A ‘Caring Thinking’ Module in Mathematics: Its Impact on Social Attitudes and Behaviours of Students

HC-NY Education Seminar

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First Aim

- To develop interval level, unidimensional scales of **Self-Discipline**, **Moderation**, **Dependability** and **Responsibility**, with attitude items linked to behaviour items, based on conceptual models of the four values using a **Rasch measurement model**

Second Aim

- To investigate the **effects** of teaching values in a mathematics context through the ‘Caring Thinking’ way on **students’ social attitudes and behaviours in the four values**, using the scales developed

Significance and Relevance (1)

- **Implications** on:

  (a) the way caring values are **taught** – not didactically but **through subject curriculum**

  (b) the **role** of teachers – not just as deliverers of subject content, but also as **teachers of caring values**

  (c) the way students **learn** caring values – values are **contextualised** in the **real** world through subject matter

Significance and Relevance (2)

- The **successful** development of these four interval level, unidimensional scales of Self-Discipline, Moderation, Dependability and Responsibility have not been produced **before** this study (although attitudes and behaviour have been measured on the same Rasch scale for other variables)

Significance and Relevance (3)

- The development of the current scales could pave the way for developing scales for **measuring other values**
- The **strength** of these scales lies in being able to attach **quantitative performance indicators** to an attitude towards a value and to behaviours directly connected to that value

General Research Question

- What is the **impact** of a ‘Caring Thinking’ mathematics module on the social attitudes and behaviours (values) of secondary four (year 10) male students at a premier high school in Singapore?

Specific Research Question (1)

- Does the ‘Caring Thinking’ mathematics module develop **higher** levels of positive attitudes and behaviours in Self-Discipline, Moderation, Dependability and Responsibility in students who are taught the module, compared with, students who are taught the same mathematics in the traditional way?

Specific Research Question (2)

- What are the **inter-relationships** between the four dependent variables, Self-Discipline, Moderation, Dependability and Responsibility, for the experimental group posttest data?

Specific Research Question (3)

- What is the relationship between **Self-Discipline**, as dependent variable, and Housing Type, Level of Participation in Community Service and Level of Compliancy, as independent variables, for the experimental group posttest data?

Specific Research Question (4)

- What is the relationship between **Moderation**, as dependent variable, and Housing Type, Level of Participation in Community Service and Level of Compliancy, as independent variables, for the experimental group posttest data?

Specific Research Question (5)

- What is the relationship between **Dependability**, as dependent variable, and Housing Type, Level of Participation in Community Service and Level of Compliancy, as independent variables, for the experimental group posttest data?

Specific Research Question (6)

- What is the relationship between **Responsibility**, as dependent variable, and Housing Type, Level of Participation in Community Service and Level of Compliancy, as independent variables, for the experimental group posttest data?

Caring Thinking (1)

- Consists of **four** distinct but interdependent aspects –

  (a) **valuational thinking**

  (b) **affective thinking**

  (c) **active thinking**

  (d) **normative thinking**

  (Lipman, 1994)

Caring Thinking (2)

- **Valuational thinking** taps into **two** dimensions:

  (a) **appreciating** concrete things for their sensuous and aesthetic appeal, rather than material worth

  (b) **understanding abstract human qualities**, including attitudes, behaviours and values (part of **affective thinking**)

  (Lipman, 1994)

Caring Thinking (3)

- Valuational thinking results in **values realisation** – awareness of what one's values are and the ethical principles that guide one's actions (**active thinking**)

Caring Thinking (4)

- **Values clarification** process (or **normative thinking**) – involves:

  (a) **choosing** from alternatives

  (b) **believing** in the importance of one's chosen values or beliefs

  (c) **asserting** one's beliefs in communication with others

  Brunt (1996), Lipman (1994) and Lickona (1991)

The Mathematics Module (1)

- A means of developing values in students through the 'Caring Thinking' way by **creating the context in mathematics teaching** to allow students to engage in **valuational thinking**, **values realisation** and **values clarification**

The Mathematics Module (2)

- Students are taught *Probability* concepts, knowledge and problem-solving
- Interwoven with discussion on values of Self-Discipline, Moderation, Dependability and Responsibility surrounding the theme of *gambling* through video clips, newspaper articles, pair discussion, group discussion, presentations, information-gathering, debate

Definitions (1)

- **Self-Discipline** in this study referred to a student's **self-control** in **three domains** in his life – **physical**, **mental** and **financial** – in order to avoid an extreme and unbalanced lifestyle

Definitions (2)

- **Moderation**, within this study, referred to a student's **control** of his appetite in **three aspects** of the physical domain in his life: **speaking**, **eating** and **exercising**.

