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Graded Response Models on the Curiosity Measurement of Elementary School Students

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Abstract: Curiosity is one of the most important characters for elementary school students. However, the facts in the field show that the measurement model used by the teacher to identify the student's curiosity is not yet available in a standardized manner. This study aims to develop a model for measuring the curiosity of elementary school students using the graded response model (GRM) approach. This research uses quantitative method with descriptive type. The research sample used was 236 elementary school students who were randomly selected. Data were collected using a questionnaire of 16 statement items using a Likert scale approach. The data were analyzed using the response item theory approach with the GRM. The results showed that the model for measuring student curiosity in elementary schools had good location parameters, a good discriminant index, a fairly good information function with a small estimation error. The curiosity measurement model in this study can be used as an alternative for teachers to identify students' curiosity in elementary schools.

Keywords: *Curiosity measurement, elementary school, graded response models.*

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Introduction

Character education is one of the main programs of the Government of Indonesia which is carried out to prepare the nation's next generation of quality (Sujati et al., 2020). This has become an essential agenda by the Indonesian government (Husnaini et al., 2020). In general, the purpose of character education in Indonesia is to educate the nation's children to become the next generation who has a dignified character and national civilization. Based on the nation's ideals, it strengthens the hope that through character education, the quality of the Indonesian nation in the future will be better. This is the basis that is in line with various previous researches that confirm that character education is a very important thing to be realized in the implementation of education in Indonesia (Marzuki, 2018; Supriyadi et al., 2021; Sutarman et al., 2020).

Basically the character of the nation can be formed and developed by the nation itself in order to prepare the next generation (Kennedy et al., 2013). Moreover, in the current era, the influence of globalization is very much so that it is very important for the country to strengthen its national character (Arfani & Nakaya, 2020). Character education should ideally be strengthened from the basic education path. This is very important because character education is the basis for children to navigate social life in adulthood (Agustini, 2021; Junaedi & Syukur, 2017). Therefore, character strengthening is something that must be done by a teacher at school.

The role of teachers in education is very important (Tjabolo & Herwin, 2020; Wuryandani & Herwin, 2021). Teachers have obligations that do not only carry out learning but are broader than that to the formation of attitudes and skills. A teacher must be able to lead students to strengthening positive characters (Wulandari et al., 2022). Strengthening this character is one of the tasks that must be carried out by teachers who are set on the pedagogic competencies that must be possessed. This means that a teacher is able to know the development of their students, including strengthening the character values that already exist in their students.

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Curiosity is one of the eighteen values in the character of the nation that are of concern to the government in Indonesia. This curiosity implies that attitudes and actions are always trying to find out more deeply. This is very important because it is a motivation to obtain information. Through curiosity students will try to understand by learning something (Singh & Manjaly, 2022). Therefore, this character is certainly needed and must be developed in students, especially students at the elementary school level.

The character of curiosity comes from thinking. The existence of curiosity is the initial stage used to investigate and find something from the spirit of learning (Nafisa & Hidayah, 2021; Zetriuslita et al., 2017). Students who have this character will be more sensitive to events around them. This sensitivity will foster a desire to find out so that students always try to learn more deeply. Furthermore, being interested in something will stimulate children's thinking to be more advanced.

Because of the importance of curiosity for students, the teacher must have a measurement model that can be used accurately in measuring and identifying this curiosity. This study examines the GRM. GRM are measurement models that display the parameters of each item to accurately estimate students' abilities (Mirunnisa & Razi, 2021). The ability of students referred to here is how much curiosity students have. This is considered very useful for teachers to identify the curiosity of their students from an early age. GRM is very appropriate for the estimation model of ordered polytomous measurement scales for both student parameters and measurement item parameters. This model is recommended to support differentiating parameters. This is very important and needed in the preliminary estimation phase which is suitable for the development of the questionnaire and the selection of quality statement items (Matteucci & Stracqualursi, 2006).

In educational research, GRM has previously been applied to measure cognitive scales on students' critical thinking skills (Nurul & Anasha, 2013). However, in this study, GRM was used to develop a curiosity scale for elementary school students. Graded response is a measurement model that is very suitable for psychological scaling. This model is very suitable for measuring student curiosity because it uses a polytomy approach and can perform analysis accurately on a scale that is more than two categories (Auné et al., 2019; Ostini & Nering, 2005).

