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Uncovering major barriers for not seeking mathematics assistance in the education industry: DEMATEL modelling approach

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Abstract: The Decision Making and Trial Evaluation Laboratory (DEMATEL) is an effective method for structural modelling that is comprehensively based on matrices. It is a commonly used method for modelling relationships between variables. DEMATEL has been applied in various areas, including project management, environmental engineering, social science, facility location problems, and education, to investigate the relationships among variables. DEMATEL reveals the relationship and the severity of the effects of factors on each other. It is a valuable and applicable method for industries. This method utilises matrices and diagrams to visualise the structure of complex causal relationships, making it suitable for evaluating industrial problems, resulting in effective decision making.

The participation rate of students in mathematics is falling, and this is concerning worldwide, especially in the education sector. The declining participation rate has led to a level of mathematical skills required for students to pursue their studies successfully at universities being inadequate. Currently, many countries, including Australia, are increasing resources to improve the uptake of mathematics in secondary schools. In the short term, however, there are numerous students enrolled in universities and other tertiary institutions who lack mathematical skills and, in some cases, severely. Despite the lack of mathematics skills in schools and the community, as well as the requirement of mathematics in most university units, several students fail to avail themselves of mathematics support. The education sector, as an industry, establishes Mathematics Learning Support Centres (MLSCs) to provide extra assistance to students currently enrolled in a university, but the usage is not satisfactory.

The authors identified twelve barriers for not seeking mathematics support through a literature review and interviews with five Mathematics Learning Advisers (MLA) experts at the Academic Learning Centre (ALC) at Central Queensland University (CQU). The interrelationships among the barriers were considered in the application of the DEMATEL method to determine the key barriers for not seeking mathematics support. The DEMATEL method has identified the top three critical barriers for not seeking mathematics help at the Mathematics Support Centre at Central Queensland University (CQU).

Keywords: *DEMATLEL, structural model, mathematics support, barriers*

1. INTRODUCTION

Mathematics Learning Support Centres (MLSCs) at universities are an effective way to support students and minimise the decline of mathematics knowledge for successful education in the tertiary setting. Mathematics Learning Support (MLS) at the university in the education industry can be described as any extra, non-credit, optional, and non-compulsory program that helps students develop their mathematical skills during their enrolled studies in a degree course (MacGillivray, 2008). While these facilities are available at the universities to help students, several students do not use them. Studies by Symonds et al. (2008), Grehan et al. (2011), Mac an Bhaird et al. (2013), Ryland and Shearman (2015), and Rylands and Shearman (2018) outline several reasons why students do not use MLSCs for MLS. A study by Breen et al. (2015) analysed students' comments and identified some barriers to why students did not seek MLS in a focus group discussion. A recent study by Deacon and Ni Fhloinn (2025) also examined the reasons students gave for not using MLS. They determined the most frequent barriers to students' non-attendance for support in the study. Even though there were discussions regarding the barriers for not seeking at MSLCs in the literature (Mac an Bhaird et al. 2013; Breen et al., 2015; Deacon and Ni Fhloinn), none of the studies examined the barriers in detail in terms of interrelationships among the barriers. While none of the studies above have examined the interrelationships among the variables, Dzator and Dzator (2019) applied the DEMATEL method to determine factors that cause students to seek mathematics support. As no study has used DEMATEL to identify the key barriers preventing students from seeking mathematics support, this study will contribute to the literature by applying DEMATEL to these barriers.

Barriers are defined by Pia (2015) as factors that inhibit or prevent people from participating in activities. For this study, barriers refer to factors that prevent or discourage students from seeking MLS. The authors used literature reviews and expert opinions to determine the barriers for not seeking mathematics support in this study. Ranking the barriers will help students and Mathematics Learning Advisers (MLAs) focus on key barriers to the problem when students do not seek MLS. This paper will utilise a decision-making model (DEMATEL) to rank the barriers for not seeking MLS, enabling us to identify the most important barriers necessary to improve seeking MLS. The objective of this paper is to use DEMATEL to identify key barriers for not seeking mathematics support in universities. The remainder of the paper is organised as follows. Section 2 discusses the DEMATEL method. The methodology is presented in Section 3, and the results and discussions are presented in Section 4. We present key findings, results implication and limitations (with suggestions for future research) in Section 5. The conclusion of the paper is presented in Section 6.