Definitions (3)

- **Dependability** referred to **loyalty**, entailing **support**, **service** and **contribution**, to **three circles** of people in a student's life – **family**, **school** and **friends** – to which commitments are made

Definitions (4)

- **Responsibility** referred to a student's **reliability** in his **commitments** to his **family**, **school** and **friends**
- Doing what he says he will do and even anticipating their needs beforehand.

Definitions (5)

- **Housing Type** – students were required to indicate the type of house they live in on the students' survey
- Used as a **proxy** for students' socioeconomic status

Definitions (6)

- Data on whether students had participated, or were involved in, Service-Learning projects provided an indication of students' **Level of Participation in Community Service**

Definitions (7)

- **Level of Compliancy** – students completed an ad hoc, **self-report rating scale**
- Not measured using an established measurement

First Aim

- To develop interval level, unidimensional scales of **Self-Discipline**, **Moderation**, **Dependability** and **Responsibility**, with attitude items linked to behaviour items, based on conceptual models of the four values using a **Rasch Measurement Model**

Questionnaire

- A questionnaire was **developed** to measure *Self-Discipline*, *Moderation*, *Dependability* and *Responsibility*
- **Pilot testing** of the questionnaire
- Rasch measurement and the computer programme, RUMM 2020 (Andrich, Sheridan & Luo, 2005), were chosen to **analyse the data** collected from the questionnaire

Rasch Measurement Model (1)

- The **Rasch Measurement Model** was developed at the *Danish Institute for Educational Research* in the 1950s by the Danish Mathematician and Statistician, Georg Rasch (1901 – 1980)

Rasch Measurement Model (2)

- Rasch Measurement Models show how to:

  (a) determine what is **measurable** on a linear scale

  (b) determine what data can be **reliably** used to create a linear scale, and what data cannot be used

  (Wright, 1999; Waugh, 2006)

Rasch Measurement Model (3)

- When the data fit a Rasch Measurement Model, **scale-free person measures** and **sample-free item difficulties** are mathematically calculated to produce a linear scale with standard units
- The units are called '**logits**' (the log odds of successfully answering the items)

  (Waugh, 2006)

Rasch Measurement Model (4)

- There are **six** Rasch Measurement Models designed to apply to different measuring situations

  (Waugh, 2006)

Rasch Measurement Model (5)

- For example, the **Simple Logistic Model of Rasch** (Rasch, 1960/1980) is used to create measures for items with **two response categories**, that is, yes or no, right or wrong, high or low
- **Equations** for the Simple Logistic Model of Rasch

Rasch Measurement Model (6)

- The **Partial Credit Model of Rasch** is used when the item response categories are **three or more** (Andrich, 1989)
- The Partial Credit Model of Rasch was used in this study to derive **four** scales of **16 items each**: *Self-Discipline*, *Moderation*, *Dependability* and *Responsibility*
- **Equations** for this model

Rasch Measurement Model (7)

- The Partial Credit Model of Rasch (Masters, 1997; Andrich, 1989) was used with the **Rasch Unidimensional Measurement Models (RUMM 2020)** (Andrich, Sheridan & Luo, 2005) programme to analyse the data and create **four** scales of *Self-Discipline*, *Moderation*, *Dependability* and *Responsibility*

Rasch Measurement Model (8)

- The computer programme makes **six tests of the data** (see Waugh, 2002a, 2002b, 2006) to fit the measurement model so that a linear scale can be created

Rasch Measurement Model (9)

- **Six tests of the data**:

  (a) **Item thresholds** are calculated in relation to the category responses

  (b) **Item-trait test-of-fit** is calculated with a corresponding probability of fit

  (c) **Item-person interaction** and **person-item interaction** are calculated

  (d) **Person Separation Index** is constructed

  (e) **Residuals** are calculated for item and for persons

  (f) **Construct validity** of the data is tested

Rasch Measurement Model (10)

(a) **Item thresholds**

- For this study, there are four responses to each item so there are **three thresholds** for each item

- The thresholds for the item should be **ordered** in correspondence with the ordered response categories if the students responded consistently in line with their person measures and the item difficulty

