

國立交通大學

企業管理碩士學位學程

碩士論文

透過 fsqca(模糊集質性比較分析)重新詮釋 SEM 調查
數據

Reinterpreting SEM modeled Survey Data through the
Lens of fsQCA

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雷松亞

中華民國一百零五年六月

National Chiao Tung University

Global MBA

Thesis

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Student: Arturo Heyner Cano Bejar

Advisors: Dr. Jin-Su, Kang (NCTU)

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A Thesis

Submitted to Master Degree Program of Global Business
Administration

College of Management

National Chiao Tung University

In Partial Fulfillment of the Requirements

For the Degree of

Master

in

Business Administration

June 2016

Hsinchu, Taiwan, Republic of China

中華民國一百零五年六月

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摘要

社會科學具有高複雜性的特徵。一般利用結構方程模式(SEM)來處理。然而，一種根據集理論(set theory)和布爾代數(Boolean algebra)來評估複雜性的較新技術(fsQCA)是可運用的。在這項研究中，我們應用模糊集定性比較分析(fsQCA)在 SEM 被用來尋找四個狀態的因果關係的實證實驗研究的調查數據。感知視覺新穎性、感知視覺複雜性為獨立變數，而喚起和認知投入作為中介變數來解釋方法並排除由大學提供的非正式在線視頻。研究中，88 個個案回應動畫般視頻和 95 個演講般視頻。考慮 VidType(動畫或演講視頻)的分組資料的三種比較方法是比較由 fsQCA 和早期 SEM 結果兩者的因果關係獲得的。這項研究顯示藉由必要性發現中介變數證明 fsQCA 的可能用途。例如：單一條件“認知投入”是必要條件，也恰好是一個中介變數。

Key words: fsQCA, SEM, 認知參與，複雜性

Reinterpreting SEM modeled Survey Data through the Lens of fsQCA

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Abstract

Social Science is characterized by high complexity. A common approach to deal with it is Structural Equation Modeling (SEM). However, a relatively new analytic technique (fsQCA) based on set theory and Boolean algebra aiming to assess complexity is available. In this study, Fuzzy-Set Qualitative Comparative Analysis was applied to online survey data borrowed from an empirical experimental research where SEM was used to find causal relations among four conditions; Perceived visual novelty, perceived visual complexity as independent variables, and arousal and cognitive engagement as mediator variables to explain approach and avoidance to Informal Online Videos offered by universities. From here, 88 cases correspond to people responding to animation-like videos and 95 cases to lecture-like videos. A comparison of three ways of grouping data considering VidType (animation or lecture video) was made before contrasting causal relations obtained with fsQCA against previous SEM results. This study shows evidence of a possible use of fsQCA for finding mediator variables through necessity. For example; single condition “cognitive engagement” is a necessary condition for approach and avoidance, and also happens to be a mediator variable.

Key words: fsQCA, SEM, Cognitive Engagement, Complexity

Acknowledgement

In first place, I would like to demonstrate my appreciation to National Chiao Tung University for offering the Scholarship for Outstanding Students, clearing the path for the research career I always wanted.

To the Global Master in Business Administration – GMBA group of the College of Management at NCTU. Special thanks to Dr. Jin-Su, Kang and Dr. Ray Soumya for their guidance and help which made possible the conclusion of this work.

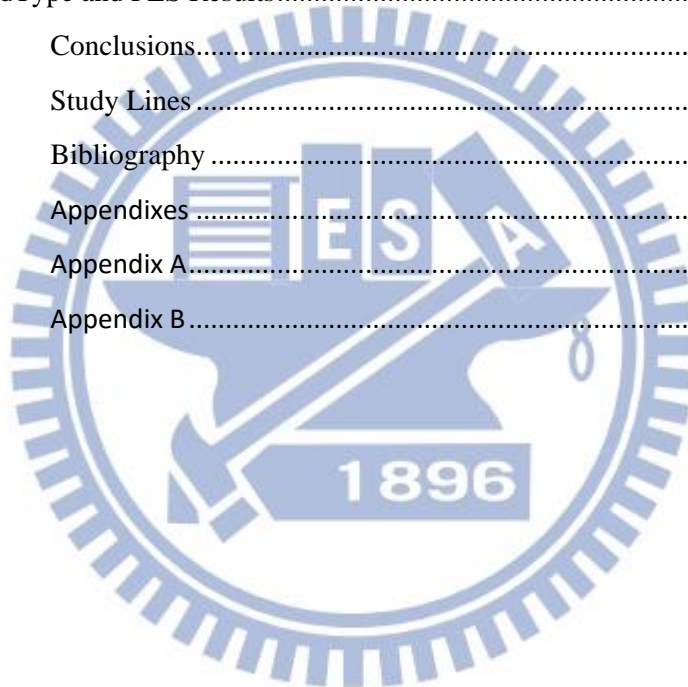
To my wife who was always loving and supportive. And to my mother and family who always believed in me.



Table of Contents

	Page
Chinese Abstract	i
English Abstract	ii
Acknowledgement	iii
Table of Contents	iv
List of Tables	vi
List of Figures	vii
Symbols	viii
I. Introduction.....	1
II. Research Objectives.....	3
III. Literature Review	4
3.1 Antecedents.....	4
3.2 Fuzzy Sets Qualitative Comparative Analysis - fsQCA	5
3.3 Necessary and Sufficient conditions.....	6
3.4 Consistency and Coverage.....	6
3.5 The Calibration Process	7
3.5.1 The Direct Method.....	7
3.5.2 The Indirect Method	8
3.6 The Truth Tables Algorithm	8
3.7 Mediation in SEM Modeled Data	9
IV. Methodology	10
4.1 The Data.....	10
4.2 Seven-Point Likert and Semantic Differential Survey.....	10
4.3 The Method.....	12
4.3.1 The Calibration Process for Grouped Data	12
4.3.1.1 Paths 2 and 3 – AD80 and ARNB	12
4.3.1.2 Path 4 – ASNB.....	14
4.3.1.3 Necessity Analysis.....	14
4.3.2 Generation of Truth Tables.....	14
4.3.2.1 Paths AD80 and ARNB	15
4.3.2.2 Path ASNB.....	16

4.3.3	The Calibration Process for the Inclusion of a Dummy Condition.....	18
4.3.3.1	Path ARNB for Isolated Data and VidType Inclusion.....	18
4.3.3.2	Path ARNB – Truth Tables for Isolated Data and VidType Inclusion	19
4.4	The Research Design	19
V.	Results and Discussion	21
5.1	Necessity Overview	21
5.2	Sufficiency Overview	22
5.2.1	Consistency Cut-Off Points and Unique Coverage Relevance.....	22
5.2.2	Path ARNB Grouped Data and ARNB Isolated Data.....	25
5.2.3	Comparison between ARNB Grouped data, ARNB Isolated Data and ARNB VidType and PLS Results.....	32
VI.	Conclusions.....	35
VII.	Study Lines	36
VIII.	Bibliography	37
IX.	Appendixes	39
9.1	Appendix A.....	39
9.2	Appendix B.....	42



List of Tables

Table 3.1: Fields of QCA application with calibration and consistency cut-off points.	4
Table 4.1: Demographic parameters organized by gender. UG: Undergraduate, G: Graduate, PK(<3):No Prior Knowledge, PK(>=3): Prior Knowledge, Ani: Animation Videos, Lec: Lecture Videos.	10
Table 4.2: First paths for data analysis; R: Reverse questions used, NR: No Reverse Questions Used, NBP: Natural Break of Data Consistency Cut-Off Point, REC: Recommended Consistency Cut-Off Point, SEM: Semantic Cut-Off Point. Red paths account for the analysis in Excel.	11
Table 4.3: Threshold chart for FM(0.95): Full Membership at 0.95, COP(0.5): Cross Over Point at 0.5, and FNM(0.05): Full Non Membership at 0.05 for four conditions and the outcome (Approach/Avoidance) using Excel.	12
Table 4.4: Qualitative calibration thresholds using the indirect method; FM: Full Membership, PM: Partial membership, COP: Cross Over Point, PNM: Partial Non-Membership, and FNM: Full Non Membership for four conditions and the outcome (Approach/Avoidance). Data sequencing was done using the last right column "Membership Degree".	14
Table 4.5: Truth table for solution AD80 and ARNB showing all sufficient configurations for the positive outcome approach (aa) and the negative outcome avoidance (~aa).	15
Table 4.6: Truth Table for solution ASNB showing all sufficient configurations for the positive outcome approach (aa) and the negative outcome avoidance (~aa).	17
Table 4.7: Natural break consistency cut-off points for the path ARNB for isolated data.	19
Table 5.1: Necessity analysis using fsQCA Software for solution paths AD80 – Average Data treatment Default Consistency Cut-off; ARNB – Average Data Treatment Natural Break Consistency Cut-Off; and ASNB – Semantic Data Treatment Natural Break Consistency Cut-Off.	21
Table 5.2: Complex solution for Approach in fsQCA Software showing general data parameters for solution paths AD80 – Average Data treatment Default Consistency Cut-off; ARNB – Average Data Treatment Natural Break Consistency Cut-Off; and ASNB – Semantic Data Treatment Natural Break Consistency Cut-Off.	22
Table 5.3: The most parsimonious solution for Approach in fsQCA Software showing general data parameters for solution paths AD80 – Average Data treatment Default Consistency Cut-off; ARNB – Average Data Treatment Natural Break Consistency Cut-Off; and ASNB – Semantic Data Treatment Natural Break Consistency Cut-Off.	23
Table 5.4: Complex solution for Avoidance in fsQCA Software showing general data parameters for solution paths AD80 – Average Data treatment Default Consistency Cut-off; ARNB – Average Data Treatment Natural Break Consistency Cut-Off; and ASNB – Semantic Data Treatment Natural Break Consistency Cut-Off.	24
Table 5.5: Complex solution for Avoidance in fsQCA Software showing general data parameters for solution paths AD80 – Average Data treatment Default Consistency Cut-off; ARNB – Average Data Treatment Natural Break Consistency Cut-Off; and ASNB – Semantic Data Treatment Natural Break Consistency Cut-Off.	25
Table 5.6: Full Solutions for the outcome approach. Letters in the left column represent the type of solution. C: complex solution, P: parsimonious solution, A: animation data and L: lecture data. ARNB – Average Data Treatment Natural Break Consistency Cut-Off Point. H. Uniq. Cov.: the highest unique coverage value from among all the configurations, the number after the hyphen is the configuration number starting from the left one.	33
Table 5.7: Full Solutions for the outcome avoidance. Letters in the left column represent the type of solution. C: complex solution, P: parsimonious solution, A: animation data and L: lecture data. ARNB – Average Data Treatment Natural Break Consistency Cut-Off Point. H. Uniq. Cov.: the highest unique coverage value from among all the configurations, the number after the hyphen is the configuration number starting from the left one.	34

List of Figures

Figure 3.1: The direct calibration method, mathematical translation of verbal labels into fuzzy set values.....	8
Figure 4.1: Survey questionnaire example with equal semantic value for the outcome Approach/Avoidance “aa”. The second statement is a reverse question*.....	11
Figure 4.2: Example of obtained values in all stages of the calibration process for the condition arousal “aro” using the Direct Method proposed by Ragin (2000). 1) Deviation from the Cross-Over Point, 2) Scalars, 3) Product CxD and 4) Degree of membership.	13
Figure 4.3: Natural break consistency cut-off point for the outcome approach “aa_cal” (a) and avoidance “~aa_cal” (b) for solution ARNB.	16
Figure 4.4: Natural break consistency cut-off point for the outcome approach “aa_cal” (a) and avoidance “~aa_cal” (b) for solution ARNB.	18
Figure 4.5: Research design for the analysis of data using fsQCA. AD80: Average Default Consistency Cut-Off Point 0.80, ARNB: Average Recommended Natural Break Consistency Cut-Off Point, ASNB: Average Semantic Natural Break Consistency Cut-Off Point.....	20
Figure 5.1: XY plots for all possible configurations of the complex solution ARNB for animation (left) and lecture (right) data and for the outcome approach, using fsQCA software.	27
Figure 5.2: XY plots for all possible configurations of the most parsimonious solution ARNB for animation (top) and lecture (bottom) data and for the outcome approach, using fsQCA software.....	28
Figure 5.3: XY plots of all possible configurations of the complex solution (top plot), the full complex solution (bottom left) and the most parsimonious solution (bottom right) for path ARNB animation data for the outcome avoidance, using fsQCA software.....	29
Figure 5.4: XY plots of the all possible configurations of the complex solution (top plots), the full complex solution (bottom left) and the most parsimonious solution (bottom right) for path ARNB lecture data for the outcome avoidance, using fsQCA software.	30
Figure 5.5: Complex solution of grouped data obtained with fsQCA software including VidType as dummy condition for lecture and animation data for the outcomes approach (left) and avoidance (right) for the best solution ARNB.	31
Figure 5.6: The most parsimonious solution of grouped data obtained with fsQCA software including VidType as dummy condition for lecture and animation data for the outcomes approach (left) and avoidance (right) for the best solution ARNB.....	31
Figure 5.7: PLS analysis for the model on approach and avoidance showing the path coefficients or standardized regression weights (values on the arrows) and the coefficients of correlation of the model (inside the boxes), the percentage of variance explained by the explanatory variables.	32

Symbols

AD80: Average Data Treatment Default Consistency Cut-Off.

