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Validity and Reliability of Needs Analysis Questionnaire for Dyscalculia Instrument

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ABSTRACT

Dyscalculia is a specific learning difficulty in Mathematics. Intervention instrument is needed to assist the pupils to overcome their learning difficulties during this situation. Thus, this paper presents the evaluation of validity and reliability of a needs analysis questionnaire to investigate the needs to design and develop a dyscalculia instrument. This four-point Likert-type scale questionnaire consisted of 46 items that represented four constructs. The assessment of content validity is done through nine domain experts. Content validity index and Kappa statistics were implemented for content validity. After the validity analysis, one construct with low scale content validity index (S-CVI) and another three items with low item content validity index (I-CVI) and Kappa statistics had been removed. Overall, a number of 13 items had been removed and 33 items had been retained. Subsequently, reliability analysis was done by carrying out a pilot test. During the pilot test, the questionnaire had been implemented among 30 Mathematics teachers to obtain the Cronbach's Alpha value. One item had been removed after the reliability analysis due to the low value of [corrected item-total correlation] and 32 items were retained. Thereafter, the questionnaire was ready to be used for data collection in the actual study. As stated in the preceding statement, it will assist teachers in identifying problems and planning appropriate interventions to meet the needs of dyscalculic students.

Keywords: Content Validity, Dyscalculia, Learning Difficulty, Mathematics, Needs Analysis, Reliability, Questionnaire

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INTRODUCTION

Mathematics is an important subject and it is needed in our everyday life. However, there are many pupils who are afraid of it (Yoong, 2020). In year 2019, there are 16.87 percent of the UPSR candidates failed in Mathematics subject. In another words, there is a total of 72,812 out of 431,610 Year Six Pupils obtained an E for their Mathematics subject during UPSR examination (Ministry of Education Malaysia, 2019). This is a very serious issue because Mathematics is one of the major subjects in primary school education (Yoong & Ahmad, 2018a).

There are around four to six or seven percent of the pupils among the population are dyscalculic (Bird, 2017; Butterworth, 2019). If these dyscalculic pupils were not being identified, they will continue to be left out or labelled (Yoong & Ahmad, 2020a). The significance of dyscalculia remains greatly underappreciated. The burden of having inadequate mathematical ability falls on both the individual and society (Aquil & Ariffin, 2020). In short, dyscalculia is yet a new term to be developed. More researches need to be done in the field of dyscalculia. A needs analysis questionnaire had been evaluated to investigate the needs to design and develop an instrument for dyscalculia. The purpose of this study is to determine the validity and reliability of the needs analysis questionnaire for dyscalculia instrument.

LITERATURE REVIEW

The literature reviews to be discussed in this section are dyscalculia, needs analysis, validity, and reliability.

Dyscalculia

Despite the fact that Mathematics is one of the most important subjects, dyscalculic pupils are having difficulty in mastering it (Yoong & Ahmad, 2018b). An individual with scores that are typical on the capacity tasks would not be considered dyscalculic, but as needing more or better teaching (Laurillard, 2016). Dyscalculia is also known as number dyslexia (Yoong & Ahmad, 2020b). It affects a significant portion of the population and often goes undiagnosed, learning to unnecessary disability in school and personal life (Schelke et al., 2017). It is a defect with a high prevalence that can extend from childhood to adulthood (Aquil, 2020).

Teachers and educators should be able to differentiate those who might have signs of minor problems which might grow worse through time or those who have high risk of developing the

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problems later, so that proper services can be provided timely to avoid or reduce the problems (Shyielathy, Kway & Zainiah, 2020). Dyscalculic pupils are having average intelligence quotient as their peers. However, they are having persistent problems in mastering Mathematics and may be completely unaware of the condition (Miundy, Zaman, Nordin & Ng, 2019). Dyscalculic pupils need to be detected in order to provide them with appropriate activities or interventions (Yoong, Fu, Wong, & Lijuan, 2021).

Dyscalculic pupils may be studying in the general education class, remedial education class, or special education class. They are having poor number sense, and are poor in arithmetic skills. Thus, a needs analysis should be carried out in order to investigate the needs for the dyscalculia instrument. This questionnaire could be a useful tool for the teachers and educators to better understand the needs of dyscalculic pupils so better and equal education services and opportunities can be provided to these pupils.