2. DEMATEL METHOD

The Decision Making and Trial Evaluation Laboratory (DEMATEL) method was developed in Switzerland by Gabus and Fontel (1972, 1973) to serve as a tool that would make it possible to solve complex problems and to analyse a variety of causal links. For example, a set of complex issues has a set of elements that have a binary relation with each other. It is a commonly used method for modelling the relationship between variables. DEMATEL, which involves five steps, is described as follows:

Step 1: Generate the direct relation matrix. The matrix represents the aggregate influence scores for various variables or factors. The rating of 0 (No influence), 1 (Low influence), 2 (Medium influence), 3 (High influence) and 4 (Very high influence) among the various factors or variables is done by experts. The average of the matrices which represent the rating from each expert are determined which will result in a square matrix *A* with zero at the principal diagonal $A = [a_{ij}]_{n \times n}$

where, a_{ij} represents the degree which factor *i* impacts factor *j.* That is

$$A = \frac{1}{N}\sum_{k=1}^{N} a_{ij}^{(k)}$$

where *N* is the number of experts (1)

Step 2: Normalize the direct relation matrix. The normalized direct relation matrix *B* is obtained as follows

$$B = \frac{A}{\max\left[\max \sum_{i=1}^{n} a_{ij}, \max \sum_{j=1}^{n} a_{ij}\right]}, i, j \in \{1, 2, ..., n\} \tag{2}$$

That is divide matrix *A* by the maximum of the sum of rows and sum of columns.

Step 3: Develop the total relation matrix C from the normalized direct relation matrix B as follows. The total relation matrix C in which I is the identity matrix and B^m is m-indirect influence is obtained by

$$C = \left[c_{ij}\right]_{n\times n} = B + B^2 + \cdots + B^m$$

In the limit as $m \to \infty$, $C = B(I - B)^{-1}$,

(3)

Step 4: Produce a causal diagram by using the sum of rows D and sum of the columns E

$$D = \left[d_{ij}\right]_{n\times 1} = \left[\sum_{j=1}^{n} c_{ij}\right]_{n\times 1} \quad E = \left[e_{ij}\right]_{1\times n} = \left[\sum_{i=1}^{n} c_{ij}\right]_{1\times n}$$

(4)

The horizontal axis (*D*+*E*) represents the importance of the variables, whereas the vertical axis (*D*-*E*) shows the cause-and-effect relationships. The variables with positive (*D*-*E*) values are the cause factors, whereas those with negative values are effect factors. The sum of the *ith* row *D* is the causal influence, and the sum of the *jth* column *E* is the effect influence of the total relation matrix *C*.

Step 5: Depict structural relation between variables

The structural relation amongst variables is shown through an inner dependence matrix by retaining only those variables whose effect in the matrix *C* is greater than the threshold value μ, as determined by experts, based on a literature review, or by averaging the values of *C* matrix elements. The use of the threshold to simplify the total relation matrix is to filter out the variables having negligible effects from the total relation matrix *C*. The matrix obtained by setting the values that are less than the threshold value is known as the inner dependency matrix.

There have been recent studies that have applied the DEMATEL method to examine problems within the university sector. A DEMATEL method was used by Aldowah et al. (2025) to explore the factors that shaped student engagement in an online environment. This study is to uncover hidden relationships and understand the roots of low engagement among university students. Mehta and Sharma (2023) and Hu (2023) also examined student learning in the online environment. Yan et al. (2025) also applied DEMATEL to investigate the behaviour of students in a university flipped classroom environment. The DEMATEL method emphasises causal relationships and decision-making, whereas factor analysis and principal component analysis focus on data reduction and structure identification (Hsu, 2012).