This study is very important for the practice of providing education for both teachers and educational researchers. For teachers, the findings of this study serve as a model for measuring students' curiosity in the classroom. For researchers, this study can be a reference for developing a scale for measuring student curiosity and making a theoretical contribution in the development of relevant concepts. Previous studies have developed the construct of students' curiosity using polytomy categories. On this basis, the current study was conducted with the aim of obtaining a model for measuring student curiosity in elementary schools based on the GRM.

Methodology

Research Design

This research was conducted using quantitative methods. In addition, this study runs using a descriptive approach. This design is designed to find a scaling model for measuring student curiosity in elementary schools based on the GRM. Curiosity measurement construct has been designed in previous research (Herwin & Nurhayati, 2021). The items in this measurement were developed by researchers based on indicators which are a synthesis of various theoretical proposals (Kashdan et al., 2004; Litman, 2005; Rowson, 2012). Through consideration of these various views, it was decided to use four measuring indicators, namely: pay attention, take notes, asking and comparing. The scale used in this study uses a self-report approach which is filled in directly by students as a form of self-assessment. The scale used in this study has been tested for validity and reliability based on a confirmatory factor analysis approach. The validity results for all items are valid and have a factor loading coefficient of more than 0.7. In addition, the reliability of this scale has also been proven with a reliability coefficient of 0.9. Therefore, all items used in this scale have met the aspects of validity and reliability. The following is presented (in Table 1) the construct of curiosity measurement that has been formed to be continued in the GRM in this study.

Table 1. Elementary School Student Curiosity Measurement Construct Design

Items	Statement Focus	Dimensions
PA 1	Pay attention to the teacher's explanation	Pay attention (PA)
PA 2	Pay attention to the explanation of friends	
PA 3	Paying attention to presentations in class	
PA 4	Pay attention to the task	
TN 1	Take notes from the teacher	Take notes (TN)
TN 2	Recording information from friends	
TN 3	Complete notebook for all subjects	
TN 4	Record school information	

Table 1. Continued

Items	Statement Focus	Dimensions
Ask 1	Ask the teacher about the subject matter	Asking (Ask)
Ask 2	Asking for new information from the media	
Ask 3	Actively ask questions in class discussions	
Ask 4	Asking friends about information they don't understand	
Comp 1	Comparing current information with previous information	Comparing (Comp)
Comp 2	Using various references and learning resources	
Comp 3	Comparing the opinions of more than one teacher	
Comp 4	Comparing the opinions of more than one friend	

Sample and Data Collection

The sample in this study was taken from elementary school students with high grade levels. Specifically, the sample of students used is in the age range of 10 to 12 years or in Indonesia students of this age are at the fourth, fifth and sixth grade levels. When viewed from the economic status of the family, the sample of students used is heterogeneous starting from high, medium and low economic status. The same thing is also used for aspects of learning achievement. This study uses a sample of students who have high achievement, medium to students who have low achievement. The characteristics of the students used in the research sample are upper class students who are at the concrete operational level and have been able to respond to self-assessments. In addition, the sample of students comes from areas that vary from cities to villages. The total sample used was 236 students spread from four elementary schools. The sample selection was done using a simple random technique.

The data collection used in this study uses a questionnaire technique. The instrument used contains a psychological scale containing statements to measure each of the dimensions of student curiosity. The total item statements used are 16 items that are formed from the four main dimensions of the curiosity variable (more details can be seen in Table 1). Data collection was carried out by giving instruments directly to students to respond according to the circumstances and experiences they had experienced. In this study, researchers and teachers at school gave measurement items to students. At the time of giving the items, students are asked to provide a code (checklist) on the choice of scale according to their condition. All students involved as a sample were directed by the teacher to read the statements carefully before giving a response. Students are given about one hour to complete the given instrument. In addition, the researcher gave instructions so that students filled in according to the actual situation and there was no need to worry because all personal identities were kept secret by the researcher. Consideration of sample selection is done by stratified random sampling method. This is done by dividing the population into strata (such as class levels), then selecting a random sample of each of these strata.

Analyzing of Data

The data analysis technique used in this study is item response theory with a GRM approach. The selection of the GRM was based on its suitability for items that have categorical responses such as the Likert scale as applied to the curiosity measurement in this study. This model is a polytomy model and an extension of the 2-Parameter Logistics Model (on dichotomous data) where each response category on an item is treated like a dichotomous item so that the probability curve is as many as the number of categories. In addition to item characteristics, what is estimated in this model is the information function. Another important thing to do in this study is to identify the Standard Error of Measurement (SEM). The expected scale is a scale that has a small error. This is relevant to reliability. The higher the reliability, the smaller the error. The GRM in this study was carried out with the help of the R Program through the Latent Trait Model Package.