Needs Analysis

A need analysis questionnaire is an important tool for analysing whether the population's present services are adequate. If such services are insufficient and a solution is accessible, it indicates that a need exists (Hosshan, Stancliffe, Villeneuve & Bonati, 2020). Needs analysis involves the decision of identifying and analysing the needs to study the selected scope, which will determine the findings later. This identifying and analysing process tend to focus on the kind of problems faced by the targeted population. It can be systematically structured based on several models, namely (a) discrepancy model, (b) marketing model, and (c) decision-making model (McKillip, 1987).

In this study, the researchers adopted the discrepancy model as a guiding model for the need analysis phase. The reason being, the researchers would like to know the current practice and the challenges (Shyielathy, 2020) that the primary school Mathematics educators are facing with students who are having difficulties in learning Mathematics so that what ought to be done can be sorted. Insights from these aspects have helped to identify the gap of the study hence has to lead to the design and development of the dyscalculia instrument.

Validity

Content validity ensures that operationalization of the construct is based on items which were taken from the specific domain of content relevant to the specific situation of measurement. It is recommended that at least three experts to be involved in evaluating the content validity (Shrotryia

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& Dhanda, 2019). Two types of content validity index (CVI) are (a) CVI for item (I-CVI) and (b) CVI for scale (S-CVI) (Yusoff, 2019). To generate the CVI, the experts were asked to give their view points on the items for needs analysis questionnaire. The CVI was calculation for all individual items (I-CVI) and the overall scale (S-CVI). For CVI, each scale item in terms of its relevance to the underlying constructs were rated by the experts. To prevent a neutral point, a four-point scale was applied. The four points on the item rating scale were: [1] not relevant; [2] somewhat relevant; [3] quite relevant; and [4] highly relevant. I-CVI should not be less than 0.78, whereas a minimum of S-CVI should be 0.8 for reflecting content validity (Lynn, 1986; Shrotryia & Dhanda, 2019).

Table 1 shows the number of experts and its implication on the acceptable cut-off score of CVI. The acceptable CVI for two experts is at least 0.80; the acceptable CVI for three to five experts should be 1; the acceptable CVI for six to eight experts is at least 0.83; whereas the CVI for at least nine experts is at least 0.78. Since there were nine experts validated on the questionnaire, hence the acceptable CVI value is at least 0.78.

Table 1. The Number of Experts and Its Implication on the Acceptable Cut-off Score of CVI

Number of Experts	Acceptable CVI Values	Source of Recommendation
Two experts	At least 0.80	Davis (1992)
Three to five experts	Should be 1	Polit & Beck (2006), Polit et al., (2007)
At least six experts	At least 0.83	Polit & Beck (2006), Polit et al., (2007)
Six to eight experts	At least 0.83	Lynn, 1986
At least nine experts	At least 0.78	Lynn, 1986

Reliability

The reliability of the measurement procedures is described as a measure of consistency or stability (Liew & Idris, 2017). Cronbach's Alpha calculates the average of all possible split-half reliability coefficients to obtain an inter-item correlations coefficient. It is a measure of the internal consistency among the items. It is also used for multi-item scales (Cohen, Manion & Morrison, 2018). To determine the reliability of needs analysis questionnaire, a pilot test had been carried out among 30 Mathematics teachers in primary schools.

Table 2 shows the interpretation of alpha coefficient. If the alpha coefficient is above 0.90, the item is very highly reliable. If the alpha coefficient is between 0.80 to 0.90, the item is highly

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reliable. If the alpha coefficient is between 0.70 to 0.79, the item is reliable. If the alpha coefficient is between 0.60 to 0.69, the item is marginally or minimally reliable. Finally, if the alpha coefficient is below 0.60, then the item is unacceptable low reliable.

Table 2. Interpretation of Alpha Coefficient

Alpha Coefficient	Interpretation
> 0.90	very highly reliable
0.80 – 0.90	highly reliable
0.70 – 0.79	reliable
0.60 – 0.69	marginally/ minimally reliable
< 0.60	unacceptably low reliably

METHODOLOGY

Expert validation had been carried out among nine domain experts, whereas reliability evaluation had been done by carrying out a pilot test among 30 Mathematics teachers.