ARNB: Average Data Treatment Natural Break Point Consistency Cut-Off.

ASNB: Semantic Data Treatment Natural Break Consistency Cut-Off.

FM: Full Membership

COP: Cross-Over Point

FNM: Full Non-Membership

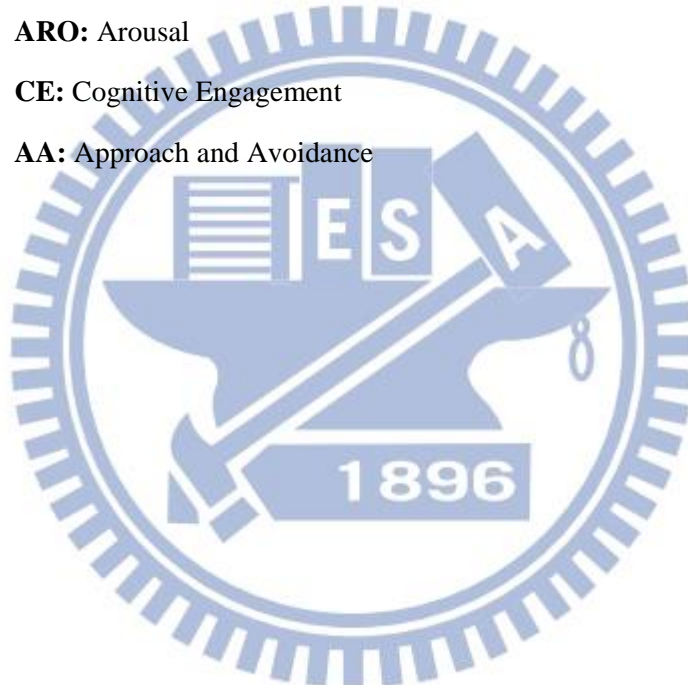
VN: Preceived Visual Novelty

VC: Perceived Visual Complexity

ARO: Arousal

CE: Cognitive Engagement

AA: Approach and Avoidance



I. Introduction

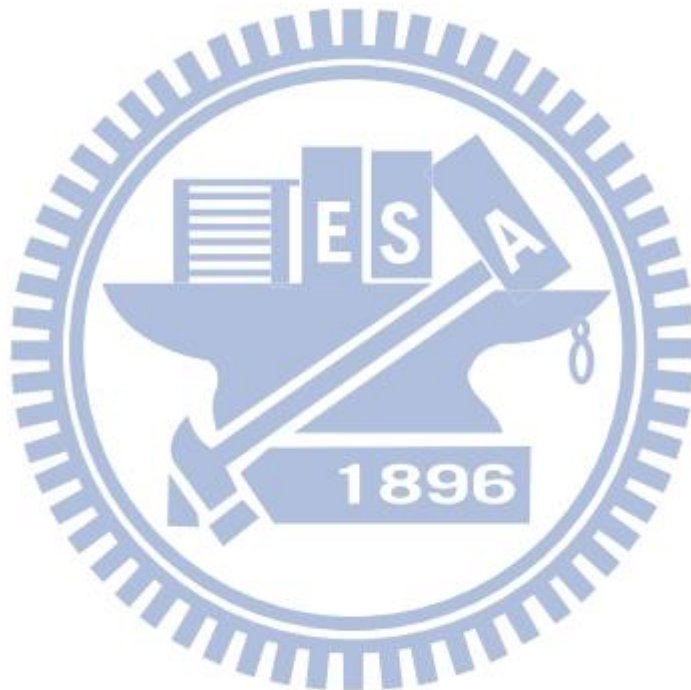
“Scientist’s tools are not neutral” (Gigerenzer, 1991) in Woodside (2013). Social Science Researchers have been extensively using regression based analyses to deal with qualitative data. However, this method seems not to resemble social phenomena accurately. For example, explains Fiss (2007) ...”the classical regression model treats variables as competing in explaining variation rather than showing how variables combine to create outcomes”.

Complexity is a common dish in social science research. In attempts to deal with it expert case analyst Charles Ragin (1987) introduced a new family of methods, Qualitative Comparative Analysis (QCA) based in three principles of complexity theory; Equifinality – many explanations lead to the same outcome; Conjunctural causation – combination of conditions commonly lead to the outcome; and Asymmetry – conditions leading to a positive outcome do not necessarily lead to the negative outcome (Schneider & Wagemann, 2012). Set-theoretic family methods share three important characteristics; they work with membership scores assigned to cases in the set; they use set relations to describe social phenomena, and these set relations are interpreted in terms of sufficiency and necessity. Also INUS (Insufficient and necessary for the configuration but unnecessary and sufficient for the solution) and SUIN (Sufficient and Unnecessary for the configuration but insufficient and necessary for the solution) conditions are perceived (Wagemann & Schneider, 2010).

While Crispy-Set QCA uses the presence (1) or absence (0) of a condition, Fuzzy-Set QCA uses the full range between 0-1. Therefore fsQCA is the most common in this family taking its name due to the way data is classified inside the degree of membership (1) or non-membership (0). This characteristic provides information not only about whether a case belongs to the set but also about the intensity of this relation. However, fsQCA requires calibration which is ideally theoretically informed (Ragin, 2008 in Morgan 2013). FsQCA is more than a data analysis technique but a research approach so it aims a deep understanding of cases and theory – researcher experience (Ragin, 2008; Wagemann & Schneider, 2010).

The motivation for this thesis is to compare the application of fsQCA against SEM modeled survey data to understand the set relations of the conjunctions and conditions agreeing with the occurrence of multiple realities and limitations of symmetric statistical tests. The data was collected from a thesis research from ISS Department at NTHU; here the author proposes a model for the influence of four variables; Perceived Visual Novelty, Perceived Visual Complexity, Cognitive Engagement and Arousal on Approach or Avoidance to two main kinds of videos; lecture-like and animation-like to unveil course taker behavior. In order to fulfill this objective two calibration methods proposed by Ragin (2008) were applied, the direct and the indirect method; two different consistency cut-off points for sufficiency were used; and three ways of data aggrupation were

contrasted. This SEM model seems to be suitable for the application of fsQCA due to the inclusion of independent and dependent variables, but also a third type – mediator variables. The former one is highly related with fsQCA by the principle of complexity. Namazi & Namazi (2016) explain that the nature of complex business problems will be more transparently captured by considering moderating and mediating variables.



II. Research Objectives

GENERAL OBJECTIVE

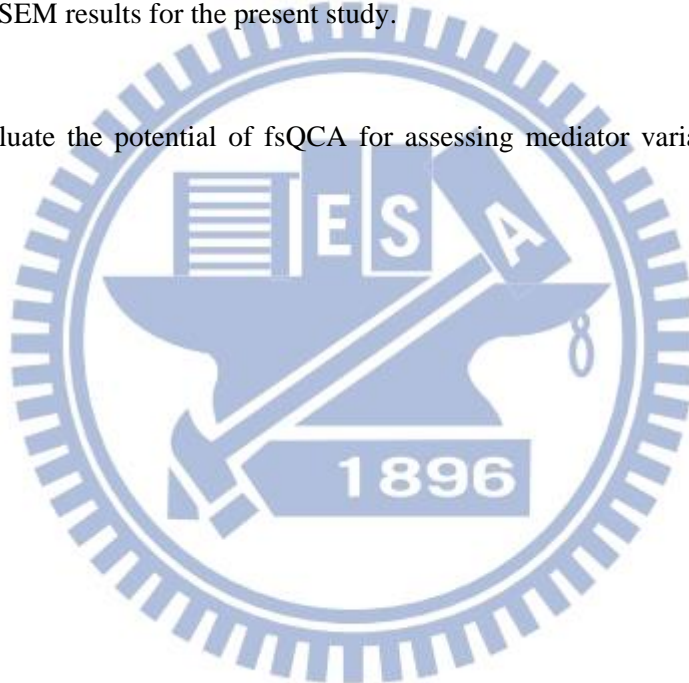
GO: Reinterpret SEM modeled survey data through the lens of fsQCA .

SPECIFIC OBJECTIVES

SO1: Evaluate the influence on solutions of two ways of data calibration to decide the most suitable criteria for fsQCA and SEM results comparison for the present study.

SO2: Determine the best criteria to analyze data in terms of data aggrupation to compare fsQCA and SEM results for the present study.

SO3: Evaluate the potential of fsQCA for assessing mediator variables in SEM modeled research.



III. Literature Review

3.1 Antecedents

Table 3.1: Fields of QCA application with calibration and consistency cut-off points.

Title	QCA	Consist. Cut-off	Calibration thresholds	Year
Self-Organizing Processes in Top Management Teams: A Boolean Comparative Approach	csQCA	-	-	1995
Does technology have an impact on learning? A fsQCA of historical data on the role of digital repertoires in shaping outcomes of classroom pedagogy	fsQCA	0.8	Theory based	2013
Linking multi-level governance to local common-pool resource theory using fuzzy-set qualitative comparative analysis: Insights from twenty years of biodiversity conservation in Costa Rica	fsQCA	Natural Break	Theory based	2013
Asymmetric modeling of intention to purchase tourism weather insurance and loyalty	fsQCA	0.8	7-Likert Scale (0.95;0.5;0.05)	2016
Explaining online shopping behavior with fsQCA: The role of cognitive and affective perceptions	fsQCA	0.85	7-likert scale (6,4,2)	2016
Exploring Explanations for Local Reductions in Teenage Pregnancy Rates in England: An Approach Using Qualitative Comparative Analysis	csQCA	-	-	2013
Manager's educational background and ICT use as antecedents of export decisions: A crisp set QCA analysis	csQCA	-	-	2016
Country-based comparison analysis using fsQCA to investigate the relationship between entrepreneurial attitudes and activity	fsQCA	0.87	0.95;0.5;0.05	2015
Conjoint analysis of drivers and inhibitors of e-commerce adoption	fsQCA	0.88/ 0.87	data-dependent (0.90;0.5;0.10) 7-Likert Scale (5;4;2)	2016
Testing innovation systems theory using Qualitative Comparative Analysis	fsQCA	Natural Break	7-Likert Scale Estimate parameters	2015
Explaining knowledge-intensive activities from a regional perspective	fsQCA	0.75	0.95;0.5;0.05	2016
Innovation at universities: A fuzzy-set approach for MOOC-intensiveness	fsQCA	0.8	0.95;0.5;0.05	2016

Source: Author's compilation

Many papers have been published using fsQCA or csQCA as a new approach analysis in social science research. Table 1.1 shows how different criterion is applied for calibration of data and for deciding the consistency cut-off points used to determine solutions. Fields like Management,

Environmental Science Policy, Education, Tourism, Online Marketing, Health, and Entrepreneurship are some of them. Notwithstanding, recent papers focus is more oriented to the use of fuzzy sets instead of crispy sets.

Woodside et al., (2011) applies Qualitative Comparative Analysis (QCA) to consider how cultural recipes – complex configurations of national culture affect international experiential behavior. Here the author uses a comparison of a grouped data and separated data by age group; then, the results are presented in XY plots.

Jenson et al., (2015) use the natural break point for consistency cut-off with a 7-point Likert scale for testing innovation systems.

Pappas et al., (2016) use complexity theory through fsQCA to better understand the causal patterns of factors (conditions) stimulating on shopping behavior in personalized e-commerce environments. Using Cognitive and Affective perceptions as essential factors on a sample of 582 online experienced shoppers from a snowball survey they find that in almost all the solutions (8 out of 9) at least one cognitive perception is present.

3.2 Fuzzy Sets Qualitative Comparative Analysis - fsQCA

Qualitative Comparative Analysis (QCA) is a new analytic technique that uses Boolean algebra and set-theory to implement principles of comparison used by scholars engaged in the qualitative study of macro social phenomena (Ragin, 2008). In qualitative research academics look for case studies to be analyzed intensive and integrative. This method aims to identify the necessary and/or sufficient conditions that lead to the specified outcome including equifinality and the complex causality (Fiss, 2007).

