrate STEM spheres in an attempt to amplification student attentiveness, mindfulness of the scope and prominence of STEM for solving problems within society, accomplishment within separable STEM subjects and enthusiasm to chase livelihoods within STEM [4], [5].

Problem-solving ability is one of the capabilities that students required [6]. Problem-solving is a diversified cognitive progression and important part of physics learning. the right abilities to regenerate knowledge and restore the ability to get used to trying fluently, which are then disseminated to students to become more resilient students [7]. The students prerequisite have the proficiencies to reoccurrence to the happenstances of the 21st century, and one of these proficiencies is problem-solving. Problem-solving is the most complex and pervasive challenge of the 21st century [8]. In other words, problem-solving skills are mandatory as one of the challenges in studying physics hard.

As known that STEM education and problem solving quite new in Indonesia, thus there is still deficiency of school [9]. The developed Questionnaire on Students' Perceptions of STEM and Problem-solving (SPSP) can be used to analyze the implementation of STEM and problem solving skills implemented in schools from the student's point view. However, SPSP Questionnaire was still analysed using regularly statistics analysis, and there are on the odd occasion researchers who have developed instruments to analyze students' perceptions of STEM learning and problem solving in physics learning in schools with newly modelling such as Rasch analysis.

The Rasch analysis was at the outset fulfilled by Georg Rasch in 1960 to test construction in psychology with two varieties of boundaries, a ruthless for each item and an knack for respectively person [10], [11], [12], [13]. Rasch analysis is a statistical method for styles the interface of personnel with test item that can be rumoured as a psychometric apparatus in social science and it has heavy-duty measurement properties [14], [15], [16], [17], [18], [19]. Rasch analysis is related to instrument analysis, thus it is timely to run-through in the pitch of education. Rasch model can be castoff by teachers and lecturers to foster test items as well as an obligatory tool that can serve relevant information regard to student assessment for learning [15]. In educational setting, Rasch model consumed commanded for distinguishing the most applicable extent of rating scale strength of mind for an deputy ealuation rating tools [20], [21], [22].

The Rasch model is used to check the reliability and validity of the instruments charity. In contemporary years, Rasch models as well discussed as item-response theory (IRT) or concealed has a characteristic models, have appointed an substitute charter for considerate dimension and substitute strategy for judges the quality of a measuring instrument [23]. Bids of Rasch model be able to construct an instrument that is reliable and valid [24].

However, the use of this form of diagnosis depends on them needs of the study. In decisive the validity and reliability of the SPSP Questionnaire, the item functionality solitary drafts accomplish on (i) the reliability and separation item respondents, (ii) the fit item, (iii) item result (iv) the analysis on the appraisal of the logit person and logit item.

2. Method

2.1 Research Design

Development of SPSP Questionnaire using procedure of product development model 4-D (Four D model) from Thiagarajan [25]. The research stages is Defining, Designing, Developing and Disseminating. The defining stage has been done to literature studies about implementation of STEM and problem solving learning, the designing stage is an instrument design, the developing is developed Questionnaire on Students' Perceptions of STEM and Problem-solving (SPSP) that consist of 9 statement about implementation of STEM and Problem Solving Learning, and the disseminating was dissaminated to student. The 4D model flowchart can be shown in Figure 1.

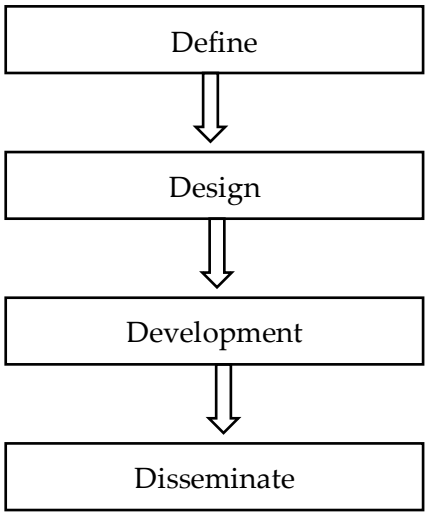

Figure 1. Flowchart of 4D Model

2.2 Participant

After the questionnaire goes through the design and development stage step so it was disseminate to the research sample was 59 out of 175 population students class XI MIPA of one of Senior High School in Kuningan Regency.