Respondents

Content validity questionnaires should be sent to the experts working at different locations. The survey should be distributed to the experts in the same field of the research (Taherdoost, 2016). In this study, nine experts had validated the content validity, which were three experts in dyscalculia, three experts in Mathematics, and three experts in learning difficulties. Figure 1 shows the expert panel in validating the content of needs analysis questionnaire.

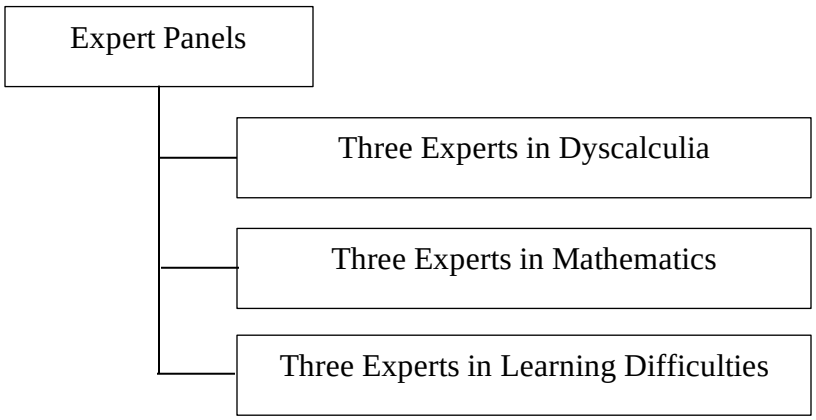

Figure 1. Expert Panel in Validating the Needs Analysis Questionnaire

Among these nine experts, there were one professor from United Kingdom who are expertise in the field of dyscalculia, two experts in dyscalculia who has a doctorate degree, one associate

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professor in university who is expertise in Mathematics education, one lecturer of Mathematics who has a doctorate degree, one Mathematics lecturer in Teacher Education Institution, one university lecturer and one Teacher Education Institute lecturer who are expertise in learning difficulties, and one Excellent Teacher Award receiver who is expertise in learning difficulties of Mathematics.

For reliability evaluation, the researchers had carried out a pilot test for needs analysis survey. The pilot test involved 30 Mathematics teachers in primary schools. The purpose of selecting Mathematics teachers in primary schools as the respondents is to obtain the perceptions on the needs to design and develop dyscalculia instrument for dyscalculic pupils in primary schools. Among the participants, nine of them (30 percent) were male and 21 of them were female (70 percent). Ten of them were aged between 21 to 30 years old, 17 of them were 31 to 40 years old, and three of them were 41 to 50 years old. Half of them completed their bachelor degree (50 percent); 13 of them completed their master degree (43.3 percent); one of them had certificate (3.3 percent); and one of them had diploma (3.3 percent).

Instruments

The first instrument in this study was needs analysis questionnaire. Three purposes of needs analysis questionnaire were (a) to evaluate teachers' knowledge towards difficulties of dyscalculic pupils, (b) to evaluate teachers' efficacy to teach dyscalculic pupils, and (c) to obtain opinions on the needs and design of dyscalculia instrument. Originally, there were five parts in the needs analysis questionnaire, namely (a) demographic data, (b) your knowledge towards difficulties of dyscalculic pupils, (c) your perception towards your efficacy to teach dyscalculic pupils, (d) your opinion on the needs and design of dyscalculia instrument, and (e) your opinion towards content of dyscalculia instrument.

The second instrument in this study is content validity questionnaire for needs analysis. Four objectives of this content validity questionnaire are (a) to measure the content validity of the items in Part A: your knowledge towards difficulties of dyscalculic pupils, (b) to measure the content validity of the items in Part B: your perception towards your efficacy to teach dyscalculic pupils, (c) to measure the content validity of the items in Part C: your opinion on the needs and design of dyscalculia instrument, and (d) to measure the content validity of the items in Part D: your opinions towards content of dyscalculia instrument. In answering this questionnaire, the experts need to

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circle the number that represents their answer based on the relevant levels, which were represented by the scale from [1] not relevant; [2] somewhat relevant; [3] quite relevant; and [4] high relevant.

RESULTS

The results of this study had been discussed in two sections, which are content validity and reliability.