Findings

This study was conducted with the aim of obtaining a scaling model of measuring student curiosity in elementary schools. This curiosity measurement construct has been formed in previous studies by obtaining four dimensions and measured by a total of 16 statement items (Herwin & Nurhayati, 2021). In this study, the focus is on the scaling model to obtain an estimate of the item parameters information function and Standard Error of Measurement.

This study focuses on three main things. The first thing is the estimation of item characteristics based on the GRM. This is done to obtain the characteristics of all the items that have been developed, namely as many as 16 items. Through this estimation, information related to measurement characteristics in each of the categories formed can be obtained or in terms of Graded Response known as location. The second focus is to describe the characteristic curve of the item. This is done to visualize the characteristics of the items so that it is easier to know the details of the scaling of each item clearly. The third focus is on describing the function of information. This is important for users who will use this measurement model to adjust the level of ability that is suitable for use in students in elementary schools.

The measurement model that has been developed has a categorical response with a Likert scale approach. The data were analyzed using the GRM approach with scores of 1, 2, 3, 4 and 5. Through the R Program with the Latent Trait Model (ltm) package, the characteristics of all items used were obtained. In Table 2, the results of the characteristics of the items that have been carried out based on the GRM are presented.

Table 2. Characteristics of Curiosity Measurement Items with GRM

Item	a	b_1	b_2	b_3	b_4
PA1	1.388	-1.884	-0.864	0.066	1.310
PA2	1.326	-2.541	-1.268	0.128	1.545
PA3	1.398	-1.803	-0.863	0.194	1.399
PA4	1.498	-2.243	-1.100	0.135	1.370
TN1	1.902	-2.211	-1.031	-0.157	1.126
TN2	1.472	-2.575	-1.207	0.132	1.271
TN3	1.689	-2.418	-1.015	-0.036	1.198
TN4	1.736	-2.260	-1.107	0.065	1.346
Ask1	1.593	-2.302	-1.041	0.184	1.410
Ask2	1.648	-2.624	-0.952	0.163	1.508
Ask3	1.514	-2.488	-0.970	0.327	1.326
Ask4	1.980	-2.053	-0.906	-0.006	1.025
Comp1	1.706	-2.232	-1.188	-0.001	1.032
Comp2	1.563	-2.227	-1.201	0.170	1.399
Comp3	1.679	-2.831	-1.224	-0.083	1.139
Comp4	1.478	-2.730	-1.184	0.082	1.059

Based on the results of the analysis presented in Table 2, information is obtained that the discriminant index parameter (a_i) of each item varies from 1.326 as the lowest coefficient to 1.98 as the highest coefficient. All of these coefficients are acceptable because a good discriminant index (a_i) is in the range 0 to 2 (Tjabolo & Otaya, 2019). In addition, the location parameter (b_i) consists of four groups or four intersections. This location parameter indicates the level of difficulty of each item to achieve a certain ability or level of curiosity in the student who is the object of the assessment. Judging from the chances of achieving the score, the coefficient of the b_i parameter for each category is different. The higher the achievement category, the higher the coefficient b_i. In the context of this study, the higher the location coefficient achieved by students, the higher the level of curiosity they have. All levels of difficulty (b_i) are in the ideal category. This is based on the view that the ideal level of difficulty is around -2 and 2 (Ayala, 2022).

Another thing that can be explained based on the results of item analysis using the GRM Model is the item characteristic curve. The item characteristic curve is described to make it easier to understand the relationship between each location parameter (b_i) which is the level of difficulty with the characteristics of the participant students to achieve the level of curiosity with a certain category. The following is an example of an item characteristic curve from the curiosity measurement model developed in this study.