2.3 Instrument and Data Analysis

Instruments of research in this research paper is Questionnaire on Students' Perceptions of STEM and Problem-solving (SPSP) which consists 9 statement. In an attempt to cross each other the validity of the instrument composed treating rasch analysis, [26] alluded to exercising three criteria, explicitly MNSQ Outfit value inaccuracies between 0.5 <MNSQ <1.5; ZSTD outfit (-2.0 <ZSTD <2.0); and item correlation value between 0.4 to 0.85.

Data was attained from the product of student's response to statement in SPSP Questionnaire. That information was analyzed by Rasch modeling by holding at the reliability of the item, validity of item, and wright map, using the Ministep 4.3.1 instrument test.

3. Result and Discussion

3.1 Define

The defining stage has been done to literature studies about implementation of STEM and student's problem solving ability in Indonesia. This stage is used to find references from research about STEM and student's problem solving skills. Researcher adapt indicators of problem solving skills by Doctor and Heller.

3.2 Design

In the next level of 4D, we have built the SPSP Questionnaire item on indicator of problem solving skills and STEM aspects. After define indicators of problem solving skills and STEM aspects, researchers design the format of questionnaire. For more detail, the format can be shown in Table 1.

Table 1. The design of SPSP Questionnaire

Indicator of problem solving skills : Devise a plan
Statement : describe students' activities in delivering ideas to solve physics problems given by the teacher
Answer choice : if you totally agree 3. if you agree 2. if you disagree 1. if you totally disagree

3.3 Development

The development of Questionnaire on Students' Perceptions of STEM and Problem-solving (SPSP) consist of 9 statement about implementation of STEM and Problem Solving Learning. The unearthing will be deliberated concurring to reliability and separation index, items validity and variable map. The distribution of items on an instrument to each indicator of problem solving skills and STEM aspects is assumed in Table 2.

Table 2. The statement distribution

Entry Number	Factor	Element	Code
1	STEM	Science	S1
2	STEM	Technology	S2
3	STEM	Technology	S3
4	STEM	Engineering	S4
5	STEM	Mathematics	S5
6	KPM	Problem-solving test	K1
7	KPM	Interested	K2
8	KPM	Active	K3
9	KPM	Active	K4

3.4 Disseminate

After generating a good questionnaire on the stage Design and Development step, then the questionnaire was implemented to student. The instrument test applicated to get quality of instrument including item reliability, validity, item fit, and wright map.

Figure 2 shows that the value of Cronbach Alpha (α) is 0.90. From this Cronbach Alpha value it can be concluded that the reliability of the SPSP Questionnaire instrument over all is included in very good category and can be applied in learning activities. The value of person reliability is 0.23, which the reliability for a person included in the weak category. While the value of item reliability 0.91, which the test item has reliability in a good category. In the meantime, the person size of -0.92 expressions the average ability of students is lower than the level of difficulty of the item (established by default at 0.0). This shows that students' persception about STEM learning and problem solving are still rarely done in schools. The results of the SPSP questionnaire analysis can be shown at Figure 2.