- Otherwise the item is rejected

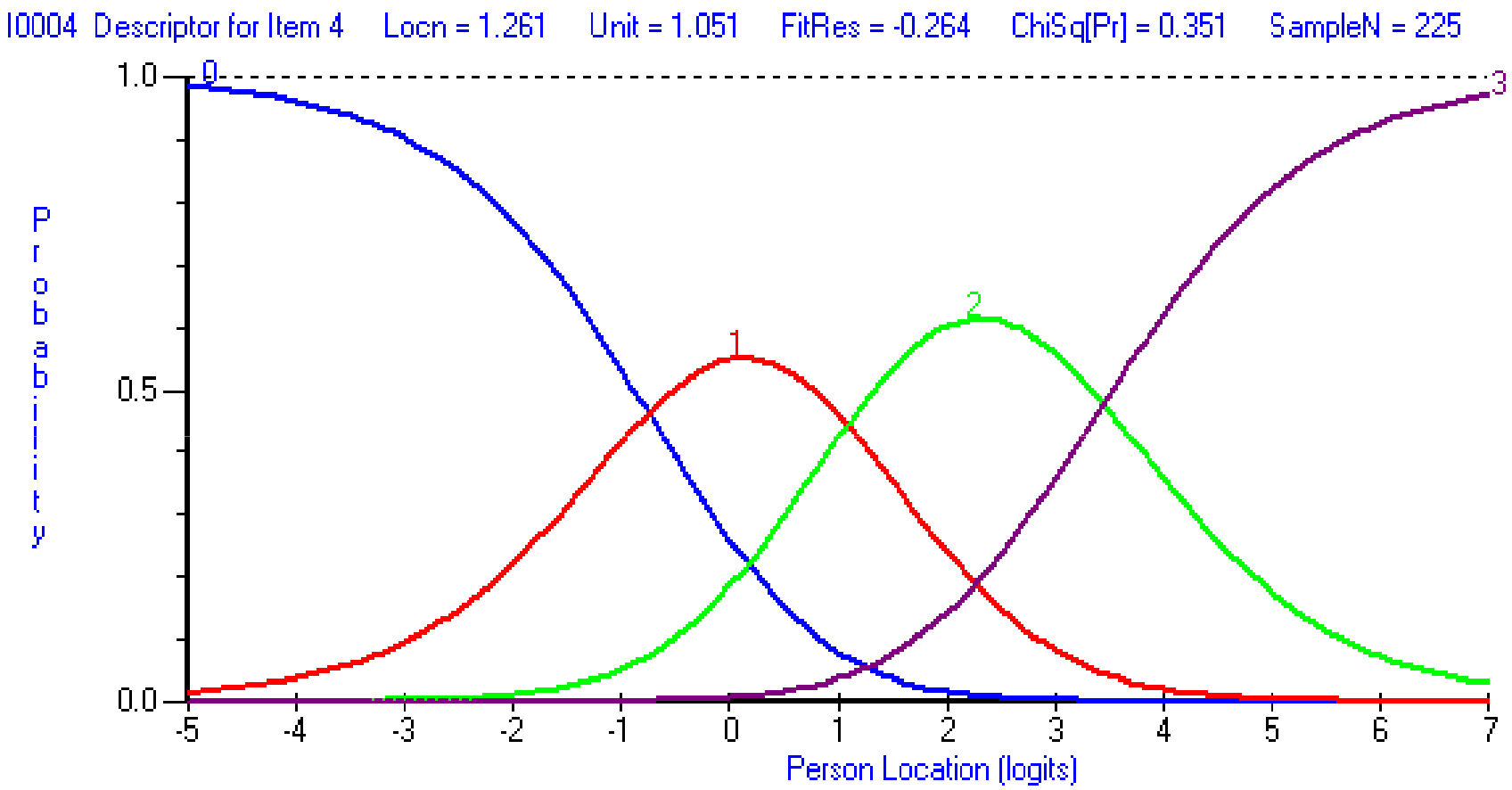


Figure 1. Response Category Curves for Item 4 (Self-Discipline scale)

Rasch Measurement Model (11)

(b) **Item-trait test-of-fit**

- This test shows the **consistency of responses** for all items across students of different measures along the scale and indicates whether a **unidimensional trait** can be used to describe each student's item response

Rasch Measurement Model (12)

(c) **Item-person interaction** and **person-item interaction**

- The **item-person test-of-fit** examines the response patterns for items across students and the **person-item test-of-fit** examines the response patterns for students across items

- When the data fit the model, the standardised fit statistics approximate a distribution with a **mean near zero** and a **standard deviation near one**

Rasch Measurement Model (13)

(d) **Person Separation Index**

- The **ratio of estimated true variance among students and estimated observed variance among students**, using the estimates of their locations (measures) and the standard errors of these locations (measures) (Andrich & Van Schoubroeck, 1989)

- For good Rasch measures, the index is expected to be **greater than 0.90** (can be interpreted in the same way as a Cronbach Alpha)

Rasch Measurement Model (14)

(e) **Residuals** are calculated for items and for persons

- The **difference** between the expected values predicted from the model and the observed values

- The residuals should be **minimised** for a good measure

- Dependent on collecting good data and on the students answering the questionnaire consistently, logically and truthfully

Rasch Measurement Model (15)

(f) **Construct validity** of the data is tested

- **Items** designed **from easy to difficult** in each scale

- **Each item**, answered in two perspectives '*I aim for this*' (measuring attitude) and '*I actually do this*' (measuring behaviour), is **ordered from easy to hard**