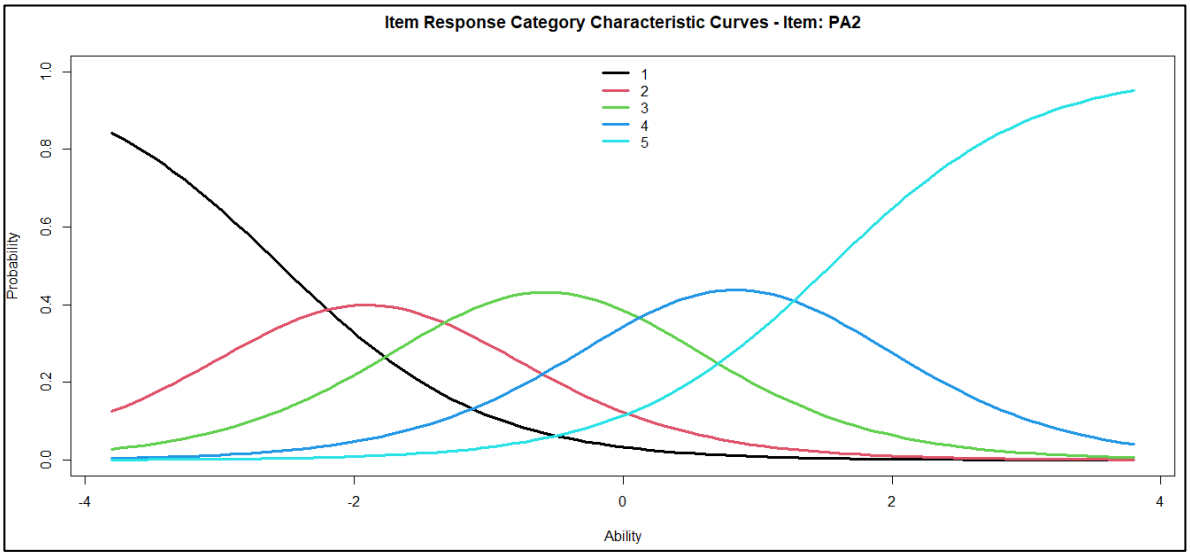

Figure 1. PA2 Item Characteristics Curve of Student Curiosity Measurement Model

Figure 1 is an example of an item characteristic curve from the curiosity measurement model of elementary school students with the GRM, namely the PA2 item. If it is associated with the results of the item calibration in Table 2, it can be explained that basically this PA2 item has a power difference parameter a_i of 1.326 with parameters b_1 of -2.541, b_2 of -1.268, b_3 of 0.128 and b_4 of 1.545. Graphically b_i or level of difficulty can be interpreted as the intersection of the curves of each category. From the figure, it can be explained that to achieve category 2 or to get a score of 2 on the PA2 item, a curiosity level (b_i) is needed around -2.541 to -1.268. In this paper only examples are given for PA2 items. For more details, the characteristic curves for all items in the curiosity measurement model that have been developed in this study can be observed by visiting the following link: http://bit.ly/AppendixItem.

In addition to the item characteristic curve, another thing that can be explained from the quality of the student curiosity measurement model in this study is the value of the instrument's information function. The information function basically shows the extent to which the instruments in this model that have been developed can provide maximum information if they are applied to certain participant characteristics (θ). In the following, the information function of the instrument on the curiosity measurement model of elementary school students is presented.