Causal research in Social Sciences is complex by nature. Lieberman, 1985 (in Schneider & Wagemann, 2012) explain that this type of causality is defined by three characteristics: Equifinality – many explanations lead to the same outcome; Conjunctural causation – combination of conditions commonly leading to the outcome; and Asymmetry – conditions leading to a positive outcome do not necessarily lead to the negative outcome.

Different paths for the same outcome are closer to the interpretation of reality. According to Morgan, (2013) in set-theoretic causal models, equifinality is expressed using the logical “OR”; “... for example, consider two causal paths $ABc + ACDE$ for Y ; each letter is a condition and the small letter represents low levels of this condition, the sign “+” represents the logical OR. In this example, there are two possible ways to the outcome Y , one is ABc and the other is $ACDE$ ”. Fiss (2007) explains

that set theoretic methods extend the analysis of equifinality by offering a technique for examining the importance of each path. This relative importance is the coverage value that is the proportion of instances of the outcome that exhibit a certain causal configuration.

On the other hand, the asymmetry assumption implies that a causal role attributed to a condition always refers to only one of the two qualitative states – presence or absence – in which this condition can potentially be found. Research reality will provide us with conditions which are sufficient and necessary only in combination with other conditions (Schneider and Wagemann, 2012). This is known as the principle of conjunctural causation.

Schneider & Wagemann (2010) say that thresholds for consistency and coverage vary with the design of the research; namely, number and knowledge of cases, quality of data, specificity of theories, hypotheses and aim of the research. This implies a potential number of ways to analyze data and therefore obtain results. They also mention that researchers should not follow conventions but argue for their decisions made. In this respect we analyze three possibilities for the consistency threshold, more often called cut-off point (Ragin, 2008).

3.3 Necessary and Sufficient conditions

A single causal condition is necessary if the cases presenting the outcome are a subset of the cases showing the causal condition. The convention is that if consistency is higher than 0.9 for one condition that condition is necessary or almost always necessary (Schneider et al. 2010 in Ospina-Delgado et al., 2016). FsQCA recommends conducting a necessity analysis before performing the core analysis, which identifies sufficient configurations using a truth table (Schneider & Wagemann, 2012 in Dul. J., 2015). At the same time a causal condition is sufficient if the cases presenting the outcome are a superset of the cases showing the causal condition. Dul (2015) explains that a sufficient cause ensures that the outcome exists; it produces the outcome.

3.4 Consistency and Coverage

FsQCA uses two parameters to control for empirical informative outcomes. One of them is called consistency, meaning the proportion of cases consistent with the configuration and coverage, meaning the relative importance of the configuration for the outcome (Ospina-Delgado, 2016). Consistency and coverage are related with imperfect set relations; consistency values resemble the subset degree relation between the configuration and the outcome while coverage the portion of the outcome covered by the configuration. Ragin, (2008) suggests a 0.8 consistency value to obtain

informative results. Formulas (1) and (2) show the way to calculate consistency and coverage for the configurations (Woodside, 2013).

$$\text{Consistency } (Xi \leq Yi) = \frac{\Sigma[\min (Xi, Yi)]}{\Sigma(Xi)} \quad \dots (1)$$

$$\text{Coverage } (Xi \leq Yi) = \frac{\Sigma[\min (Xi, Yi)]}{\Sigma(Yi)} \quad \dots (2)$$

3.5 The Calibration Process

In QCA the focus is on the cases, which are classified according to their membership in a range of 0-1 delineated sets. Crispy-sets indicate whether a case is a member of a set or not, noting membership with “1” and non-membership with “0”. At the same time, fuzzy-sets indicate the degree to which a case is a member of a set, so membership can be partial, somewhere between “fully in the set” and “fully out the set” (Morgan, 2013).

Calibration is the process of fitting the data into these above mentioned parameter. CsQCA and fsQCA require calibration that is ideally theoretically informed; two methods for this objective are the Direct Method or the Indirect Method (Ragin, 2008).

3.5.1 The Direct Method

The “direct method” is a mathematical oriented method focusing on the three qualitative anchors that structure fuzzy sets: the threshold for full membership (0.95 percentile), the threshold for full non-membership (0.05 percentile), and the cross-over point (0.5 percentile). The cross-over point is where cases cannot be seen as in or out the set it is the point of maximum ambiguity. The essential task of calibration using the direct method is to transform interval-scale values into the log odds metric as an intermediate step in a way that respects the verbal labels of full membership or full non-membership as well as the middle terms between 0-1 (Ragin, 2000) – figure 3.1.

<i>Verbal Label</i>	<i>Degree of membership</i>	<i>Associated odds</i>	<i>Log of full membership</i>
<i>Full membership</i>	0.993	148.41	5.0
<i>Threshold of full membership</i>	0.953	20.09	3.0
<i>Mostly in</i>	0.881	7.39	2.0
<i>More in thn out</i>	0.622	1.65	0.5
<i>Cross-over point</i>	0.500	1.00	0.0
<i>More out than in</i>	0.378	0.61	-0.5
<i>Mostly out</i>	0.119	0.14	-2.0
<i>Threshold of full nonmembership</i>	0.047	0.05	-3.0
<i>Full nonmembership</i>	0.007	0.01	-5.0

Figure 3.1: The direct calibration method, mathematical translation of verbal labels into fuzzy set values.
Source: Adapted from Ragin, 2000.

3.5.2 The Indirect Method

In contrast to the direct method, which relies on specification of the numerical values linked to three qualitative anchors, the indirect method relies on the researcher's broad groupings of cases according to their degree of membership in the target set (Ragin 2000). Basically, the researcher sorts the cases into different levels of membership based on his experience, and then refines these membership scores using the interval-scale data.

Both methods yield precise calibrations of set membership scores based upon either qualitative anchors (direct method) or qualitative groupings (indirect method). Calibrated measures have many uses. They are especially useful when it comes to evaluating theory that is formulated in terms of set relations. “While some social science theory is strictly mathematical, the vast majority of it is verbal. Verbal theory, in turn, is formulated almost entirely in terms of set relations” (Ragin 2000).

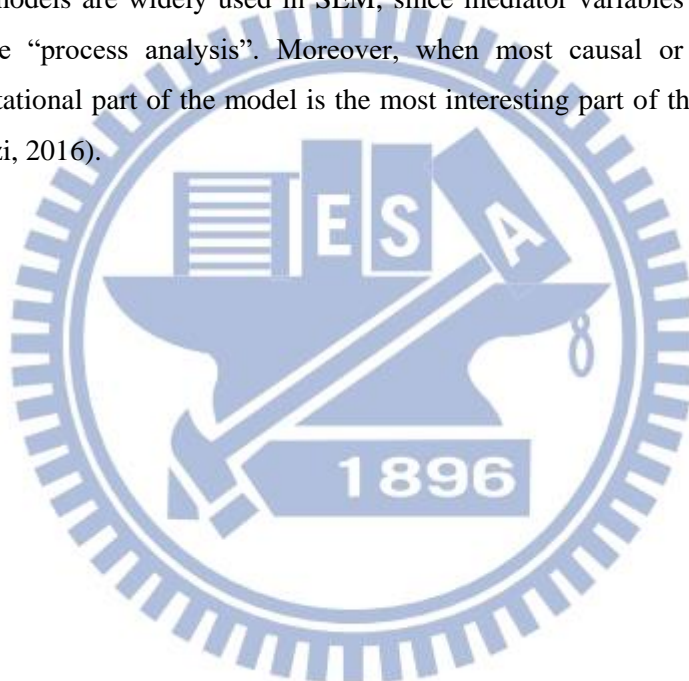
3.6 The Truth Tables Algorithm

The truth table is no more than a table containing all possible logical configurations (or combinations). According to Schneider & Wagemann (2012) and based on the calibrated values for each case, a truth table can be built in tree steps; first, using the formula 2^k (where k is the number of conditions) all possible logical value combinations are organized in rows; second, each case is placed in each row in which its membership exceeds 0.5; finally, the outcome value is determined for each row. It is important to notice that a row can be sufficient for the outcome (1), not sufficient for the outcome (0) or a logical reminder (rows without cases). The same truth table algorithm construction is followed if one uses the fsQCA Software.

3.7 Mediation in SEM Modeled Data

Mediating variables may be identified to explain the kind and effects of the relationship between independent and dependent variables in an attempt to determine the nature of the study more accurately and functionally. A mediator variable, also called “intervening or process variable”, is the variable that causes mediation in the relationship between the dependent variable (outcome) and the independent variable (causal variable) (Baron & Kenny, 1986 in Namazi & Namazi, 2016). Said differently a mediation model is a model in which there is no relation between the independent and dependent variable. Instead, there is a mediator variable that receives the influence of the independent variable and at the same time influences the dependent variable.

Mediation models are widely used in SEM, since mediator variables are a key part of what has been called the “process analysis”. Moreover, when most causal or structural models are examined, the meditational part of the model is the most interesting part of that model (Kenny, 2014 in Namazi & Namazi, 2016).



IV. Methodology

4.1 The Data

Data was obtained from a thesis study after the title of “The Effects of Visual complexity and Visual Novelty on Learning Experience: A Comparison of Educational Lecture Videos and Animation” by Yu-Cheng Chou and under the supervision of Dr. Soumya Ray from National Tsing Hua University. Data collection was made by means of an online survey through Esearch.com in order to investigate the influence of lecture videos or animated videos. The topic of the lecture was “the Divided Brain” given by Iain McGilchrist, a psychiatrist, doctor, writer, and former Oxford literary scholar. The lecture video is from RSA Talk (<https://www.youtube.com/watch?v=SbUHxC4wiWk>) and the animation version is from RSA Animate (<http://www.thersa.org/events/rसानimate/animate/rsa-animate-the-divided-brain>). For experimental purposes the animation version’s audio was modified to be the same as in the lecture version. Interviewees accounted for 286, from which only 183 were left after selecting complete answers (Chou, 2013).

In the present research conditions such as arousal, perceived visual complexity, perceived visual novelty, cognitive engagement and the outcome approach/avoidance were chosen to demonstrate the use of fsQCA analysis and compare it with PLS analysis. Table 4.1 shows the demographics of the data.

Table 4.1: Demographic parameters organized by gender. UG: Undergraduate, G: Graduate, PK(<3): No Prior Knowledge, PK(>=3): Prior Knowledge, Ani: Animation Videos, Lec: Lecture Videos.

	UG	G	PK(<3)	PK(>=3)	Ani	Lec
Male	28	72	64	36	50	50
Female	27	56	58	25	38	45
183	55	128	122	61	88	95

Source: Own.

4.2 Seven-Point Likert and Semantic Differential Survey

Raw data was divided by the questions originally designed to cover the theoretical background of each condition as well as the outcome for comparison reasons and following the Likert and Semantic Differentiation question format. All answers and conditions grouping appear in Appendix A.

Considering that all the questions in a group were designed to measure a specific condition/outcome but with paraphrased questions or statements (figure 4.1) and that it acts as interval

data, the decision to use the average value for question reduction was made. The complete survey can be found in Appendix B.

Chou (2013) did not include reverse questions in his PLS analysis. Also, Hartley & Betts 2013 (in Hartley, 2014) mention that slightly higher scores were obtained with English respondents, when the question is reversed. Therefore, reverse questions were not considered as such, but as ordinal answers*.

 (AA)

	Strongly disagree				Netural				Strongly agree
I would enjoy watching more of this kind of video.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I would like generally avoid watching this kind of video.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I liked this video.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I would have a positive attitude toward this kind of video.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Figure 4.1: Survey questionnaire example with equal semantic value for the outcome Approach/Avoidance “aa”. The second statement is a reverse question*.

Source: Borrowed from Chou (2013).

Three out of eight possible ways to process data were chosen (Table 4.2). Paths 6 to 8 used the mode instead of the average (assuming the data as ordinal data) but since this process reduced the number of cases to fewer than the half they lacked of empirical strength, for this reason they were not considered in the analysis. Paths 1 and 2 used the reversed questions as reversed. Although these two paths were worth for comparison, due to comparison and data management reasons only paths 3 to 5 were considered for the analysis.

Table 4.2: First paths for data analysis; R: Reverse questions used, NR: No Reverse Questions Used, NBP: Natural Break of Data Consistency Cut-Off Point, REC: Recommended Consistency Cut-Off Point, SEM: Semantic Cut-Off Point. Red paths account for the analysis in Excel.