- So, **vertically**, the questionnaire has different items ordered from easy to hard, with each item perspective ordered **horizontally** from easy to hard

- By examining the actual item difficulties, the **structure** of conceptual item difficulties can be tested

Summary of Fit Statistics for Dependability from the Rasch Analysis (N = 226, I = 16)

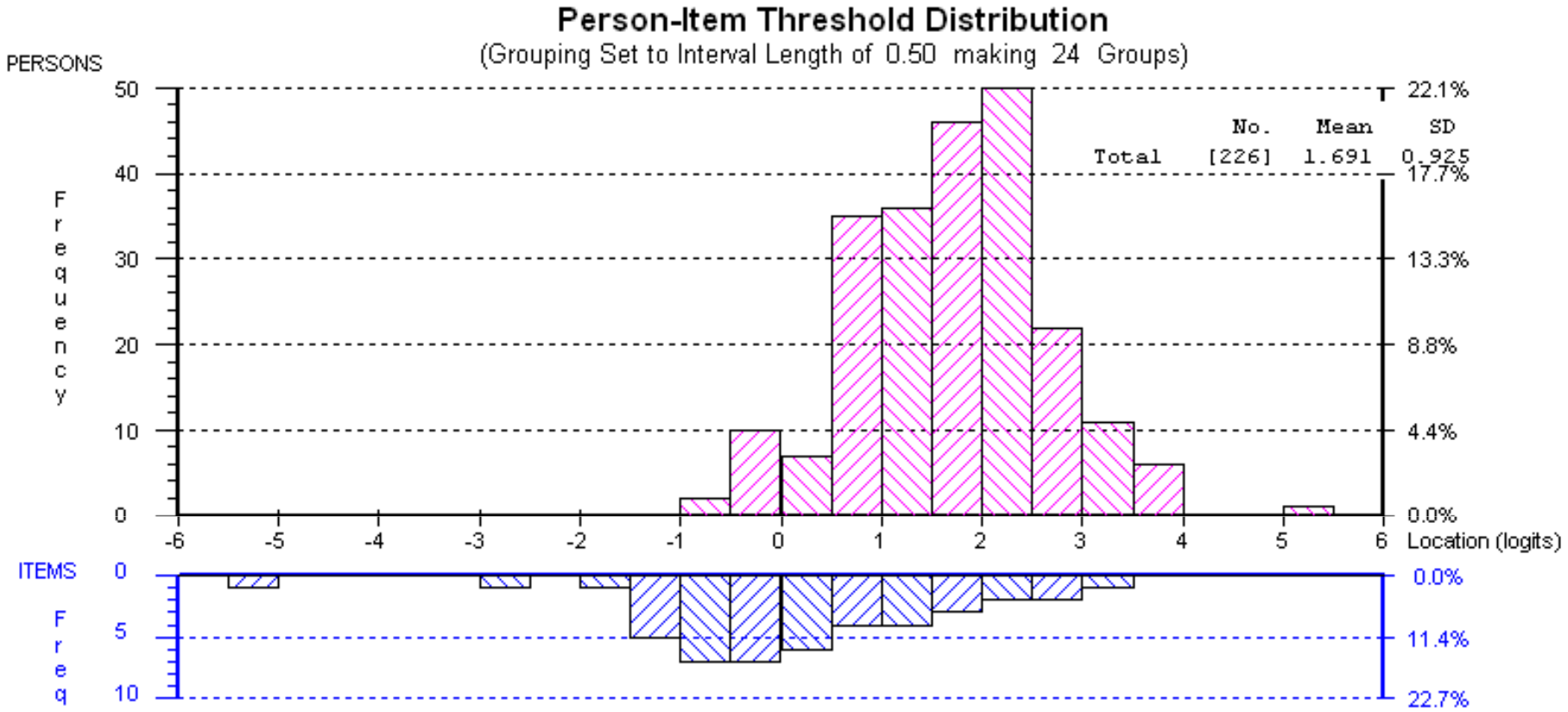


Figure 2. Person-Item Threshold Graph showing the distribution of 226 student measures and the 16 item thresholds (Self-Discipline scale)