3. METHODOLOGY

The first step of the methodology involves the selection of barriers for not seeking support through the literature review and discussions with advisers. the ALC for MLS. Teng (2002) proposed that 5 to 15 experts are appropriate for group decision making. The five experts whom we used for the pairwise evaluation of the barriers are suitable for this study because of the type of problem to be solved. Moreover, several studies used five or fewer experts. For example, Hiete et al. (2011) used three experts to evaluate building ratings in the building industry in Germany. In a study by Singhal et al. (2018) to identify key issues influencing the remanufacturing process in developing countries, they used five experts for the study. Sawaragi et al. (2006), Khazai et al. (2013), and Chang and Chen (2018) all used experts ranging from two to five. The second step involves classifying the barriers into a matrix form. The third step consists of the application of DEMATEL. DEMATEL is used as a solution methodology since it is best suited for analysing interrelationships among the barriers. It will also help us to identify the important barriers for not seeking Mathematics Learning Support.

3.1. Barriers (Factors) for not seeking MLS

The list of 12 barriers for not using Mathematics Learning Support was obtained from the results of the literature (Breen et al., 2015; Symonds et al.,2008; Mac an Bhaird et al., 2013; Grehan et al., 2011) and by brainstorming. There was further discussion with five MLAs at CQU in Australia. All the barriers for not using MLS were retained after the discussion and presented as follows, with explanations:

Explanation of the Barriers

B1 (b1). Unawareness of Location: Many students are unaware of where the Mathematics Learning Support Centre (MLSC) is situated.

B2 (b2). Unfamiliarity with Resources: There is a lack of knowledge about the specific facilities and resources offered at the MLSC.

B3 (b3). Underestimating the Need: Some students do not recognise their own need for mathematics support, leading to missed opportunities for assistance.

B4 (b4). Overwhelming Challenges: The perception of too many academic challenges can discourage students from seeking help.

B5 (b5). Fear of Judgment: Students may hesitate to seek support due to fears of embarrassment, intimidation, or stigma associated with asking for help.

B6 (b6). Misconceptions about Inclusivity: Non-STEM students might believe that mathematics support services are only tailored for those in science, technology, engineering, and mathematics fields.

B7 (b7). Lack of Initiative: Some individuals may struggle with motivation or may simply lack the initiative to pursue mathematics support.

B8 (b8). Poor Facility Conditions: The state or quality of the facilities may be a deterrent for students looking to access support.

B9 (b9). Time Constraints: Students often cite a lack of time or inconvenient scheduling as a barrier to accessing mathematics support services.

B10 (b10). Doubt in Effectiveness: There may be a scepticism surrounding the quality and effectiveness of the support provided, leading to reluctance in seeking help.

B11 (b11). Self-Sufficiency Beliefs: Some students hold the belief that they do not require assistance with mathematics.

B12 (b12). Non-Mandatory Nature: Since seeking mathematics support is not a compulsory aspect of their education, students may choose to forgo it.

4. RESULTS AND DISCUSSIONS

The expert rated the influence of the barriers on each other on a scale of 0 (no influence) to 4 (very high influence). The results from the MLA experts are presented and analysed in the steps below.

Step 1: The average matrix is obtained by adding the five matrices from the experts and dividing by 5 using the Microsoft Excel. Matrix A is obtained using Equation 1 and shown in Figure 1 below:

$$\begin{bmatrix}
0.0 & 2.6 & 1.2 & 2.0 & 1.4 & 1.2 & 2.2 & 1.4 & 2.4 & 1.8 & 2.2 & 1.0 \\
1.8 & 0.0 & 3.0 & 2.6 & 1.0 & 2.0 & 2.0 & 2.0 & 1.6 & 2.8 & 1.8 & 1.6 \\
1.8 & 2.8 & 0.0 & 2.4 & 1.6 & 2.4 & 2.8 & 1.8 & 1.6 & 2.2 & 3.0 & 2.2 \\
2.6 & 3.0 & 2.0 & 0.0 & 2.6 & 1.8 & 2.8 & 1.2 & 3.2 & 2.8 & 2.6 & 1.8 \\
2.2 & 2.0 & 2.2 & 1.8 & 0.0 & 2.2 & 2.6 & 1.2 & 1.0 & 1.4 & 2.2 & 1.2 \\
2.0 & 1.8 & 1.6 & 2.2 & 2.2 & 0.0 & 2.2 & 1.4 & 1.0 & 2.8 & 2.6 & 2.0 \\
2.8 & 2.4 & 2.8 & 2.8 & 2.2 & 2.2 & 0.0 & 0.8 & 1.4 & 1.6 & 2.8 & 1.6 \\
1.6 & 1.8 & 1.2 & 1.2 & 1.2 & 1.8 & 2.2 & 0.0 & 0.6 & 1.8 & 1.8 & 1.4 \\
2.8 & 2.4 & 2.2 & 2.8 & 1.6 & 1.0 & 2.4 & 0.8 & 0.0 & 1.8 & 3.0 & 1.2 \\
2.2 & 2.6 & 2.2 & 2.4 & 1.6 & 2.8 & 2.8 & 1.4 & 1.8 & 0.0 & 2.6 & 2.0 \\
2.2 & 2.2 & 3.0 & 2.4 & 1.8 & 2.2 & 3.0 & 1.8 & 2.6 & 3.4 & 0.0 & 1.4 \\
1.8 & 2.2 & 2.4 & 1.4 & 2.2 & 2.4 & 2.8 & 1.6 & 1.4 & 2.6 & 2.4 & 0.0
\end{bmatrix}$$

Figure 1 Average Matrix A

Step 2: Matrix A is divided by the max (sum of rows, sum of columns) = Matrix A is divided by max (26.400, 27.800). Matrix A is divided by 27.800, which is the maximum value. This is obtained using Equation 2 and presented in Figure 2

$$\begin{bmatrix} 0.000 & 0.094 & 0.043 & 0.072 & 0.050 & 0.043 & 0.079 & 0.050 & 0.086 & 0.065 & 0.079 & 0.036 \\ 0.065 & 0.000 & 0.108 & 0.094 & 0.036 & 0.072 & 0.072 & 0.072 & 0.058 & 0.101 & 0.065 & 0.058 \\ 0.065 & 0.101 & 0.000 & 0.086 & 0.058 & 0.086 & 0.101 & 0.065 & 0.058 & 0.079 & 0.108 & 0.079 \\ 0.094 & 0.108 & 0.072 & 0.000 & 0.094 & 0.065 & 0.101 & 0.043 & 0.115 & 0.101 & 0.094 & 0.065 \\ 0.079 & 0.072 & 0.079 & 0.065 & 0.000 & 0.079 & 0.094 & 0.043 & 0.036 & 0.050 & 0.079 & 0.043 \\ 0.072 & 0.065 & 0.058 & 0.079 & 0.079 & 0.000 & 0.079 & 0.050 & 0.036 & 0.101 & 0.094 & 0.072 \\ 0.101 & 0.086 & 0.101 & 0.101 & 0.079 & 0.079 & 0.000 & 0.029 & 0.050 & 0.058 & 0.101 & 0.058 \\ 0.058 & 0.065 & 0.043 & 0.043 & 0.043 & 0.065 & 0.079 & 0.000 & 0.022 & 0.065 & 0.065 & 0.050 \\ 0.101 & 0.086 & 0.079 & 0.101 & 0.058 & 0.036 & 0.086 & 0.029 & 0.000 & 0.065 & 0.108 & 0.043 \\ 0.079 & 0.094 & 0.079 & 0.086 & 0.058 & 0.101 & 0.101 & 0.050 & 0.065 & 0.000 & 0.094 & 0.072 \\ 0.079 & 0.079 & 0.108 & 0.086 & 0.065 & 0.079 & 0.108 & 0.065 & 0.094 & 0.122 & 0.000 & 0.050 \\ 0.065 & 0.079 & 0.086 & 0.050 & 0.079 & 0.086 & 0.101 & 0.058 & 0.050 & 0.094 & 0.086 & 0.000 \end{bmatrix}$$