Paths	7-Point Likert Scale		Calibration			
	Mode/Average	Reverse/No reverse	Fully in threshold	Fully out threshold	Cross-over point	NBP/REC/SEM
1	AVG	R	0.95	0.05	0.5	REC
2	AVG	NR	0.95	0.05	0.5	REC
3	AVG	NR	0.95	0.05	0.5	NBP
4	AVG	NR	0.95	0.05	0.5	NBP
5	AVG	NR	VARY	VARY	VARY	NBP
6	MODE	R	7	1	4	REC
7	MODE	R	7	1	4	NBP
8	MODE	R	6	2	4	SEM

Source: Own.

4.3 The Method

Fuzzy-Set Qualitative Comparative Analysis was applied with the purpose of refining the understanding of its application into SEM (PLS analysis). Three steps of fsQCA – namely, calibration of conditions, analysis of fuzzy-set truth table algorithm which includes the decision of the application of the consistency cut-off point, and counterfactual analysis of the causal conditions that lead to approach and avoidance were performed for all data comparison.

4.3.1 The Calibration Process for Grouped Data

In a previous step the average was taken to combine answers from the 7-point Likert Scale Survey with not reversed questions. Calibration of the data was the second step. The upper and lower thresholds and the cross-over points for the selected paths were decided. Later the truth tables were built and finally the different consistency cut-off points were applied.

4.3.1.1 Paths 2 and 3 – AD80 and ARNB

Paths 2 and 3 were renamed after AD80 (Average Default Consistency Cut-Off Point – 0.80) and ARNB (Average Recommended Natural Break Consistency Cut-Off Point). Table 4.3 shows the thresholds for full membership, cross-over point, and full non-membership for all the conditions including the outcome. These points were obtained using the direct method for calibration, explained in section 3.5.1 of the literature review chapter.

Table 4.3: Threshold chart for FM(0.95): Full Membership at 0.95, COP(0.5): Cross Over Point at 0.5, and FNM(0.05): Full Non Membership at 0.05 for four conditions and the outcome (Approach/Avoidance) using Excel.

	Arousal (aro)	Visual Novelty (vn)	Visual Complexity (vc)	Cognitive Engagement (ce)	Approach/Avoidance (aa)
FM (0.95)	5.475	6.967	6.200	6.627	7.000
COP (0.5)	4.000	4.000	3.600	3.909	4.000
FNM (0.05)	1.750	1.000	1.000	1.282	1.000

Source: Own.

The calculation was made using the percentile formula in Excel “PERCENTILE(ARRAY,K)” where array refers to the column data for analysis and “k” is the percentile value (0.95; 0.5; 0.05). Figure 4.2 shows the calculation of other parameters for the first ten cases of the outcome Approach/Avoidance; the rest of the conditions go under the same procedure.

Cases	aro	Dev. Cross-Over	Scalars	Product CxD	Degree of Membership
1	4.00	0.000	1.333	0.000	0.50
2	3.75	-0.250	1.333	-0.333	0.42
3	3.75	-0.250	1.333	-0.333	0.42
4	2.50	-1.500	1.333	-2.000	0.12
5	4.00	0.000	1.333	0.000	0.50
6	6.25	2.250	2.034	4.576	0.99
7	4.25	0.250	2.034	0.508	0.62
8	4.50	0.500	2.034	1.017	0.73
9	4.00	0.000	1.333	0.000	0.50
10	6.00	2.000	2.034	4.068	0.98

Figure 4.2: Example of obtained values in all stages of the calibration process for the condition arousal “aro” using the Direct Method proposed by Ragin (2000). 1) Deviation from the Cross-Over Point, 2) Scalars, 3) Product CxD and 4) Degree of membership.

Source: Own.

The log of odds is used for this purpose. The process of calibration is as follows:

- First the Deviation from the Cross-Over Point is calculated by subtracting the cross-over point value from the value in “aro” column.
- Scalars are included to transform the data into fuzzy set values (0-1) by means of the log of odds. The calculation was done using the next formula;

$$Scalars = \frac{\pm 3}{(FNM - COP)} \dots (a)$$

Here, formula (a) is applied to the threshold points where the log of odds +/- 3 represents the FM/FNM respectively and it is related to the values in the Dev. Cross-Over column; if the value is positive as in case 1 the positive 3 and FM should be included, if not as in case 2 the negative 3 and FNM should be used. This arrangement is in order to obtain only positive values in the column Scalars.

- Product CxD column was obtained by multiplying the Dev. Cross-Over column by the Scalars column.
- Finally, the Degree of Membership column was obtained by reversing the log of odds by using its inverse function EXP, as in the next formula where we obtained the relative value of the Product CxD column.

$$\text{Degree of Membership} = \frac{\text{EXP}(\text{Product CxD})}{(1 - (\text{EXP}(\text{Product CxD})))} \dots\dots(b)$$

The same values can be obtained using the calibration function in the fsQCA Software. For the analysis these obtained Degrees of Membership were introduced to the fsQCA Software and processed as needed to obtain the truth tables. After that the complex and most parsimonious solutions were used to compare outcomes with and without logical reminders (rows without cases).

4.3.1.2 Path 4 – ASNB

Path 4 was renamed after ASNB (Average Semantic Natural Break Consistency Cut-Off Point) Semantic because it uses the definitions of the concepts as principle for calibration; meaning an indirect calibration. Although this criterion for calibration seems to be random, it follows the logic of the researcher which is highly valuable for fsQCA application. The thresholds used for both paths are as in table 2.4. Assignment of the Membership Degree was done using the Membership Degree column in the table and following a logic sequencing of data.

Table 4.4: Qualitative calibration thresholds using the indirect method; FM: Full Membership, PM: Partial membership, COP: Cross Over Point, PNM: Partial Non-Membership, and FNM: Full Non Membership for four conditions and the outcome (Approach/Avoidance). Data sequencing was done using the last right column “Membership Degree”.

	Arousal (aro)	Visual Novelty (vn)	Visual Complexity (vc)	Cognitive Engagement (ce)	Approach/Avoidance (aa)	Membership Degree
FM	6.000	6.000	6.000	6.000	6.000	1.00
PM						0.75
COP	4.500	3.500	3.500	3.500	4.000	0.50
PNM						0.25
FNM	2.000	2.000	2.000	2.000	2.000	0.00

Source: Own.

4.3.1.3 Necessity Analysis

Before following with the analysis of sufficient conditions, the necessity analysis was made for all single conditions (high values and low values) using fsQCA Software which by default sets a 0.90 consistency cut of point. Results for these tables are placed in the results section.

4.3.2 Generation of Truth Tables

Right after calibration, the respective truth tables were generation for the three calibrated analyses paths; namely, AD80, ARNB and ASNB. Special attention was paid in the last two paths where the natural break consistency cut-off point was not always visible.

4.3.2.1 Paths AD80 and ARNB

Following the asymmetric nature of causal complexity; both, approach and avoidance as outcomes were assigned their consistency values for sufficiency (Table 4.5). Although a manual construction was possible, fsQCA Software was used for the sake of ease. Truth tables show 16 rows or sufficient configurations for the outcome since there are 4 conditions ($k=4$) - $2^4 = 16$ configurations.

Rows were organized in such a way that the distribution of cases could be more visible. The consistencies for the outcome “aa_cal” approach and “~aa_cal” avoidance were organized from high to low to find of the consistency for sufficiency of 0.80 because in this solution we followed the default value found in the fsQCA Software, which is the same as the one recommended by Ragin (2008). The values found for approach and avoidance were row 15 (0.840) and row 8 (0.826) respectively – red highlighted cells.

Table 4.5: Truth table for solution AD80 and ARNB showing all sufficient configurations for the positive outcome approach (aa) and the negative outcome avoidance (~aa).

Rows	Conditions				Outcome Consist.		Cases
	aro_cal	vn_cal	vc_cal	ce_cal	aa_cal	~aa_cal	
1	0	0	0	0	0.639	0.918	24
2	0	0	0	1	0.922	0.837	4
3	0	0	1	0	0.648	0.967	16
4	0	0	1	1	0.917	0.896	1
5	0	1	0	0	0.857	0.940	2
6	0	1	0	1	0.959	0.773	5
7	0	1	1	0	0.731	0.947	10
8	0	1	1	1	0.914	0.826	3
9	1	0	0	0	0.863	0.913	2
10	1	0	0	1	0.952	0.779	4
11	1	0	1	0	0.842	0.947	1
12	1	0	1	1			0
13	1	1	0	0			0
14	1	1	0	1	0.970	0.633	11
15	1	1	1	0	0.840	0.938	3
16	1	1	1	1	0.919	0.671	16

Source: Own.

Using both fsQCA Software and QCAGUI package in R Software the process of rows minimization was run using only the cases that present the outcome giving as the complex solutions. Parallely, an even more parsimonious logical minimization process was possible by including the two logical reminder rows (12 and 13), allowing for the construction of the most parsimonious solutions.

Path ARNB followed the same procedure of truth table construction, however, to find the consistency cut-off point for sufficiency all of the 16 configuration's consistency values were plotted in figure 4.3. Here, Figure 4.3 (a) represents the natural break consistency cut-off point for the outcome approach "aa_cal" while figure 4.3 (b) for avoidance "~aa_cal". Respectively the values for consistency of sufficiency were 0.914 and 0.896.

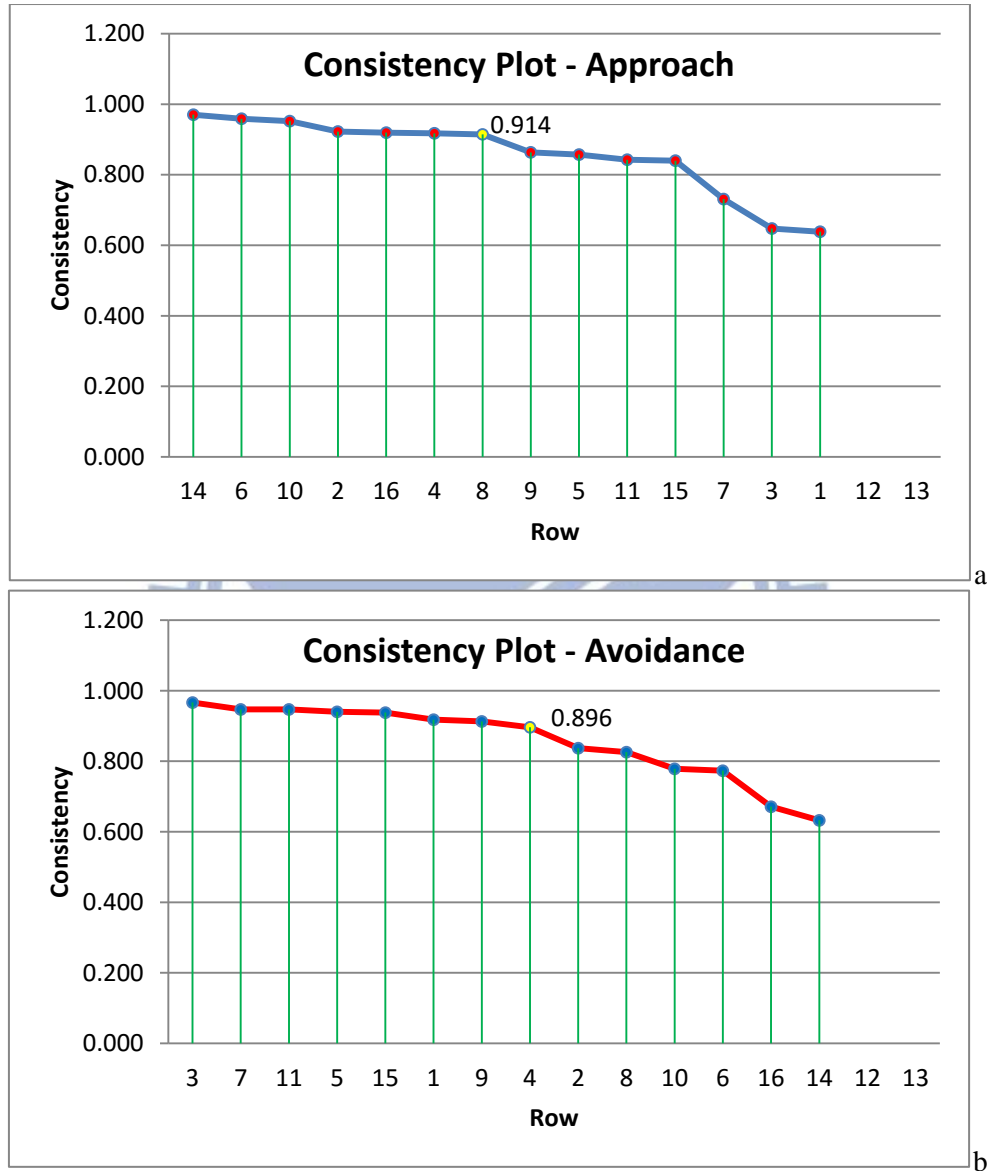


Figure 4.3: Natural break consistency cut-off point for the outcome approach "aa_cal" (a) and avoidance "~aa_cal" (b) for solution ARNB.