	TOTAL SCORE	COUNT	MEASURE	MODEL S.E.	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD
MEAN	20.1	9.0	-.92	.62	1.00	-.04	1.00	-.05
SEM	.3	.0	.10	.00	.07	.15	.07	.15
P.SD	2.0	.0	.78	.01	.54	1.11	.53	1.11
S.SD	2.0	.0	.79	.01	.54	1.12	.54	1.12
MAX.	28.0	9.0	2.11	.64	2.57	2.49	2.56	2.45
MIN.	15.0	9.0	-2.91	.61	.20	-2.46	.19	-2.49
REAL RMSE	.68	TRUE SD	.38	SEPARATION	.55	Person RELIABILITY	.23	
MODEL RMSE	.62	TRUE SD	.47	SEPARATION	.76	Person RELIABILITY	.36	
S.E. OF Person MEAN = .10								

Person RAW SCORE-TO-MEASURE CORRELATION = 1.00
CRONBACH ALPHA (KR-20) Person RAW SCORE "TEST" RELIABILITY = .90 SEM = 1.70

SUMMARY OF 9 MEASURED Item

	TOTAL SCORE	COUNT	MEASURE	MODEL S.E.	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD
MEAN	131.8	59.0	.00	.24	.99	-.08	1.00	-.08
SEM	5.1	.0	.30	.00	.11	.59	.11	.59
P.SD	14.5	.0	.84	.00	.30	1.66	.30	1.67
S.SD	15.4	.0	.89	.00	.32	1.76	.32	1.77
MAX.	158.0	59.0	1.05	.25	1.52	2.64	1.52	2.63
MIN.	114.0	59.0	-1.50	.24	.52	-2.95	.52	-2.92
REAL RMSE	.26	TRUE SD	.80	SEPARATION	3.10	Item RELIABILITY	.91	
MODEL RMSE	.24	TRUE SD	.80	SEPARATION	3.30	Item RELIABILITY	.92	
S.E. OF Item MEAN = .30								

Figure 2. Reliability

Item validity was measured according to Point Measure Correlation (PTMea Corr.), INFIT and OUTFIT mean square (MNSQ). The validity of the items is measured based on the Point Measure Correlation (PTMea Corr.), INFIT and OUTFIT mean square (MNSQ). Analysis of the validity of this item is carried out to determine whether the product being developed achieves its objectives and this value is obtained from the respondents. Based on the investigation, the value of PTMea Corr. Of all the items there is no negative value, consequently there are no items that must be discarded at all.

Values published on PTMea Corr. duty is on positive (+). If the value obtained is negative (-), it means the specified item does not meet, and it is better to be dropped or distinguished for being unfit for use. Indicated the PTMea Corr. value of item polarization can be shown in Table 3.

Table 3. Item Polarity

Entry Number	PT Mea Corr	Item
1	0.20	S1
7	0.50	K2
2	0.47	S2
9	0.49	K4
5	0.26	S5
3	0.32	S3
4	0.34	S4
6	0.55	K1
8	0.38	K3

The item suitability check shows the value stated in the infit and the Outfit Mean Square (MNSQ). An interpretation of the importance of this guide shall be obliged to conclude whether the specified item is applicable (item fit) for the adjustable or discardable portion. The infit and outfit MNSQ would be in the assortment of concerning 0.5 to 1.5 [27]. Uncertainty the consequence disclosed rate above 1.5 logit revenues that the item is confusing, for the meantime doubt the result disclosed value beneath 0.5 logit, it revenues that the item is too tranquil as predictable by the plaintiffs. In addition, the importance of infit and outfit ZSTD must be within -2 to +2 . Nevertheless chance the significance of infit and outfit MNSQ is conventional, formerly the ZSTD guide can be disregarded. The results of this preliminary report analysis determined that there was one items that are not included in the variation indicated and it would be removed or restricted. These pieces is items S1. Value of INFIT and OUTFIT MNSQ significance of item fit can be shown in Table 4.

Table 4. Item Validity

Entry Number	Infit		Outfit		Item
	MNSQ	ZSTD	MNSQ	ZSTD	
1	1.52	2.64	1.52	2.63	S1
7	1.31	1.67	1.33	1.75	K2
2	1.16	0.82	1.16	0.83	S2
9	1.11	0.64	1.12	0.65	K4
5	0.97	-0.10	0.97	-0.15	S5
3	0.94	-0.26	0.93	-0.30	S3
4	0.76	-1.28	0.75	-1.28	S4
6	0.66	-1.91	0.66	-1.91	K1
8	0.52	-2.95	0.52	-2.92	K3

There are one items that have got to be dropped because out of standar, these items is S1 . But these item is not absolutely removed but will be improved based on the views of expert. Portray the outcome taken on the items can be shown in Table 5.