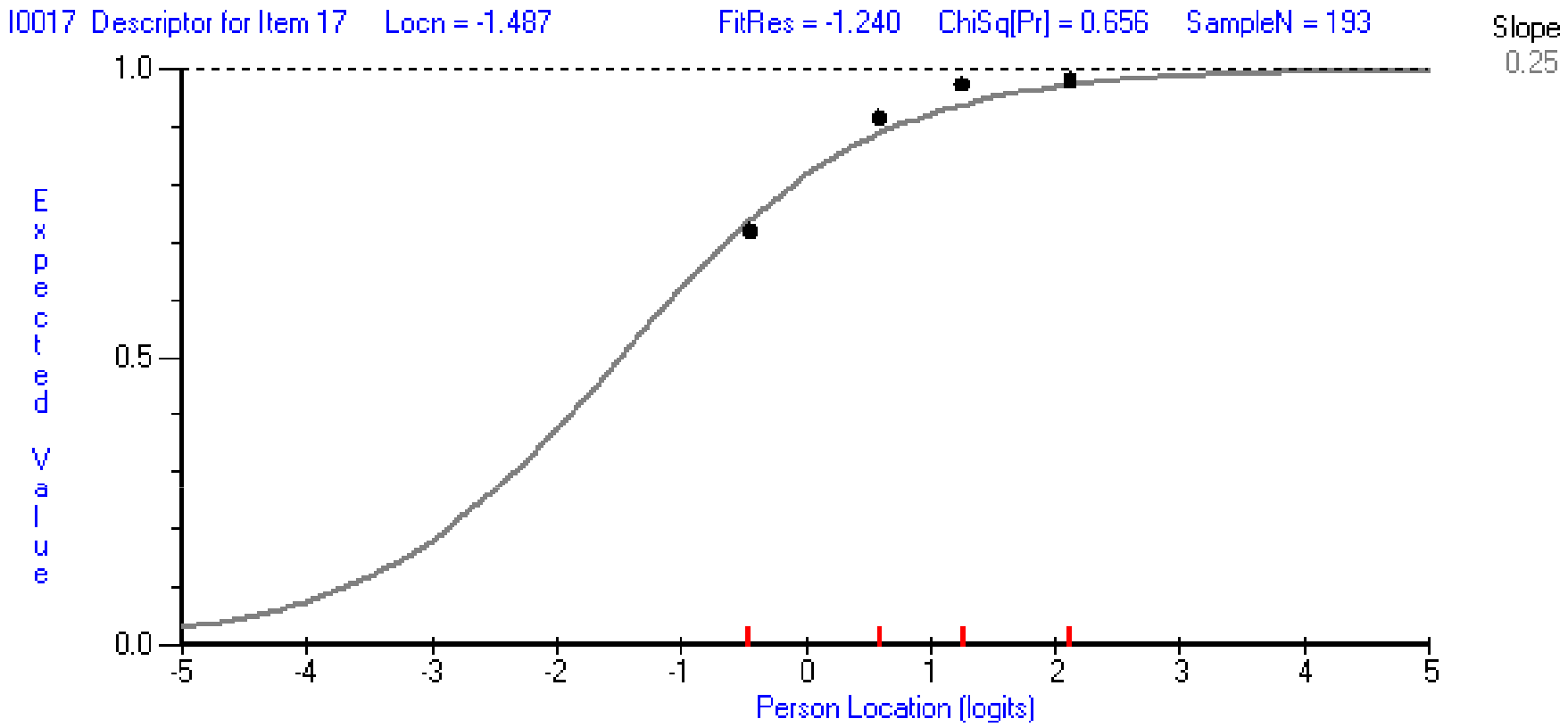


Figure 3. Item Characteristic Curve for item 17 (Moderation scale)

Note

This item discriminates rather well, as required for compliance with the Rasch Measurement Model.

Scales (1)

- Linear measures of Self-Discipline (16 items), Moderation (12 items), Dependability (16 items) and Responsibility (11 items) were created
- The **Self-Discipline** and **Dependability** measures had **good** construct validity (the conceptualised structure was supported)

Scales (2)

- The conceptualised structures of the **Moderation** and **Responsibility** measures were only **partially** supported as some item data did not fit the measurement model and were **deleted**

Scales (3)

- The linear scales had:

  (a) **Good** global item-person and global person-item fit

  (b) **Good** values of Cronbach Alpha and Person Separation Index

  (c) Acceptable item-trait interaction with reasonable agreement among students about the difficulties of the items along the scales → **unidimensional scales** were created

Scales (4)

- The linear scales had:

  (d) **Good** individual item fit statistics for items of the scales, with ordered item thresholds

  (e) **Good** Response Category Curves for the good-fitting items → the students answered the items consistently and logically

  (f) Distribution graphs → the targeting of the items against the student measures needs to be **improved** → more difficult items were added in all four scales for **future use**

Second Aim

- To investigate the **effects** of teaching values in a mathematics context through the ‘Caring Thinking’ way on **students’ social attitudes and behaviours in the four values**, using the scales developed

Research Design

- A **quantitative** approach was adopted and a **quasi-experimental** strategy was used (Punch, 1998)
- The data collected were mainly **quantitative**
- Some **qualitative** data were collected – these were participants' responses to four open-ended items.