Source: Own.

4.3.2.2 Path ASNB

One more time, following the asymmetric nature of causal complexity; both, approach and avoidance consistency values for each outcome were obtained by means of the fsQCA software; rows

were organized in a more visible way and consistency cut-off points for sufficiency were found. Table 4.6 shows the truth tables with $2^4 = 16$ configurations for path ASNB.

Table 4.6: Truth Table for solution ASNB showing all sufficient configurations for the positive outcome approach (aa) and the negative outcome avoidance (~aa).

Rows	Conditions				Outcome		Cases
	aro_cal	vn_cal	vc_cal	ce_cal	aa_cal	~aa_cal	
1	0	0	0	0	0.451	0.810	27
2	0	0	0	1	0.707	0.619	11
3	0	0	1	0	0.433	0.853	19
4	0	0	1	1	0.702	0.692	1
5	0	1	0	0	0.596	0.752	9
6	0	1	0	1	0.783	0.522	14
7	0	1	1	0	0.460	0.795	29
8	0	1	1	1	0.726	0.549	20
9	1	0	0	0			0
10	1	0	0	1			0
11	1	0	1	0			0
12	1	0	1	1			0
13	1	1	0	0			0
14	1	1	0	1	0.809	0.497	12
15	1	1	1	0	0.655	0.726	3
16	1	1	1	1	0.808	0.468	18

Source: Own.

Figure 4.4 (a) represents the natural break consistency cut-off point for the outcome approach “aa_cal” while figure 4.4 (b) for avoidance “~aa_cal”. Respective values for the consistency threshold for sufficiency were 0.783 for row 6 and 0.752 for row 5.

Similarly, using fsQCA Software and QCAGUI package in R Software the process of rows minimization was run. For the complex solution rows including the outcome (1) were logically reduced while for the most parsimonious solution the logical reminders (rows 9 to 13) were included.

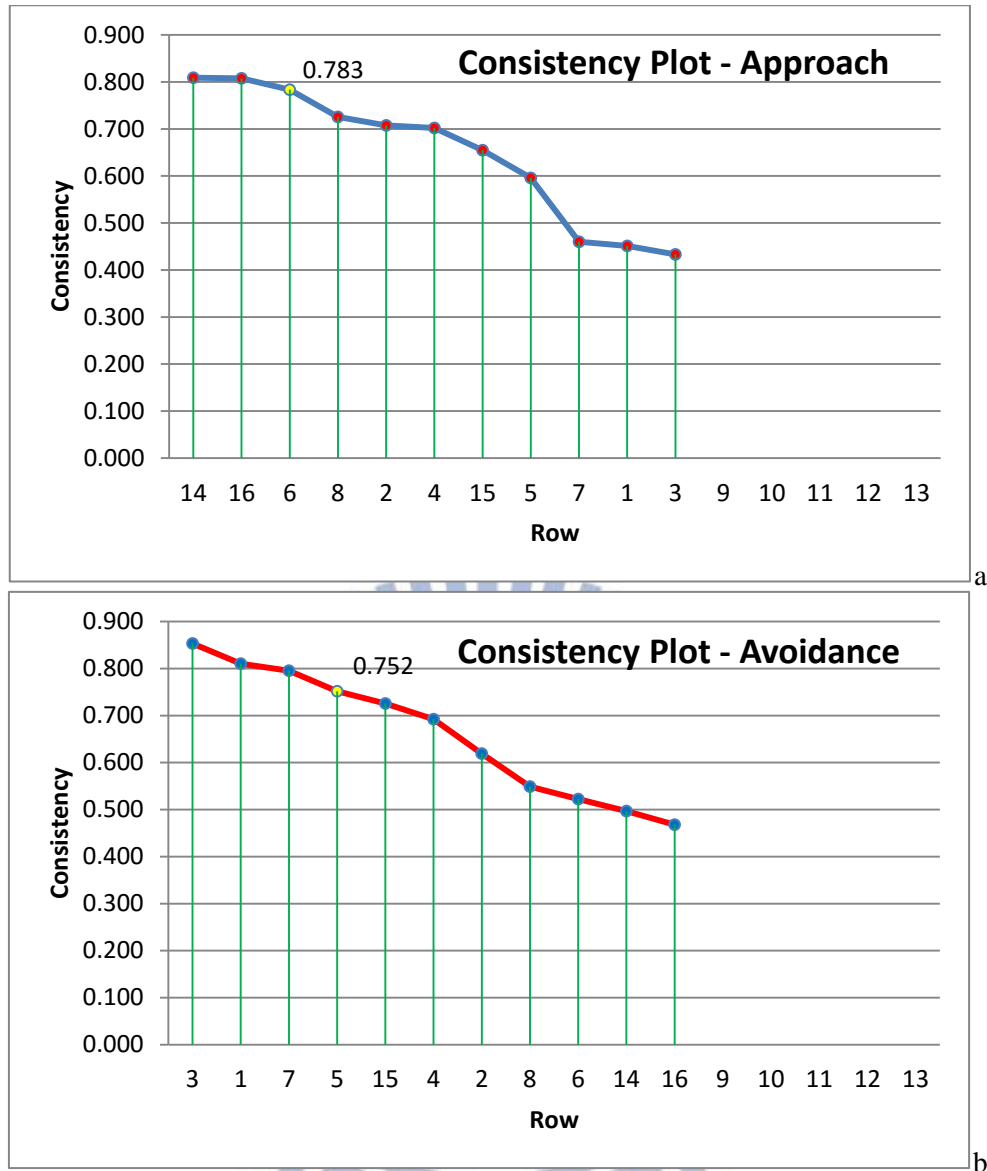


Figure 4.4: Natural break consistency cut-off point for the outcome approach “aa_cal” (a) and avoidance “~aa_cal” (b) for solution ARNB.

Source: Own.

4.3.3 The Calibration Process for the Inclusion of a Dummy Condition

4.3.3.1 Path ARNB for Isolated Data and VidType Inclusion.

The calibration of the isolated data was made in the same way as specified in the calibration of path ARNB. For details please refer to section 3.1.1. Animation data cases were calibrated separately as well as lecture data cases; meaning that two sets for analyses were obtained. Woodside et al., (2011) use the same procedure for separating data according to age group.

The calibration process for Crispy-Sets in Qualitative Comparative Analysis does not exist due to the bivalent nature of the data. Therefore csQCA focuses on the degree of membership but on

the presence or absence of the condition in the set (Ragin, 2008 in Morgan, 2013). Based on this premise the dichotomous condition VidType was only taken as a factorial variable where “1” is the presence of animation data cases and “0” represents the presence of lecture data cases (or the absence of animation data cases).

4.3.3.2 Path ARNB – Truth Tables for Isolated Data and VidType

Inclusion

The path ARNB followed the same process as in section 3.2.1. First, the truth table was generated and then the graph of consistency cut-off points for sufficiency of animation and lecture data cases isolated were obtained for the approach and avoidance outcome, in total four truth tables plus four graphs where the natural break point of data was observed and collected in Table 4.7.

Table 4.7: Natural break consistency cut-off points for the path ARNB for isolated data.

ARNB	aa	~aa
Animation	0.870	0.929
Lecture	0.920	0.908

Source: Own.

For the inclusion of the crispy-set VidType the truth tables for the positive and negative outcomes were built for the path ARNB. In this case the number of sufficient configurations (2^k) was 32 since condition VidType was included. The calibration for the other four conditions and the outcome was done as explained in the calibration of path ARNB while no calibration was needed for the condition VidType. The natural break point was found in order to get the consistency cut-off points.

Due to the high number of rows (32), the natural break of data is seen in two points; the first at 0.955 and the second at 0.889 for the outcome approach. In order to include as many cases as possible the second value was used. For the outcome avoidance the natural break point was found at 0.908.

4.4 The Research Design

Several software for the application of fsQCA analysis are available in the market. In this study three tools were used: First, Excel 2010 by Microsoft was used to recreate the process of fsQCA done by the algorithms in packages like R or fsQCA. Second, fs/QCA 2.5 Software developed by Charles Ragin and Sean Davey was used to execute formal fsQCA analysis of all data. Third, QCAGUI (Qualitative Comparative Analysis with a Graphical User Interface) Package for R interface developed by Dusa (2007) was applied to find Venn Diagrams and cases belonging to specific rows.

In general terms the three of them served as way of contrasting data for the purpose of accuracy. Data Analysis using fsQCA follows figure 4.5. The green arrows represent the first analysis or procedure; the red double arrows represent comparison; and the light blue arrows represent the final analysis.

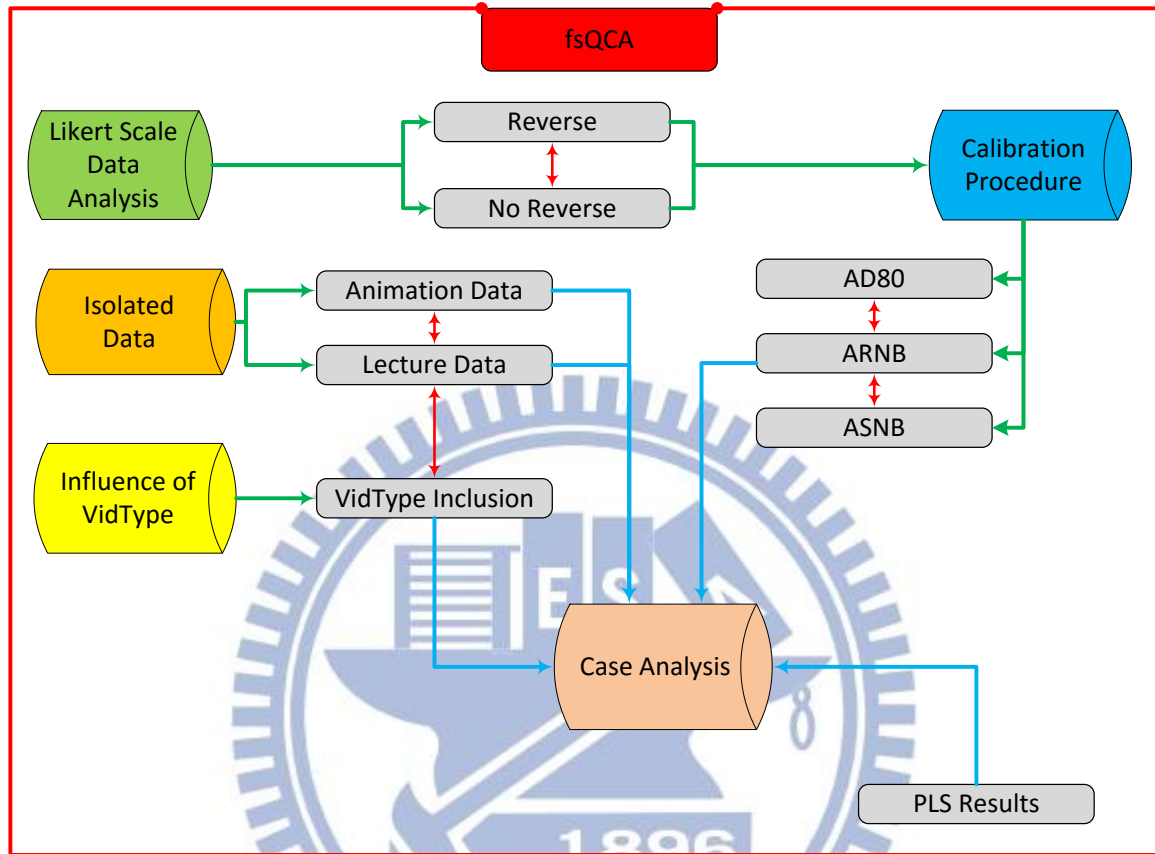


Figure 4.5: Research design for the analysis of data using fsQCA. AD80: Average Default Consistency Cut-Off Point 0.80, ARNB: Average Recommended Natural Break Consistency Cut-Off Point, ASNB: Average Semantic Natural Break Consistency Cut-Off Point.
Source: Own.

V. Results and Discussion

5.1 Necessity Overview

Table 5.1: Necessity analysis using fsQCA Software for solution paths AD80 – Average Data treatment Default Consistency Cut-off; ARNB – Average Data Treatment Natural Break Consistency Cut-Off; and ASNB – Semantic Data Treatment Natural Break Consistency Cut-Off.