Table 5. Item Result

Entry Number	Item	Result
1	S1	Refined
7	K2	Retained
2	S2	Retained
9	K4	Retained
5	S5	Retained
3	S3	Retained
4	S4	Retained
6	K1	Retained
8	K3	Retained

Wright map at Figure 3 shows there are the S code (item about STEM) and K code (item about Problem Solving) followed by the serial number of question number, and there are the serial number of students followed by code L (*Laki-laki* or Male) and P code (*Perempuan* or Female). And the top and bottom shows the highest level of ability to the lowest. Students who have the highest level is 59L (male student with 59th order) and students who have the lowest level is 36P (female student with 36th order). This indicated that the 59L students most often gave very agreeable responses, and the 36P students gave the most frequent disagreement responses. The statement item that is in the highest position is K3, this indicates that the activity that is most often carried out is the activity according to the K3 item, according to the students. And the item that is in the lowest position is S1, this indicates that the activity that is rarely carried out is STEM activity in item S1. But overall, student responses are still in the lower position, this indicates that learning activities at school have not supported STEM activities and problem solving activities. For more details, can be shown in Figure 3.

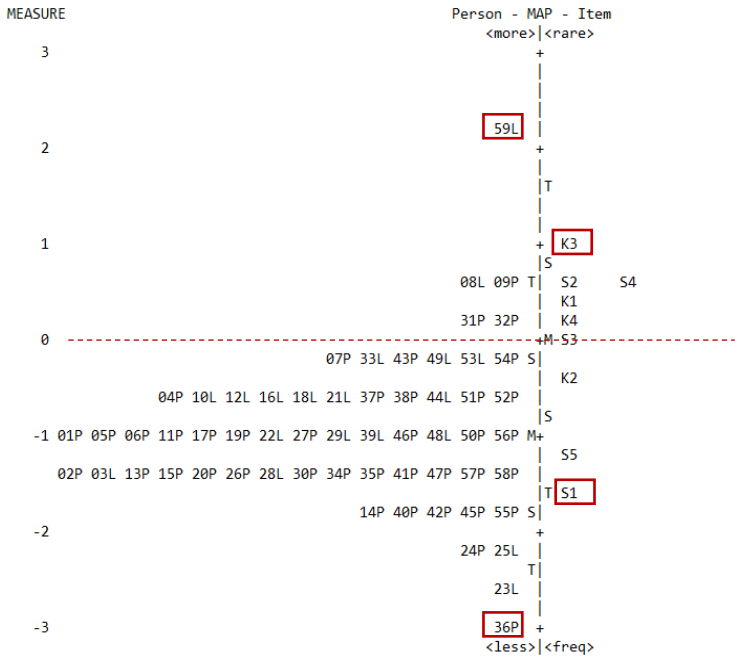

Figure 3. The Distribution of Students' Responses and The Level of Difficulty of Items

4. Conclusion

The result show that SPSP Questionnaire had high reliability. So it can be concluded that the SPSP Questionnaire is reliable and can be used. Also the results of the validity of the test show that 8 out of 9 statement items are valid and 1 statement needs to be corrected because out of MNSQ and ZSTD range. In decisive the value of an instrument presence advanced, the best technique castoff by peak researchers is analysing items. In this report, Rasch capacity model was used to analyse separately item in Questionnaire on Students' Perceptions of STEM and Problem-solving (SPSP). Solicitation of Rasch model in the questionnaire can conclude the create validity of items and bequeathed a flawless designation of constructs that can be dignified are dependable with academic opportunities. It is wished this report willpower elasticity prominence to supplementary researchers approximately the significance of analysing items to warrant the quality of an instrument developed.

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