Sample

- Secondary four students from **eight** different classes (N = 213) participated in this study:

  - **four** classes in the **experimental** group (N = 107)

  - **four** classes in the **control** group (N = 106)

Data Collection

- The **pretest** was conducted at the beginning before the treatment of experimental and control groups
- The **posttest** was conducted at the end after the treatment

Treatment

- The treatment of the experimental and control groups was **alike in all aspects** except **one**: the 'Caring Thinking' component of the mathematics module was **not** carried out with the control group
- The aspects that were similar included: the same mathematics content; the same teaching method for the mathematics content; the same period of teaching; the same assignments for mathematics content

Brief Summary of Data Analysis (1)

- The four dependent variables in the study are *Self-discipline*, *Moderation*, *Dependability* and *Responsibility*, and **linear**, **unidimensional scales** for each of these variables were created using a Rasch measurement model with the RUMM 2020 computer programme

  (Chapters 6 and 7)

Brief Summary of Data Analysis (2)

- Analysis of covariance (ANCOVA), using SPSS Release 10 (Pallant, 2001), was conducted using the pretest and posttest data to test for **possible differences between the groups** in each of the four dependent variables

  (Chapter 8)

Brief Summary of Data Analysis (3)

- Multiple regression, using SPSS Release 10 (Cramer, 2003), was conducted to study the **relationships** between each of the dependent variables and the three independent variables: *Housing Type*, *Level of Participation in Community Service* and *Level of Compliancy* (Chapter 9)

Brief Summary of Data Analysis (4)

- The **qualitative written comments**, in response to the four open-ended items, were analysed using the process called 'transcendental realism' (Miles & Huberman, 1994, p. 4)

  (Chapter 10)

Answering the Research Questions

Specific Research Question (1)

- Does the ‘Caring Thinking’ mathematics module develop **higher** levels of positive attitudes and behaviours in Self-Discipline, Moderation, Dependability and Responsibility in students who are taught the module, compared with, students who are taught the same mathematics in the traditional way?

Answer to SRQ (1)

- The ANCOVA findings were that the intervention effect of the ‘Caring Thinking’ mathematics module resulted in **significantly higher** Self-Discipline measures for the experimental group ($F = 6.68$, $df = 1, 376$, $p = 0.01$), but did not result in significantly higher Moderation, Dependability and Responsibility measures

Specific Research Question (2)

- What are the **inter-relationships** between the four dependent variables, Self-Discipline, Moderation, Dependability and Responsibility, for the experimental group posttest data?

Answer to SRQ (2)

- It can be concluded that there are **strong positive relationships** between Self-Discipline and Dependability, Self-Discipline and Moderation, and Self-Discipline and Responsibility
- In particular, **Dependability is a better predictor of Self-Discipline** than Moderation or Responsibility
- However, while the associations are strong, **conclusions for causal mechanism cannot be ascertained**, for example, it cannot be concluded that Dependability causes Self-Discipline

Specific Research Question (3)

- What is the relationship between **Self-Discipline**, as dependent variable, and Housing Type, Level of Participation in Community Service and Level of Compliancy, as independent variables, for the experimental group posttest data?

Answer to SRQ (3)

- While the correlations may not be significant, the sign (plus or minus) gives an indication of the **direction of the relationship** between variables
- There was a **negative** correlation between Self-Discipline and Housing Type → a low level of Housing Type, that is, a less luxurious home environment, relates with a high level of Self-Discipline
- **Positive** correlations between Self-Discipline and Level of Participation in Community Service, and between Self-Discipline and Level of Compliancy

Specific Research Question (4)

- What is the relationship between **Moderation**, as dependent variable, and Housing Type, Level of Participation in Community Service and Level of Compliancy, as independent variables, for the experimental group posttest data?

Answer to SRQ (4)

- There was a **negative** correlation between Moderation and Housing Type
- There were **positive** correlations between Moderation and Level of Participation in Community Service, and between Moderation and Level of Compliancy

Specific Research Question (5)

- What is the relationship between **Dependability**, as dependent variable, and Housing Type, Level of Participation in Community Service and Level of Compliancy, as independent variables, for the experimental group posttest data?

Answer to SRQ (5)

- There was a **negative** correlation between Dependability and Housing Type
- There were **positive** correlations between Dependability and Level of Participation in Community Service, and between Dependability and Level of Compliancy

Specific Research Question (6)

- What is the relationship between **Responsibility**, as dependent variable, and Housing Type, Level of Participation in Community Service and Level of Compliancy, as independent variables, for the experimental group posttest data?