	Analysis of Necessary Conditions				
AD80 and ARNB	Single Conditions	aa_cal		~aa_cal	
		Consistency	Coverage	Consistency	Coverage
	aro_cal	0.777	0.821	0.519	0.564
	~aro_cal	0.588	0.543	0.836	0.794
	vn_cal	0.791	0.764	0.577	0.574
	~vn_cal	0.560	0.563	0.763	0.789
	vc_cal	0.608	0.612	0.687	0.711
	~vc_cal	0.712	0.689	0.624	0.621
	ce_cal	0.871	0.889	0.454	0.476
	~ce_cal	0.486	0.464	0.894	0.877
ASNB	aro_cal	0.544	0.765	0.306	0.462
	~aro_cal	0.618	0.453	0.844	0.665
	vn_cal	0.762	0.641	0.527	0.476
	~vn_cal	0.377	0.426	0.602	0.730
	vc_cal	0.524	0.511	0.586	0.613
	~vc_cal	0.603	0.576	0.533	0.546
	ce_cal	0.802	0.804	0.324	0.349
	~ce_cal	0.351	0.326	0.818	0.816

Source: Own.

Table 5.1 shows the results of the analysis of necessity between causal conditions and the outcome (approach and avoidance) for the three paths of analysis chosen. Consistency values of single conditions respectively agree in all solutions AD80, ARNB and ASNB.

Values highlighted in red are the highest values for their outcome. Moreover, condition “~ce_cal” in solution AR80 and ARNB has the highest value (0.894) for avoidance “~aa_cal” and also (0.871) for approach “aa_cal”. Although none of them trespasses the limit of 0.9 in consistency required to be a necessary condition for the outcome, both of them reaches 0.90 suggesting this condition to be necessary for the outcome. For a condition to be necessary, the consistency must be greater than or equal to 0.9 (Ragin 2008 in Domenech et al. 2016; Schneider et al., 2010 in Ospina-Delgado et al., 2016).

5.2 Sufficiency Overview

5.2.1 Consistency Cut-Off Points and Unique Coverage Relevance

Table 5.2: Complex solution for Approach in fsQCA Software showing general data parameters for solution paths AD80 – Average Data treatment Default Consistency Cut-off; ARNB – Average Data Treatment Natural Break Consistency Cut-Off; and ASNB – Semantic Data Treatment Natural Break Consistency Cut-Off.

N	Configuration	Raw Cov.	Uniq. Cov.	Consist.	Cases	Overlap	Total Cases	Total Consistency	Total Coverage
AD80									
1	~aro_cal*ce_cal	0.51	0.00	0.90	13				
2	~aro_cal*vn_cal*~vc_cal	0.41	0.01	0.88	7				
3	~vc_cal*ce_cal	0.62	0.03	0.93	24				
4	vn_cal*ce_cal	0.74	0.06	0.91	35				
5	aro_cal*vc_cal*~ce_cal	0.35	0.00	0.81	4	9	52	0.82	0.88
6	aro_cal*~vn_cal*~ce_cal	0.38	0.00	0.82	3				
7	aro_cal*~vn_cal*~vc_cal	0.42	0.00	0.88	6				
8	aro_cal*vn_cal*vc_cal	0.51	0.00	0.86	19				
ARNB									
1	~vc_cal*ce_cal	0.62	0.04	0.93	23				
2	~aro_cal*ce_cal	0.51	0.00	0.90	13	23	44	0.90	0.84
3	vn_cal*ce_cal	0.73	0.14	0.92	35				
ASNB									
1	vn_cal*~vc_cal*ce_cal	0.44	0.08	0.82	26				
2	aro_cal*vn_cal*ce_cal	0.49	0.13	0.83	30	12	44	0.84	0.57

Source: Own

Table 5.2 shows the complex solutions for the three criteria applied to data; AD80, ARNB and ASNB. In general, consistency values are up 0.81 while coverage values are between 0.35 and 0.74. Total consistency is similar in all solutions with the highest being in solution ARNB (0.90). Coverage on the other side falls to 0.57 for solution ASNB and keeps constant for solutions AD80 and ARNB at over 0.80. The number of cases in solutions ARNB and ASNB are the same while solution AD80 contains 15% more cases. Overlapping cases account for 9 in solution AD80 and increases to 23 and 12 in the following solutions, respectively.

Condition “ce_cal” is present in configurations with coverage value higher than 0.51 in solutions AD80 and in all configurations in solutions ARNB and ASNB. The condition “vn_cal” is always present in configurations with unique coverage value higher than 0.06 (AD80-4, ARNB-3, and ASNB-1,2). Low levels of perceived visual complexity “~vc_cal” are present in all solutions with 24-AD80, 23-ARNB and 26-ASNB cases.

These results suggest conditions “ce_cal” and “vn_cal” necessary for the outcome approach in solution ASNB. For solution AD80, “ce_cal”, “vn_cal” and “~vc_cal” belong to the group of INUS conditions; both former statements inconsistent with the necessity analysis in section 5.1. Meanwhile, for ARNB solution path “ce_cal” would be considered as a necessary condition and “vn_cal” and “~vc_cal” as INUS conditions for the outcome “aa_cal” approach (Ragin, 2008; Schneider and Wagemann, 2012; Fiss, 2007).

According to Schneider & Wagemann (2010) regardless of which logical reminders are included, logical minimization yields a solution formula that never contradicts the empirical information at hand. In this sense, the reduction of conditions in the final solution is possible by including the logical reminders (configurations without cases) and therefore building a superset called the most parsimonious solution (Table 5.3). Also, Beynon et al. (2016) in their study about entrepreneurial attitudes and activities compare the complex and the most parsimonious solutions.

Table 5.3: The most parsimonious solution for Approach in fsQCA Software showing general data parameters for solution paths AD80 – Average Data treatment Default Consistency Cut-off; ARNB – Average Data Treatment Natural Break Consistency Cut-Off; and ASNB – Semantic Data Treatment Natural Break Consistency Cut-Off.

N	Configuration	Raw Cov.	Uniq. Cov.	Consist.	Cases	Overlap	Total Cases	Total Consistency	Total Coverage
AD80									
1	aro_cal	0.78	0.02	0.82	37				
2	ce_cal	0.87	0.09	0.89	44	36	52	0.80	0.93
3	vn_cal*~vc_cal	0.56	0.01	0.90	18				
ARNB									
1	ce_cal	0.87	0.87	0.88	44	0	44	0.89	0.87
ASNB									
1	aro_cal*ce_cal	0.51	0.15	0.82	30				
2	vn_cal*~vc_cal*ce_cal	0.44	0.08	0.82	26	12	44	0.83	0.60

Source: Own

The number of cases did not change as expected from the last paragraph. Overlapped cases increased by 27 in solutions AD80, while for ASNB remained constant. Overall total consistency and coverage values varied in the centesimal digit, except for solution AR80 (0.88 to 0.93). Unique coverage values are higher for these configurations 2-AD80, 1-ARNB, 1-ASNB.

Condition “ce_cal” is the a single solution for ARNB and in combination with “aro_cal” represent 30 out of 44 cases in solution ASNB where “vn_cal” seems to contradict the complex

solution since this condition is not anymore a necessary condition for approach meaning that the solution ASNB is biased.

Condition “aro_cal” appears as a single condition in a configuration for solution AD80 and in combination with “ce_cal” in solution ASNB. However, a necessary condition is supposed to present a consistency value higher than 0.90 (0.82) therefore it contradicts the statement of necessity and suggests this analysis path as impaired.

Table 5.4 shows the solutions for the negate outcome (~aa_cal) avoidance, following the principle of asymmetry (Fiss, 2011 in Ospina & Zorio, 2016) implying that the negation of the conditions that lead to approach do not lead to avoidance.

In general, solutions AD80, ARNB and ASNB show consistency and coverage values higher than 0.83 and 0.47 respectively. There is a higher overlap of cases than for the outcome approach. Solution ASNB provides only one configuration (1) which in solutions ARNB and AD80 is also present as configurations 2 and 2, presenting the highest consistency values of all (0.83 and 0.91). Solution AD80 considers 7 cases more than solution ARNB and encloses them in a 5-configuration solution. Coverage of solution ASNB reaches 0.76 than solution ARNB.

Table 5.4: Complex solution for Avoidance in fsQCA Software showing general data parameters for solution paths AD80 – Average Data treatment Default Consistency Cut-off; ARNB – Average Data Treatment Natural Break Consistency Cut-Off; and ASNB – Semantic Data Treatment Natural Break Consistency Cut-Off.

N	Configuration	Raw Cov.	Uniq. Cov.	Consist.	Cases	Overlap	Total Cases	Total Consistency	Total Coverage
AD80									
1	~vn_cal*~ce_cal	0.72	0.03	0.91	43	52	66	0.83	0.92
2	~aro_cal*~ce_cal	0.79	0.03	0.91	52				
3	~aro_cal*~vn_cal	0.69	0.02	0.87	45				
4	vc_cal*~ce_cal	0.62	0.03	0.94	30				
5	~aro_cal*vc_cal	0.59	0.02	0.87	30				
ARNB									
1	~vn_cal*~ce_cal	0.72	0.03	0.91	43	51	59	0.88	0.89
2	~aro_cal*~ce_cal	0.79	0.02	0.91	52				
3	vc_cal*~ce_cal	0.62	0.03	0.94	30				
4	~aro_cal*~vn_cal*vc_cal	0.47	0.01	0.93	17				
ASNB									
1	~aro_cal*~ce_cal	0.76	0.76	0.83	84	0	84	0.83	0.76

Source: Own.

The condition “~ce_cal” appears in all the solutions. Configuration 4 in ARNB solution does not contain the former condition, though. Table 5.5 shows the details for the most parsimonious solutions. The most parsimonious solutions show 16.5% higher values of coverage for solution ARNB compared to solution ASNB. Solution ASNB shows 18 and 25 more cases than AD80 and ARNB solutions respectively.

Here, the condition “~aro_cal” stops being relevant for solution ARNB. The condition “~ce_cal” appears as unique in solutions AD80 and ARNB with 0.13 and 0.40 unique coverage values. Combined conditions 2 and 3 (AD80) and 2 (ARNB) show low levels of unique coverage and high overlap of cases in their respective solutions suggesting ARNB as a more coherent solution.

Table 5.5: Complex solution for Avoidance in fsQCA Software showing general data parameters for solution paths AD80 – Average Data treatment Default Consistency Cut-off; ARNB – Average Data Treatment Natural Break Consistency Cut-Off; and ASNB – Semantic Data Treatment Natural Break Consistency Cut-Off.

N	Configuration	Raw Cov.	Uniq. Cov.	Consist.	Cases	Overlap	Total Cases	Total Consistency	Total Coverage
AD80									
1	~ce_cal	0.89	0.13	0.88	57	51	66	0.82	0.94
2	~aro_cal*~vn_cal	0.69	0.02	0.87	45				
3	~aro_cal*vc_cal	0.59	0.02	0.87	30				
ARNB									
1	~ce_cal	0.89	0.40	0.88	57	17	59	0.85	0.91
2	~vn_cal*vc_cal	0.51	0.01	0.90	19				
ASNB									
1	~aro_cal*~ce_cal	0.76	0.76	0.83	84	0	84	0.83	0.76

Source: Own.

Although the parameters for consistency and for coverage of all the solutions (for outcome approach and avoidance) fall into the description of an informative model – consistency > 0.74 and coverage 0.25 to 0.65 (Ragin, 2008 in Woodside 2013), Schneider & Wagemann (2012) suggest to focus on configurations with high uniquely coverage, since these cases show few overlap and therefore give a unique contribution to the results.