Figure 2 Normalised Direct Relation Matrix B

Step 3: Multiply Matrix B by the inverse of the identity matrix I minus Matrix B. Matrix C is obtained using Equation 3 as shown in Figure 3

$$\begin{bmatrix} 0.285 & 0.392 & 0.330 & 0.358 & 0.280 & 0.304 & 0.398 & 0.235 & 0.312 & 0.359 & 0.391 & 0.246 \\ 0.383 & 0.350 & 0.424 & 0.416 & 0.301 & 0.368 & 0.438 & 0.281 & 0.318 & 0.432 & 0.423 & 0.297 \\ 0.416 & 0.475 & 0.361 & 0.443 & 0.347 & 0.411 & 0.500 & 0.297 & 0.344 & 0.449 & 0.496 & 0.339 \\ 0.465 & 0.507 & 0.451 & 0.388 & 0.396 & 0.411 & 0.525 & 0.291 & 0.413 & 0.488 & 0.509 & 0.342 \\ 0.365 & 0.382 & 0.368 & 0.359 & 0.240 & 0.344 & 0.420 & 0.235 & 0.273 & 0.355 & 0.400 & 0.259 \\ 0.384 & 0.403 & 0.376 & 0.397 & 0.335 & 0.296 & 0.438 & 0.258 & 0.294 & 0.426 & 0.441 & 0.304 \\ 0.432 & 0.448 & 0.437 & 0.441 & 0.354 & 0.389 & 0.391 & 0.255 & 0.328 & 0.414 & 0.473 & 0.308 \\ 0.297 & 0.323 & 0.288 & 0.290 & 0.242 & 0.288 & 0.352 & 0.161 & 0.219 & 0.317 & 0.332 & 0.230 \\ 0.416 & 0.430 & 0.401 & 0.424 & 0.320 & 0.334 & 0.450 & 0.242 & 0.267 & 0.401 & 0.460 & 0.281 \\ 0.426 & 0.466 & 0.431 & 0.441 & 0.345 & 0.420 & 0.496 & 0.281 & 0.348 & 0.372 & 0.481 & 0.331 \\ 0.448 & 0.478 & 0.476 & 0.463 & 0.368 & 0.421 & 0.527 & 0.307 & 0.390 & 0.502 & 0.420 & 0.328 \\ 0.395 & 0.434 & 0.419 & 0.391 & 0.349 & 0.392 & 0.476 & 0.276 & 0.319 & 0.437 & 0.454 & 0.250 \end{bmatrix}$$

Figure 3 Total Relation Matrix C

Step 4: Sum the rows and columns of Matrix C to obtained D and E using Equation 4. The results are shown in Tables 4.

Table 1 The sum and difference of influences for the twelve barriers

Barriers	D	E	D+E	D-E	Rank	C or E	Barriers
B1 (b1)	3.889	4.713	8.602	-0.824	8	E	Unawareness of Location
B2 (b2)	4.433	5.088	9.521	-0.655	6	E	Unfamiliarity with Resources
B3 (b3)	4.878	4.761	9.639	0.117	5	C	Underestimating the Need
B4 (b4)	5.186	4.812	9.998	0.374	3	C	Overwhelming Challenges
B5 (b5)	4.000	3.877	7.877	0.123	11	C	Fear of Judgment
B6 (b6)	4.353	4.378	8.731	-0.025	7	E	Misconceptions about Inclusivity
B7 (b7)	4.669	5.412	10.081	-0.743	2	E	Lack of Initiative
B8 (b8)	3.338	3.120	6.459	0.218	12	C	Poor Facility Conditions
B9 (b9)	4.425	3.825	8.250	0.600	9	C	Time Constraints
B10 (b10)	4.837	4.950	9.787	-0.113	4	E	Doubt in Effectiveness
B11 (b11)	5.128	5.280	10.408	-0.152	1	E	Self-Sufficiency Beliefs
B12 (b12)	4.592	3.515	8.107	1.077	10	C	Non-Mandatory Nature