Content Validity

During this phase, nine experts had been involved in validating the needs analysis questionnaire. Table 3 shows the ratings on Part B of needs analysis questionnaire: items rated 3 or 4 on a 4-point relevant scale. I-CVI for every item in Part B is within the range of 0.78 to 1.00, except item nine with an I-CVI of 0.67. Meanwhile, the Kappa statistic for every item in this part is within the range of 0.76 to 1.00, except item nine with a Kappa statistic of 0.60. Due to the low I-CVI value and Kappa statistic for item nine, this item had been removed from the questionnaire. Overall, the S-CVI (Average) for Part B is 0.88. Hence, nine items in Part B: your knowledge towards difficulties of dyscalculic pupils had been maintained.

Table 3. Ratings of Part B of Questionnaire: Items Rated 3 or 4 on a 4-Point Relevant Scale

Items	E1	E2	E3	E4	E5	E6	E7	E8	E9	No. in agreement	I-CVI	Pc	K
1	1	1	1	1	1	1	1	1	1	9	1.00	0.001953	1.00
2	1	1	1	1	1	1	1	1	1	9	1.00	0.001953	1.00
3	1	1	1	1	1	1	1	1	1	9	1.00	0.001953	1.00
4	1	1	1	1	1	1	0	1	1	8	0.89	0.017578	0.89
5	1	0	0	1	1	1	1	1	1	7	0.78	0.070313	0.76
6	1	1	1	1	1	1	1	1	1	9	1.00	0.001953	1.00
7	1	1	1	1	1	1	0	1	1	8	0.89	0.017578	0.89
8	1	0	0	1	1	1	1	1	1	7	0.78	0.070313	0.76
9	0	0	1	1	1	1	0	1	1	6	0.67	0.164063	0.60
10	1	0	1	1	1	0	1	1	1	7	0.78	0.070313	0.76

Table 4 shows the ratings on Part C of needs analysis questionnaire: items rated 3 or 4 on a 4-point relevant scale. I-CVI for every item in Part C is within the range of 0.78 to 1.00, except item two with an I-CVI of 0.56. On the other hand, the Kappa statistic for every item in this part is within the range of 0.76 to 1.00, except item two with a Kappa statistic of 0.41. Since the values of I-CVI and Kappa statistics of item two are lower than the acceptable values, hence this item had been

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removed. Overall, S-CVI (Average) for Part C is 0.84. Hence, 11 items in Part C: your perception towards your efficacy to teach dyscalculic pupils had been maintained.

Table 4. Ratings of Part C of Questionnaire: Items Rated 3 or 4 on a 4-Point Relevant Scale

Items	E1	E2	E3	E4	E5	E6	E7	E8	E9	No. in agreement	I-CVI	Pc	K
1	1	0	1	1	1	1	1	1	1	8	0.89	0.017578	0.89
2	1	0	0	1	1	1	0	0	1	5	0.56	0.246094	0.41
3	1	1	0	1	1	1	1	1	1	8	0.89	0.017578	0.89
4	1	0	0	1	1	1	1	1	1	7	0.78	0.070313	0.76
5	1	0	0	1	1	1	1	1	1	7	0.78	0.070313	0.76
6	1	1	1	1	1	1	1	1	1	9	1.00	0.001953	1.00
7	1	1	1	1	1	1	1	1	1	9	1.00	0.001953	1.00
8	1	1	0	1	1	1	1	1	1	8	0.89	0.017578	0.89
9	1	1	0	1	1	1	1	1	1	8	0.89	0.017578	0.89
10	1	1	0	1	1	1	1	1	1	8	0.89	0.017578	0.89
11	1	1	0	1	1	0	1	1	1	7	0.78	0.070313	0.76
12	1	1	0	1	1	1	0	1	1	7	0.78	0.070313	0.76

Table 5 shows the ratings on Part D of needs analysis questionnaire: items rated 3 or 4 on a 4-point relevant scale. I-CVI for every item in Part D is within the range of 0.78 to 1.00, except item 11 with an I-CVI of 0.67. On the other hand, the Kappa statistics for every item in this part is within the range of 0.76 to 1.00, except item 11 with a Kappa statistic of 0.60. Since the values of I-CVI and Kappa statistics of item 11 are lower than the acceptable values, hence this item had been removed. Overall, S-CVI (Average) for Part D is 0.83. Thus, 13 items in Part D: your opinion on the needs and design of dyscalculia instrument had been maintained.