5.2.2 Path ARNB Grouped Data and ARNB Isolated Data

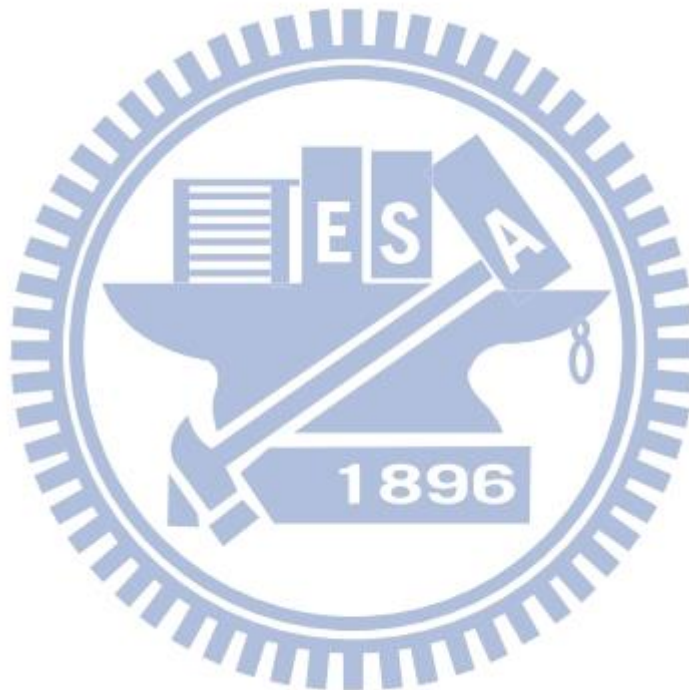
Figure 5.1 displays the XY plots for solution ARNB; data is divided between animation and lecture data cases. The right column shows the complex solutions for the animation data and the left for the lecture data. Here the full solutions for approach with both analyses respectively:

Right, Animation: aro_cal*ce_cal + ~vn_cal*ce_cal + ~aro_cal*vn_cal*~vc_cal → aa_cal

Left, Lecture: ~aro_cal*ce_cal + ~vc_cal*ce_cal + vn_cal*ce_cal → aa_cal

The full solution for lecture data cases suggest “ce_cal” as a necessary condition, however, the configurations for the animation data cases are more complex suggesting that animation videos are more complex in nature, therefore different combinations of conditions are possible.

The plots show that all consistency values are above 0.86 while the coverage values are between 0.39 and 0.78 for animation data and between 0.52 and 0.70 for lecture data. The configuration “aro_cal*ce_cal” has the highest unique coverage (0.26) for the animation data (23 cases) while the configuration “vn_cal*ce_cal” (0.11) for lecture data (30 cases).



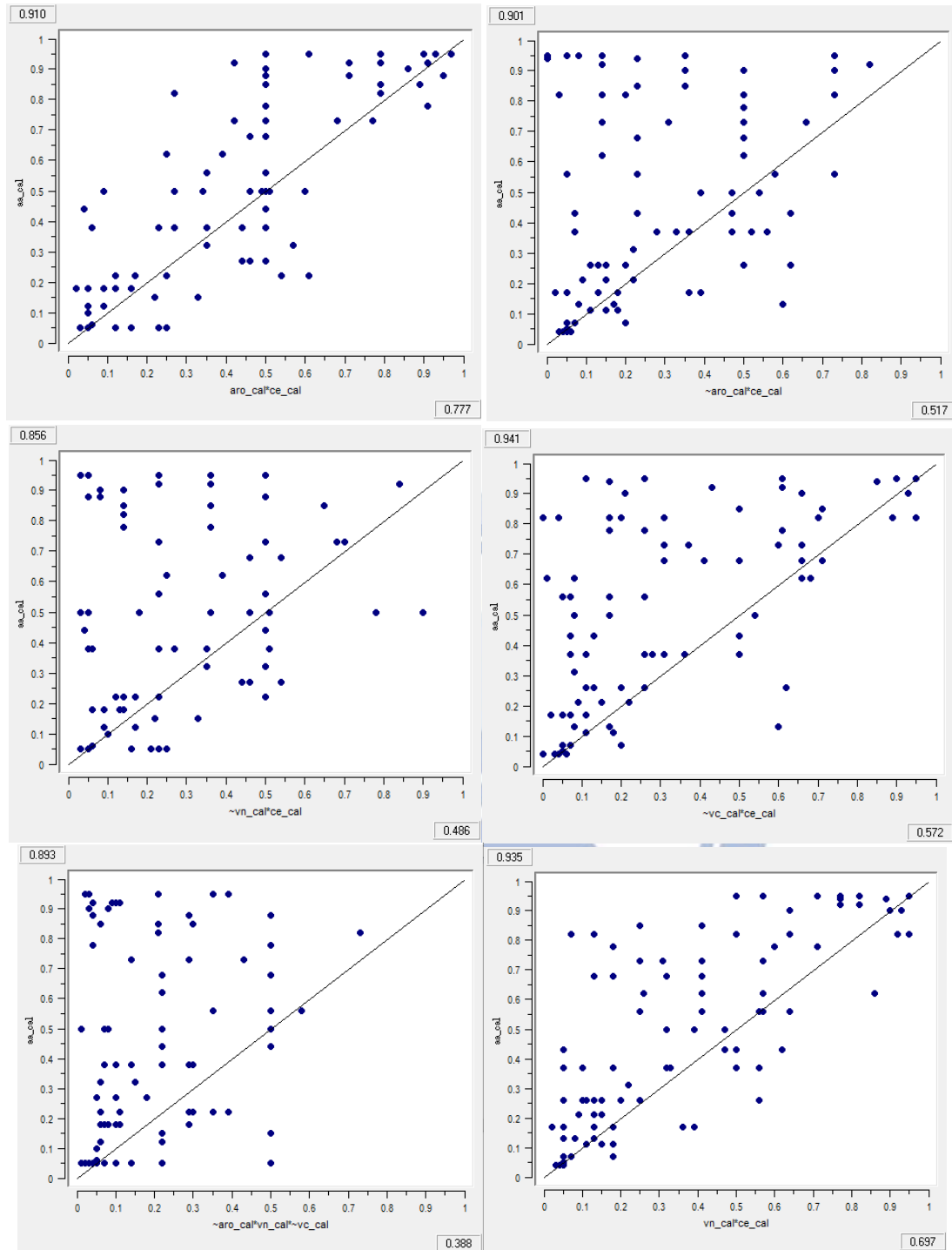


Figure 5.1: XY plots for all possible configurations of the complex solution ARNB for animation (left) and lecture (right) data and for the outcome approach, using fsQCA software. **Source:** Own.

Figure 5.2 present the most parsimonious solution. For animation data the condition “ce_cal” alone accounts for 0.37 in the unique coverage. For lecture data only one configuration is found “ce_cal” - 0.87 of unique coverage.

The aggrupation of cases around the central diagonal suggest the necessity and sufficiency of a condition (Schneider & Wagemann, 2012). Condition “ce_cal” shows these characteristics for the outcome approach and regardless of the type of video. However, the parsimonious solution also show higher degrees of complexity evidenced by the second configuration “vn_cal*~vc_cal”.

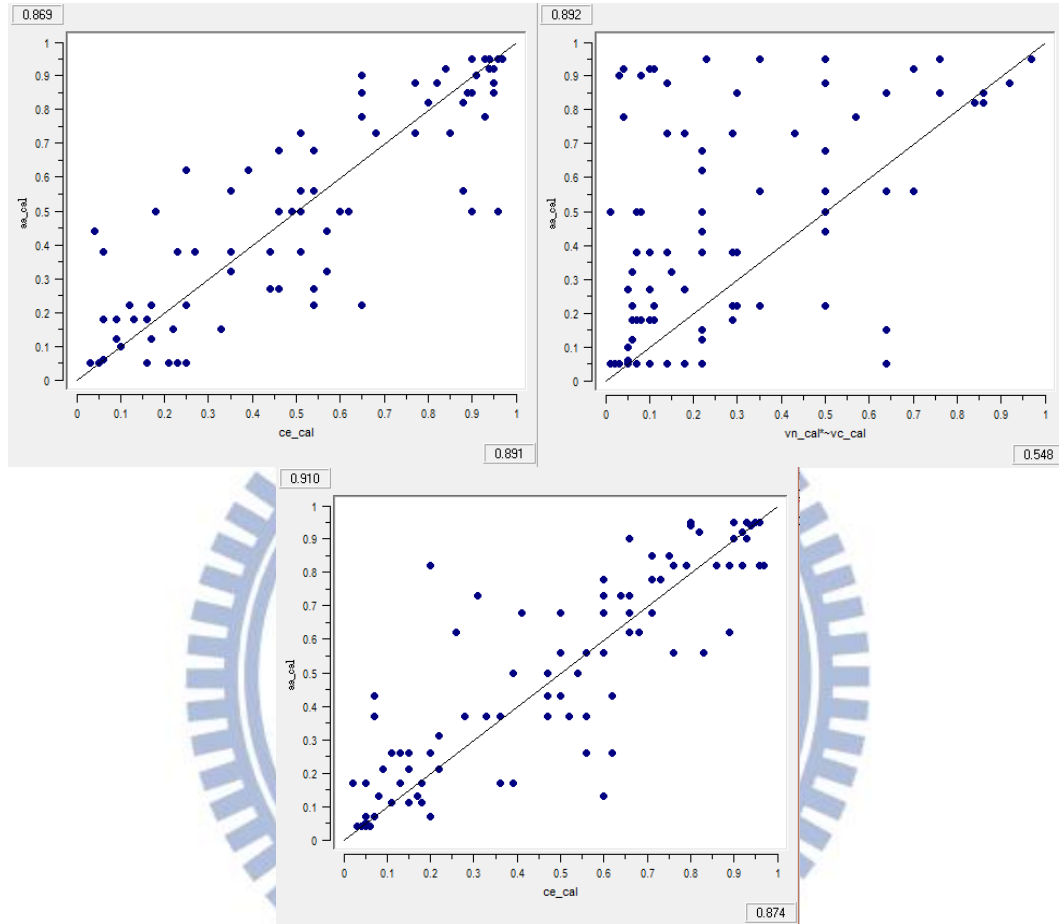


Figure 5.2: XY plots for all possible configurations of the most parsimonious solution ARNB for animation (top) and lecture (bottom) data and for the outcome approach, using fsQCA software.
Source: Own.

Figure 5.3 shows the XY plots for the animation data and for the outcome avoidance. Unique coverage is higher for the first configuration “~aro_cal*~ce_cal” (0.16) of the animation data (top XY plots). The parsimonious solution contains the single condition “~ce_cal” with a unique coverage of 0.88 or 0.9 (necessity condition). Both configurations of the complex solution (top XY plots) share 15 cases from which 11 show the outcome avoidance when the first configuration occurs. These results suggest a stronger causal relation between avoidance and the first complex configuration. The full solution (bottom left) for avoidance does not show more complexity related to animation data cases since the condition “~ce_cal” is present in the second configuration as well. Results suggest condition “~ce_cal” as necessary in the complex and parsimonious solutions.

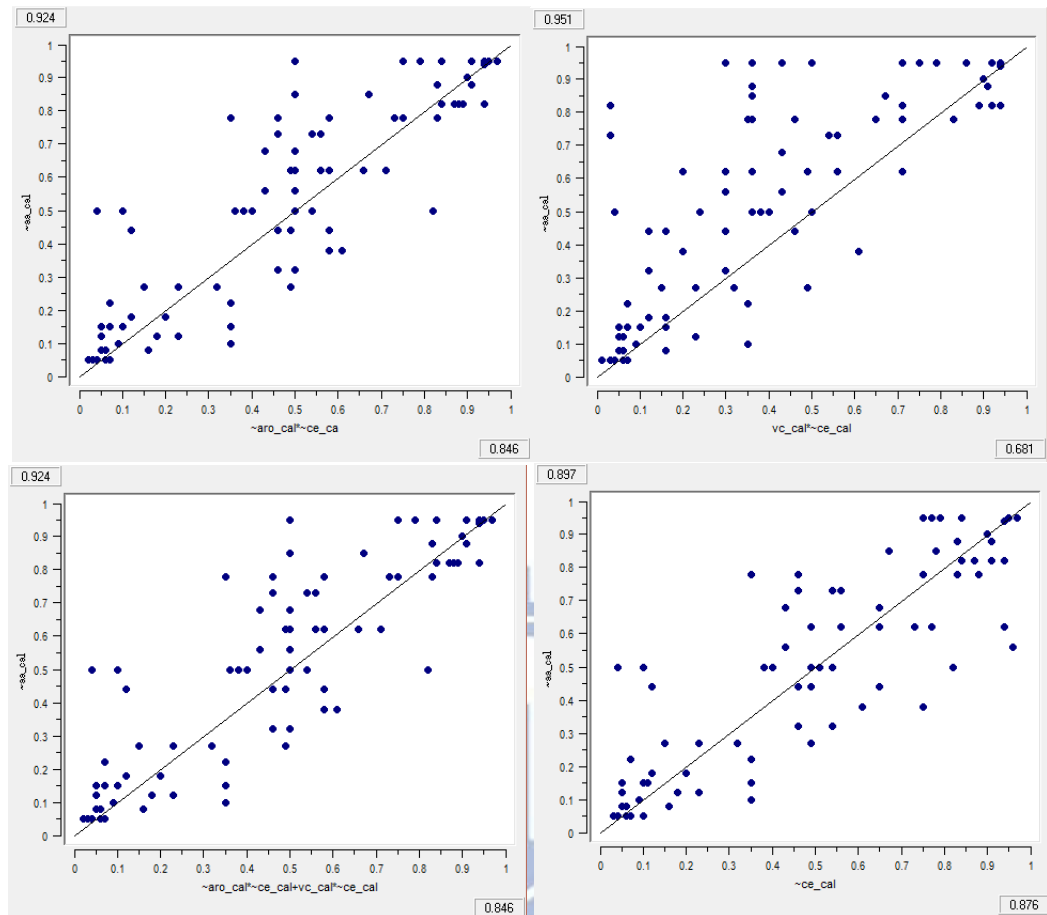


Figure 5.3: XY plots of all possible configurations of the complex solution (top plot), the full complex solution (bottom left) and the most parsimonious solution (bottom right) for path ARNB animation data for the outcome avoidance, using fsQCA software.