The results in Table 1 show the degree of influence of each barrier over the other barriers using the total relation matrix shown in Figure 3. The importance of the twelve barriers based on D+E (the greater the value, the more important the barrier) in Table 1 is as follows: b11>b7>b4>b10>b3>b2>b6>b1>b9>b12>b5>b8. The most important barrier for not seeking Mathematics Learning Support, according to the experts, is b11, which is 'self-sufficiency beliefs' with the value of 10.408, and the least important is b8, which is 'poor facility conditions' with the value of 6.459. 'Self-Sufficiency Beliefs' is the most important barrier, which is also an effect barrier and is influenced by other barriers. Table 6 shows the cause barriers and the effect barriers. A study by Mac an Bhaird et al. (2013) stated that the main reason for students not seeking Mathematics Learning Support is that they believe they do not need it. Our study supported this finding. The difference between the row sum D and column sum E determines the cause group and the effect group. The difference between the row sum D and column sum E determines the cause group and the effect group. The barriers with positive D-E values are in the cause group, while the barriers with negative values are in the effect group.

Step 5: The Inner Dependence Matrix is obtained by omitting values which are less than the threshold of 0.373 from Matrix C. The average of Matrix C is used as the threshold for the study. This is shown in Table 2 below

Table 2 Heat Map (red - most important value to green – least important value) of the Inner Dependence Matrix

	B1	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**B8**	**B9**	**B10**	**B11**	**B12**
B1	0	0.392	0	0	0	0	0.398	0	0	0	0.391	0
B2	0.383	0	0.424	0.416	0	0	0.438	0	0	0.432	0.423	0
B3	0.416	0.475	0	0.443	0	0.411	0.5	0	0	0.449	0.496	0
B4	0.465	0.507	0.451	0.388	0.396	0.411	0.525	0	0.413	0.488	0.509	0
B5	0	0.382	0	0	0	0	0.42	0	0	0	0.4	0
B6	0.384	0.403	0.376	0.397	0	0	0.438	0	0	0.426	0.441	0
B7	0.432	0.448	0.437	0.441	0	0.389	0.391	0	0	0.414	0.473	0
B8	0	0	0	0	0	0	0	0	0	0	0	0
B9	0.416	0.43	0.401	0.424	0	0	0.45	0	0	0.401	0.46	0
B10	0.426	0.466	0.431	0.441	0	0.42	0.496	0	0	0	0.481	0
B11	0.448	0.478	0.476	0.463	0	0.421	0.527	0	0.39	0.502	0.42	0
B12	0.395	0.434	0.419	0.391	0	0.392	0.476	0	0	0.437	0.454	0

Table 3 Cause and Effect Barriers

Cause Barriers	**Effect Barriers**
Underestimating the Need (b3)	Unawareness of Location (b1)
Overwhelming Challenges (b4)	Unfamiliarity with Resources (b2)
Fear of Judgement (b5)	Misconceptions about Inclusivity (b6)
Poor Facility Conditions (b8)	Lack of Initiative (b7)
Time Constraints (b9)	Doubt in Effectiveness (b10)
Non-Mandatory Nature (b12)	Self-Sufficiency Beliefs (b11)

The cause barriers include b3, b4, b5, b8, b9, and b12 since D-E is positive, and the effect barriers include b1, b2, b6, b7, b10, and b11 since D-E is negative, as shown in Table 4 and Figure 4. The cause barriers have a net influence on the effect barriers. For example, 'Underestimating the Need' will affect 'Self-Sufficiency Beliefs'. A student who underestimates the importance of Mathematics Learning Support will think that they are self-sufficient and do not need support.