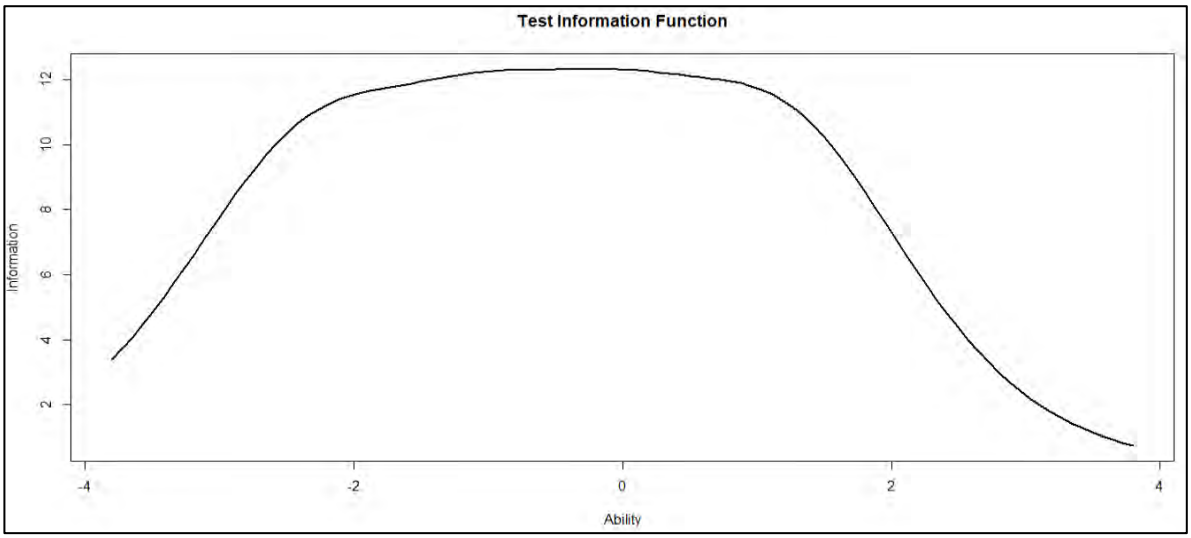

Figure 2. Information Function of Curiosity Measurement Model

Figure 2 presents the information function curve of the accumulation of 16 items in the curiosity measurement model of elementary school students. The curve shows that the instrument in the model provides maximum information on the ability (θ) around -2.0 to 1.5. Another thing that can be explained from Figure 2 is that the maximum instrument information function value is 12 on the ability scale (θ) -0.5. It can be interpreted that the coefficient of measurement error is 0.28.

Discussion

The curiosity measurement model of elementary school students in this study was developed using a GRM approach. This is based on the support of several findings which explain that the GRM is a very appropriate model to evaluate the psychometric properties of survey questionnaires with categorical data (Auné et al., 2019; Depaoli et al., 2018). The results of the empirical research show the findings that the score has three levels of item difficulty or in this study the term location, was found to vary in each item with -2.5 as the easiest level of difficulty and 1.5 for the most difficult level. If these findings are related to various concepts and previous findings which explain that ideally the difficulty level parameter or location parameter moves between -2 to 2 (Ayala, 2022; Herwin et al., 2019). Therefore, when viewed from the location parameters, this measurement model is feasible to use with location parameters that are in the ideal category.

In addition to the aspect of difficulty level or location parameters in the curiosity measurement model of elementary school students, the findings of this study also show results related to the item discrimination index. In the measurement model that has been developed, it is found that the discrimination index of all items shows positive results and moves between 1.3 to 1.9. This is very important because if a measurement device has a good information function, it will be able to carry out measurements with accuracy with small errors (Moghadamzadeh et al., 2011). Conceptually, it is explained that the discrimination index parameter is the slope on the curve at the point of difficulty level on a certain ability scale. Ideally, a good discrimination index lies between 0 to 2 (Tjabolo & Otaya, 2019). Therefore, it can be concluded that the curiosity measurement model of elementary school students developed has a good discrimination index.

In addition to the findings about the characteristics of the items in this study, findings were also obtained based on the information function of the instrument. Empirically, the information function of the measurement model that has been developed has an adequate coefficient. In addition, the Standard Error of Measurement obtained is also relatively small. If the empirical findings are associated with the expert's view which states that the function of information is a way to explain the strength of a set of instruments in revealing the latent trait to be measured (Retnawati, 2014). This means that if viewed from the findings of the information function, it can be concluded that the curiosity measurement model in elementary schools has had good power in revealing the latent trait to be measured, namely student curiosity.

Another aspect that has relevance and is considered is the Standard Error of Measurement. The information function with measurement error has an inverse relationship, the greater the value of the information function, the smaller the measurement error value and vice versa (Hambleton et al., 1991). This study shows a positive thing where the information function obtained is about 12 with an error of about 0.2. Therefore, the curiosity measurement model of elementary school students in this study has been able to minimize the estimation error well.

Several previous relevant studies have utilized GRM in calibrating and developing measurement scales. One of them is that GRM is used to measure the loneliness scale (Auné et al., 2020). GRM has been applied to measure empathic behavior and this is reported to contribute greatly in identifying a person's empathetic behavior (Auné et al., 2019). Further use of GRM to measure the scale of the entrepreneurial ecosystem (Sethar et al., 2022). Other studies have used GRM as a monitoring scale (Suryadi & Putra, 2020), even in educational research GRM has been used to map students' cognitive abilities (Falani et al., 2020; Mirunnisa & Razi, 2021; Nurul & Anasha, 2013).

Several previous studies have similarities with this study, namely the use of GRM as a calibration and scaling item. However, the difference between the previous study and this study is that in this study the focus of the scale developed was on the curiosity scale specifically for elementary school students. The hope is of course the same as previous studies, namely requiring the use of a standardized and quality scale to obtain accurate measurement results, especially on the curiosity variable.