Answer to SRQ (6)

- Greater Responsibility was associated with greater Level of Compliancy ($F_{1,93}$=13.13, p < .00)
- Thus, Level of Compliancy (standardised beta weight of 0.35) **predicts** Responsibility **moderately well**
- There was a **negative** correlation between Responsibility and Housing Type
- There were **positive** correlations between Responsibility and Level of Participation in Community Service

Open-ended Items

Transcendental Realism (1)

- The responses were carefully read and **key words** or **categories** representing the raw responses were identified
- The responses were **read again** to identify the categories present
- The responses were then **classified** under the respective themes of similar categories, and their **proportions** calculated

Transcendental Realism (2)

- 'Transcendental realism' (Miles & Huberman, 1994, p. 4), has **three** key components: **data reduction**; **data display**; and, **drawing and verifying conclusions and propositions** from the data displayed

Finding (1)

- Students felt that the ‘Caring Thinking’ mathematics module was interesting and useful due to the **connections** made with **real-life situations** (48.1%)
- Some students felt that the module was **important** and **meaningful** because they learnt about values (37.0%)
- Some other students felt that the module was an **intriguing** and **fun** way of teaching mathematics (14.8%)

Finding (2)

- It was found that most students indicated that the **lessons on odds of gambling** left the deepest impression on them (59.3%)
- Some students indicated that the **debate** left the deepest impression (22.2%)
- Others indicated that the **lesson depicting the dire situations of gambling addicts** left the deepest impression (18.5%)

Finding (3)

- 72.2% of the students selected the values of **Self-Discipline** and **Moderation** to develop further
- 16.7% chose **Humility**
- 5.6% chose **Self-reliance** and **Potential**
- 5.6% chose **Courage**

Finding (4)

- 58.8% of the students proposed to carry out a **community service project** to exhibit their selected values
- 41.2% of the students proposed to carry out an **awareness-raising public education project**

Implications

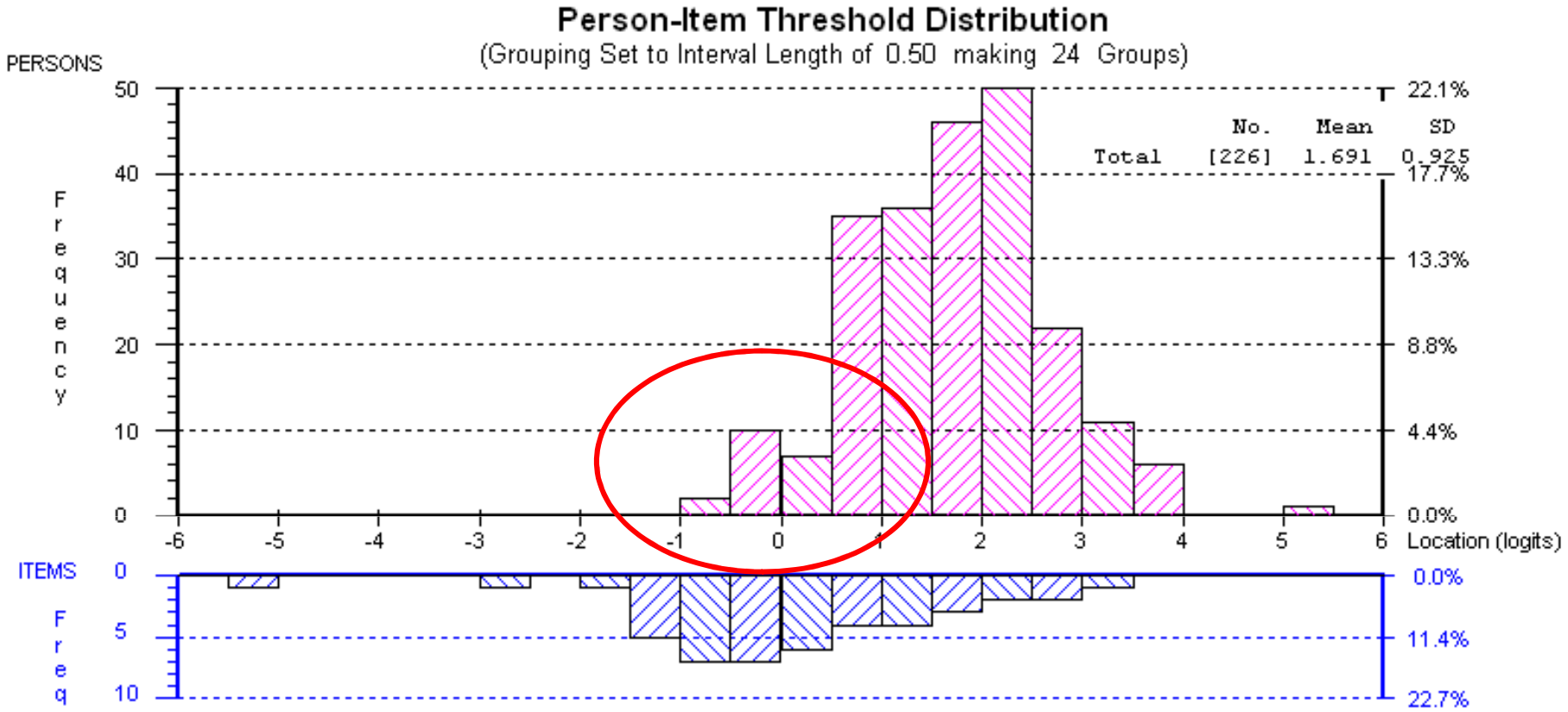
- For School Administrators
- For Teachers
- For Students
- For Further Research