Table 5. Ratings of Part D of Questionnaire: Items Rated 3 or 4 on a 4-Point Relevant Scale

Items	E1	E2	E3	E4	E5	E6	E7	E8	E9	No. in agreement	I-CVI	Pc	K
1	1	0	1	1	1	1	1	1	1	8	0.89	0.017578	0.89
2	1	0	0	1	1	1	1	1	1	7	0.78	0.070313	0.76
3	1	1	0	1	1	1	1	1	1	8	0.89	0.017578	0.89
4	1	0	0	1	1	1	1	1	1	7	0.78	0.070313	0.76
5	1	1	0	1	1	1	0	1	1	7	0.78	0.070313	0.76
6	1	1	1	1	1	0	1	1	1	8	0.89	0.017578	0.89
7	1	1	1	1	1	1	1	1	1	9	1.00	0.001953	1.00
8	1	0	0	1	1	1	1	1	1	7	0.78	0.070313	0.76
9	1	0	0	1	1	1	1	1	1	7	0.78	0.070313	0.76
10	1	0	0	1	1	1	1	1	1	7	0.78	0.070313	0.76

DOI: 10.48165/sajssh.2022.3307

11	1	0	0	1	1	1	0	1	1	6	0.67	0.164063	0.60
12	1	0	0	1	1	1	1	1	1	7	0.78	0.070313	0.76
13	1	1	0	1	1	1	1	1	1	8	0.89	0.017578	0.89
14	1	1	0	1	1	1	1	1	1	8	0.89	0.017578	0.89

Table 6 shows the ratings on Part E of needs analysis questionnaire: items rated 3 or 4 on a 4-point relevant scale. I-CVI for seven of the items in Part E is within the range of 0.78 to 1.00, except item three, item six, and item nine (I-CVI = 0.67). Meanwhile, the Kappa statistics for seven items in this part is within the range of 0.76 to 1.00, except item three, item six, and item nine (I-CVI = 0.60). Overall, S-CVI (Average) for Part E is 0.77. Since the S-CVI (Average) is lower than the acceptable value (0.80), this showed that there is a low scale-level content validity index based on the average for the construct, the items in Part E have to be removed.

Table 6. Ratings of Part E of Questionnaire: Items Rated 3 or 4 on a 4-Point Relevant Scale

Items	E1	E2	E3	E4	E5	E6	E7	E8	E9	No. in agreement	I-CVI	Pc	K
1	1	1	0	1	1	1	1	1	1	8	0.89	0.017578	0.89
2	1	1	0	1	1	1	1	1	1	8	0.89	0.017578	0.89
3	1	0	0	1	1	0	1	1	1	6	0.67	0.164063	0.60
4	1	0	0	1	1	1	1	1	1	7	0.78	0.070313	0.76
5	1	1	0	1	1	0	1	1	1	7	0.78	0.070313	0.76
6	1	0	0	1	1	0	1	1	1	6	0.67	0.164063	0.60
7	1	0	0	1	1	1	1	1	1	7	0.78	0.070313	0.76
8	1	1	0	1	1	0	1	1	1	7	0.78	0.070313	0.76
9	1	0	0	1	1	0	1	1	1	6	0.67	0.164063	0.60
10	1	0	0	1	1	1	1	1	1	7	0.78	0.070313	0.76

As a summary, three items had been removed after the process of validation using I-CVI and Kappa statistic analysis. In addition, Part E: your opinion towards the content of dyscalculia instrument had been removed due to the low S-CVI (Average) achieved. Overall, the S-CVI (Average) for Part B, Part C, Part D, and Part E were 0.88 (Table 3.10), 0.84 (Table 3.11), 0.83 (Table 3.12), and 0.77 (Table 3.13) respectively. Table 7 shows the results of validity analysis based on I-CVI, S-CVI (Average), and Kappa statistics. The original needs analysis was having 46 items at the beginning, after went through the validity analysis process, 13 items had been removed, and 33 items had been remained. On the whole, there is a total number of 38 items included five items in Part A: demographic data in this needs analysis questionnaire.