Curiosity is a very important character for children. Forward thinking will increase the willingness to find useful things in the life of oneself and others. Therefore, it is obligatory to introduce the character of curiosity to children. Especially early childhood and basic education levels. Furthermore, strengthening the character of curiosity can stimulate children to be more active. One example is actively asking. Asking questions for children is a positive thing that requires full support. In addition, the character of curiosity can also give birth to a generation that actively observes the surrounding environment. There are many things that children can learn from their surroundings. This will increase as well as improve their psychosocial competence in addition to cognitive of course. Thus, teachers should pay attention to the development of their students' curiosity by making various efforts, one of which is by applying the measurement model that has been developed in this study to identify the curiosity of elementary school students.

Conclusion

The measurement of curiosity based on the GRM formed as many as 16 items in this study has an ideal location parameter which is around -2 to 1.5. This has been supported by various previous findings and expert recommendations for location parameters. The discrimination index also has a good index. This is evidenced by the findings of this study which shows a positive index with a fairly ideal range of around 1.3 to 1.9.

Another conclusion that can be put forward in the aspect of the function of information. The findings of this study show that the information function of the measurement model is quite good with relatively small error. This indicates that the curiosity measurement model for elementary school students can be a reference in the practice of measuring student curiosity in elementary school. This research makes a theoretical contribution to the development of a curiosity measurement scale, especially in elementary schools. This provides another alternative if previous research used GRM on students' cognitive measurements.

The research findings provide an important assessment tool that both teachers and relevant researchers can use to measure student curiosity. This is very important because in Indonesia there are eighteen national character values that are of concern to the government for students of the nation's next generation, one of which is curiosity. The findings of this study are present in the field to overcome the difficulties of teachers and relevant researchers in finding standard measurement scales to measure students' curiosity.

Recommendations

Curiosity is a very important character for children, especially in elementary school. This study recommends a curiosity measurement model for students in elementary schools as an alternative for teachers and schools to measure student curiosity in elementary schools. Especially for teachers, this study suggests applying this curiosity measurement scale in schools as a demand for pedagogical competence which is not only obliged to assess students' cognitive but also to be able to assess students' non-cognitive aspects. Teachers should use this scale to identify their students' curiosity both in the indicators of paying attention, taking notes, asking questions and comparing. Through this scale, teachers are expected to be able to map their students based on indicators of specific curiosity, not just relying on judgments

that rely on instinct and subjective views. This is highly recommended because by identifying the character of student curiosity with a valid and objective, then teachers and schools can plan appropriate actions to serve students in achieving educational goals in schools.

For future researchers, it is recommended to use this scale to measure the variable of curiosity in carrying out relevant research or further development. In addition, relevant researchers can also use it in connecting students' curiosity with other variable concepts. This is to provide conceptual reinforcement related to measuring students' curiosity variables. Furthermore, it is recommended to continue this study on measurement bias analysis. This study can be reviewed based on an analysis of gender bias, culture, environmental conditions and other aspects that have the potential to cause bias on this curiosity measurement scale.

Limitations

This study has collected a sample of 236 primary school children. This can still be improved in the future. In addition, the authors are still aware that the involvement of subjects who only take high grade classes is part of the limitations of this study. Therefore, future studies should consider the representation of students at lower grade levels.

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Authorship Contribution Statement

Herwin: Developing main ideas, developing research instruments, analyzing data, and drafting manuscripts. Nurhayati: Plays a role in developing research instruments, collecting data and discussing findings. Lidyasari: Participated in data collection, data interpretation, and manuscript preparation. da Costa: contributed to reviewing the content and finalizing the manuscript.

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Appendix

Table A1. Student Curiosity Measurement Statement Items

No	Statements	Response				
		Always	Often	Sometimes	Seldom	Never
1	I pay attention to the teacher's explanation while studying					
2	I paid attention to my friends' explanations during the discussion					
3	I pay attention to the presentation in class					
4	I pay attention to the task given					
5	I wrote notes from the teacher's explanation					
6	I wrote notes regarding important information from friends					
7	My notebook is complete for all subjects					
8	I wrote notes about school information					
9	I asked the teacher about the subject matter					
10	I asked about new information from the media					
11	I asked in class discussion					
12	I ask information that is not understood from friends					
13	I compare current information with previous information					
14	I use various references and learning resources					
15	I compared the opinions of more than one teacher					
16	I compared the opinion of more than one friend					