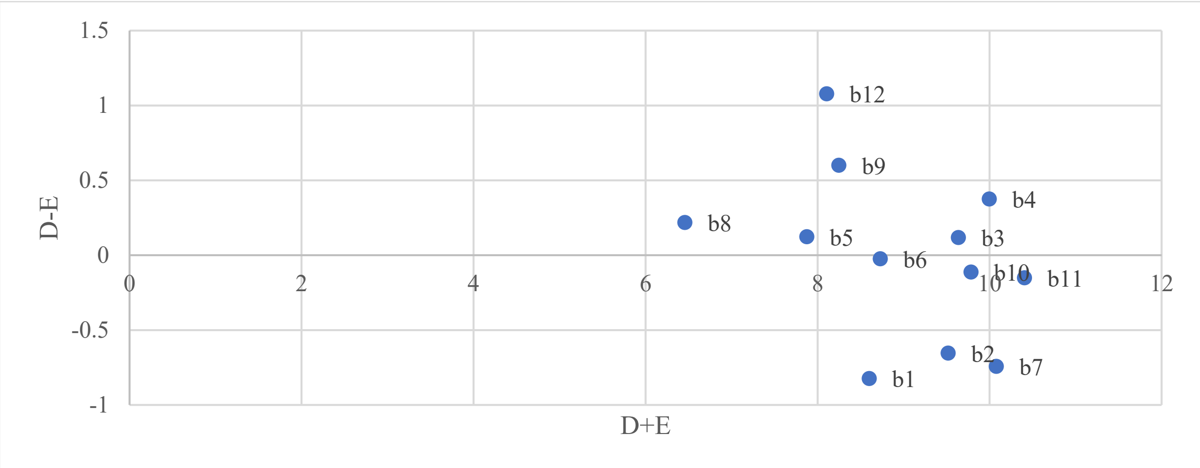

Figure 4 Prominence – Causal Diagram

Minimising the cause barriers while addressing the barriers for not seeking MLS will minimise the barriers in the effect group. For example, minimising 'Underestimating the Need' will minimise the barriers in the effect group, such as 'Self-Sufficiency Beliefs' and 'Doubt in Effectiveness'. The inner dependency matrix in Table 2 shows that none of the barriers had any significant effect on 'Poor Facility Conditions' (b8) and 'Non-Mandatory Nature' (b12), with both columns showing zero values.

5. KEY FINDINGS, RESULTS IMPLICATIONS AND LIMITATIONS

The key findings for consideration are as follows:

- The top three important barriers are 'Self-Sufficiency Beliefs', 'Lack of Initiative' and 'Overwhelming Challenges'. Two of the top three are effect barriers. To minimise the challenge of students seeking MLS, there is a need to focus on the top three barriers. For example, reducing the barrier caused by challenges students face may enhance students' ability to seek MLS.

Several limitations suggest further research. The number of experts is small. An increased number of experts may be needed for future research. There were only 12 barriers that were explored. Increasing the number of barriers could be explored through a more extensive literature review and discussions with more advisers for future research.

6. CONCLUSION

The identified barriers for not seeking Mathematics Learning Support from the literature review and the discussion with the experts. DEMATEL was then applied to the barriers to reveal the important barriers for consideration. The top three important barriers are 'Self-Sufficiency Beliefs', Lack of Initiative' and Overwhelming Challenges'. The most important barrier is 'Self-Sufficiency Beliefs'. This barrier is in the effect group and is highly influenced by all barriers except b8, which is not influenced by any barrier, as shown in Table 6. The identification of barriers and the application of DEMATEL to reveal the significant barriers will help Mathematics Learning Advisers target the most important barriers to enable students to change their attitude toward seeking mathematics support.

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