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Table 7. Results of Validity Analysis based on I-CVI, S-CVI (average), and Kappa Statistics

Part	Number of Items	Items Deleted	Items Remained	Justification
B	10	1	9	Low I-CVI and Kappa for Item 9
C	12	1	11	Low I-CVI and Kappa for Item 2
D	14	1	13	Low I-CVI and Kappa for Item 11
E	10	10	-	Low S-CVI (Average)
Total	**46**	**13**	**33**	

Reliability

In this study, Cronbach's Alpha value was used to determine the reliability of the needs analysis questionnaire. The minimum alpha value needed for overall items is 0.65, however it is better to obtain the alpha value at least 0.70 (Ismail, Yunus & Awang, 2020). Besides the five items of demographic data, there is a number of 33 items in Part B, Part C, and Part D. Table 8 shows the value of Cronbach's Alpha for needs analysis questionnaire. Overall, the items in this need analysis questionnaire have Cronbach's Alpha value of 0.893. This showed a recommended value for good internal consistency, which can be interpreted as highly reliable.

Table 8. Value of Cronbach's Alpha for Needs Analysis Questionnaire

Part	Cronbach's Alpha Value
B	0.814
C	0.889
D	0.975
Overall	**0.893**

Analysis of [Cronbach's Alpha if item deleted] for all the items showed a strong internal consistency range for the questionnaire, which is from 0.767 to 0.977. Item discrimination was determined using the [corrected item-total correlation]. This test measures how an item correlates with the total score. A correlation values of less than 0.2 or 0.3 were used as the cut-off value below which an item should be considered redundant and removed from the questionnaire (Field, 2009 in Ismail et al., 2020). In this questionnaire, the value of [corrected item-total correlation] for all the items is above 0.3, except item six in Part B [take a long time to complete calculations] with a low correlation value of 0.283.

Table 9 shows results of reliability analysis based on Cronbach's Alpha. Before the reliability analysis, the questionnaire consisted of 33 items. After went through the reliability analysis process, one item in Part B had been removed, due to the low value of [corrected item-total correlation].

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So, there were 32 items remained in this questionnaire to be used in the field study. On the whole, there was a total number of 37 items included five items in Part A: demographic data in this needs analysis questionnaire.

Table 9. Results of Reliability Analysis on Cronbach's Alpha

Part	Number of Items	Items Deleted	Items Remained	Justification
B	9	1	8	The value of [corrected item-total correlation] is below 0.3.
C	11	-	11	-
D	13	-	13	-
Total	**33**	**1**	**32**	

DISCUSSION

Content validity ensures that items drawn from the specific domain of content are relevant to the measurement situation that are used to operationalize rated on the construct (Shrotryia & Dhanda, 2019). Content validity of the needs analysis questionnaire for dyscalculia instrument was conducted with nine domain experts. These domain experts were ticked on the items on the basis of their relevance and necessity. The quantification of content validity on the basis of CVI (I-CVI and S-CVI) and Kappa coefficient indicated high content validity for the items. Based on the results, the validity and reliability of the questionnaire are high, based on expert judgment and pilot test among Mathematics teachers. This shows that the questionnaire can provide significant implication in helping to investigate the needs to design and develop an instrument for dyscalculic pupils in primary schools.

LIMITATIONS OF THE STUDY

This study has a number of limitations. First, as data were taken only from government national schools, future research could include data from different school types in our country. Differences in types of schools and backgrounds could yield different results regarding the needs on the intervention instrument for the dyscalculic pupils. Secondly, further effort should be made to adapt the needs analysis to other learning difficulties such as dyslexia, dysgraphia, dyspraxia, and so on. Different challenges are linked to different types of learning difficulties. As a result, several contributing elements may have an impact on the outcomes of needs analysis for pupils with different learning difficulties.

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CONCLUSION

The results of the study showed the success of needs analysis questionnaire for dyscalculia instrument in obtaining high validity and reliability from field experts and Mathematics teachers. This questionnaire aimed to investigate the needs to design and develop a dyscalculia instrument for dyscalculic pupils in primary schools, thus teachers' knowledge towards difficulties of dyscalculic pupils, teachers' efficacy to teach dyscalculic pupils, and teachers' opinion on the needs and design of dyscalculia instrument were crucial data in this study. Future researchers are suggested to ensure the psychometric properties of this questionnaire by checking the instrument for other forms of validity such as face, construct, and criterion validity for better applicability of the needs analysis questionnaire for dyscalculia instrument.

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