Implications for Further Research (1)

- There is relatively **little empirical research** on the effectiveness of teaching strategies for values education (Schuitema et al., 2008)
- Longitudinal studies can be conducted to **track students over time** to see whether the observed benefits of values education are maintained as time progresses

Implications for Further Research (2)

- Magdalena Mok is **Director** of the *Centre for Assessment Research and Development* and **Professor** at the *Department of Educational Psychology, Counselling and Learning Needs* at the Hong Kong Institute of Education
- She is internationally recognised for her research in **educational assessment**
- Her particular research focus is **Self-directed Learning Oriented Assessment** in school education



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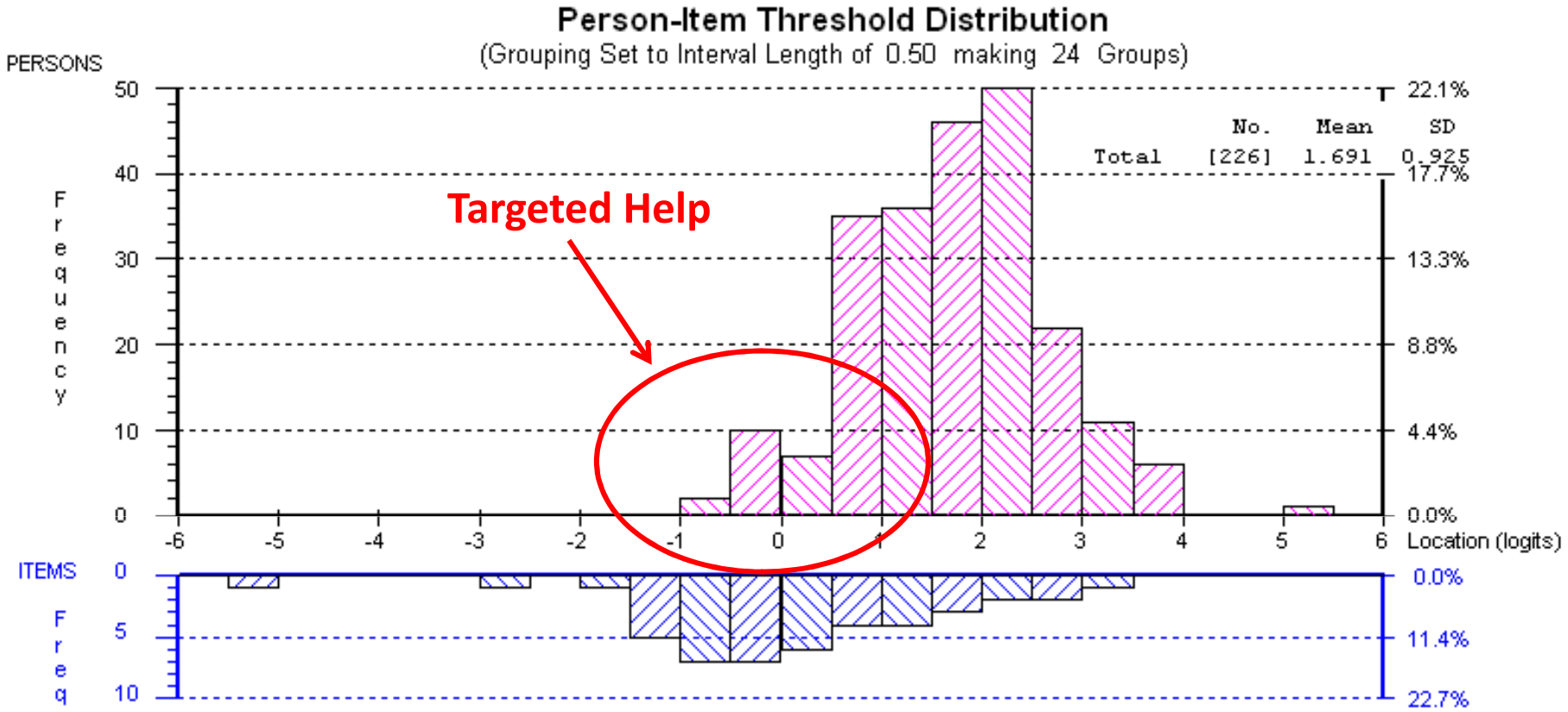

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Thank You!

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