Source: Own.

Figure 5.4 displays the results for the lecture data cases and for the outcome avoidance. These results are coherent with the ones obtained with the grouped data for the path ARNB. For example high levels of the condition “vc_cal” together with low levels of the condition “ce_cal” provoke avoidance, same as with the animations data cases but with a unique coverage of 0.12 (0.05 higher), both configurations have low raw coverage values, though. Another similarity is the parsimonious solution that in both cases appears to be a single condition “~ce_cal”. The second configuration “~aro_cal*~vn_cal*~ce_cal” (top right plot) has a unique coverage value of 0.25 and a contradictory case appears (case 34). These results suggest again the condition “~ce_cal” as necessary condition for the outcome avoidance.

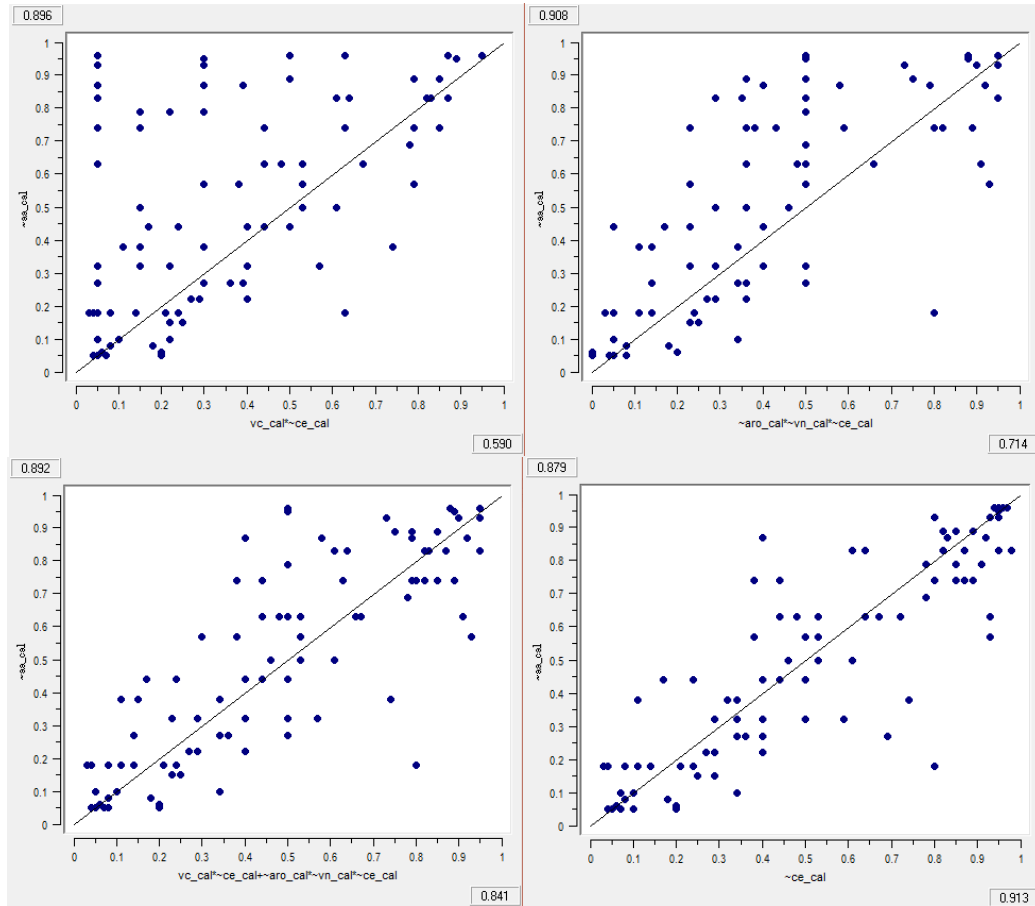


Figure 5.4: XY plots of the all possible configurations of the complex solution (top plots), the full complex solution (bottom left) and the most parsimonious solution (bottom right) for path ARNB lecture data for the outcome avoidance, using fsQCA software.

Source: Own.

Gerring et al., (2013) explain that QCA can be used with experimental data, especially with a factorial design and if finding the average treatment effect (ATE) is the objective. The condition VidType was assigned the values of “1” to animation data cases and the value “0” to lecture data cases.

For the outcome approach (left) in figure 5.5 there are two configurations starting with “vidtype” 4 and 6. Values of coverage are lower but cases included in these matching configurations are the same with both ways of analysis, grouped and isolated data cases. Similarly, configurations 3 and 5, meaning lecture data cases “~vidtype” correspond to the top and bottom right XY plots in figure 5.1 for lecture data cases. In other words, coverage values differ between both analyses, but cases included in these corresponding configurations are the same suggesting that this kind of analysis is more difficult for interpretation.

For the outcome avoidance (right) only configuration 3 is related to animation data cases with coverage value of 0.38 and 0.01 (unique coverage). This configuration contains the same cases as in the isolated analysis (figure 5.3 – top right).

For both outcomes – approach and avoidance – configurations that include animation and lecture data, meaning not showing the condition vidtype possess higher coverage values. Configurations 1 and 7 from outcome approach correspond to configurations 1 and 2 for outcome avoidance but reversed, respectively. Including the treatment “VidType” also shows that configurations (1-7) present the condition “ce_cal” and “~ce_cal” for approach and avoidance, leading to same results of necessity.

```

Model: aa_cal = f(vidtype, aro_cal, vn_cal, vc_cal, ce_cal)
Rows:      25
Algorithm: Quine-McCluskey
True: 1
--- COMPLEX SOLUTION ---
frequency cutoff: 1.000000
consistency cutoff: 0.889994

      raw    unique
coverage coverage consistency
-----
~vc_cal*ce_cal      0.598328      0.041806      0.917750
~aro_cal*~vn_cal*ce_cal 0.407358      -0.000000      0.895588
~vidtype*~aro_cal*ce_cal 0.273467      0.001003      0.900514
vidtype*~vn_cal*ce_cal 0.229097      0.002898      0.855893
~vidtype*vn_cal*ce_cal 0.368562      0.014604      0.934955
vidtype*aro_cal*ce_cal 0.366332      0.007469      0.909745
aro_cal*vn_cal*ce_cal 0.614827      -0.000000      0.946781
solution coverage: 0.830100
solution consistency: 0.896460

Model: ~aa_cal = f(vidtype, aro_cal, vn_cal, vc_cal, ce_cal)
Rows:      25
Algorithm: Quine-McCluskey
True: 1
--- COMPLEX SOLUTION ---
frequency cutoff: 1.000000
consistency cutoff: 0.908210

      raw    unique
coverage coverage consistency
-----
vc_cal*~ce_cal      0.634727      0.098392      0.924302
~aro_cal*~vn_cal*~ce_cal 0.694105      0.128189      0.924879
vidtype*~aro_cal*~ce_cal 0.380922      0.010718      0.928422
solution coverage: 0.843516
solution consistency: 0.907833

```

Figure 5.5: Complex solution of grouped data obtained with fsQCA software including VidType as dummy condition for lecture and animation data for the outcomes approach (left) and avoidance (right) for the best solution ARNB.

Source: Own.

Armstrong (in Woodside, 2013), says that in MRA the inclusion of a variable somehow means controlling for this variable in experimental data which might possibly be the case in fsQCA.

```

Model: aa_cal = f(vidtype, aro_cal, vn_cal, vc_cal, ce_cal)
Rows:      25
Algorithm: Quine-McCluskey
True: 1-L
--- PARSIMONIOUS SOLUTION ---
frequency cutoff: 1.000000
consistency cutoff: 0.889994

      raw    unique
coverage coverage consistency
-----
ce_cal      0.882386      0.882386      0.890026
solution coverage: 0.882386
solution consistency: 0.890026

Model: ~aa_cal = f(vidtype, aro_cal, vn_cal, vc_cal, ce_cal)
Rows:      25
Algorithm: Quine-McCluskey
True: 1-L
--- PARSIMONIOUS SOLUTION ---
frequency cutoff: 1.000000
consistency cutoff: 0.908210

      raw    unique
coverage coverage consistency
-----
~ce_cal      0.895177      0.895177      0.887850
solution coverage: 0.895177
solution consistency: 0.887850

```

Figure 5.6: The most parsimonious solution of grouped data obtained with fsQCA software including VidType as dummy condition for lecture and animation data for the outcomes approach (left) and avoidance (right) for the best solution ARNB.

Source: Own.

Figure 5.6 shows the most parsimonious solution for approach and avoidance with only one condition left “ce_cal” and “~ce_cal” for both of the outcomes – approach and avoidance.

5.2.3 Comparison between ARNB Grouped data, ARNB Isolated Data and ARNB VidType and PLS Results

Figure 5.7 shows the results obtained using PLS (Chou, 2013). The explanatory factors perceived visual complexity and perceived visual novelty explain about 50.5% of the variance of cognitive engagement and 34.7% of arousal. Perceived visual complexity shows a negative influence on both former conditions, meaning that its presence provokes avoidance while perceived visual novelty shows a stronger positive influence on both former conditions meaning that its presence provokes approach.

In this model, the explanatory factors arousal and cognitive engagement play the role of mediators and influence positively the outcome approach. Although both influences are significant, it seems that cognitive engagement plays a more important role (Path Coefficient = 0.51***).

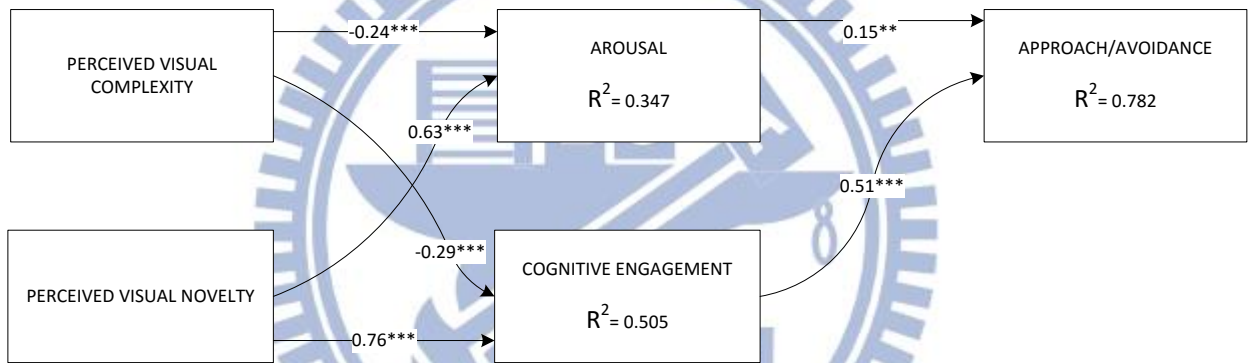


Figure 5.7: PLS analysis for the model on approach and avoidance showing the path coefficients or standardized regression weights (values on the arrows) and the coefficients of correlation of the model (inside the boxes), the percentage of variance explained by the explanatory variables.

Source: Adapted from Chou, 2013.

Table 5.6 shows three different paths full solutions for data analysis. All solutions show high consistency (>0.84) and coverage (>0.82). The condition “ce_cal” (green highlights) with the highest unique coverage value and as a unique condition for a configuration is common in all the parsimonious solutions. These results are coherent with the path coefficient obtain by Chou (2013) of Cognitive Engagement (0.51***) as being a mediator for approach in his model using the PLS analysis.

Table 5.6: Full Solutions for the outcome approach. Letters in the left column represent the type of solution. C: complex solution, P: parsimonious solution, A: animation data and L: lecture data. ARNB – Average Data Treatment Natural Break Consistency Cut-Off Point. H. Uniq. Cov.: the highest unique coverage value from among all the configurations, the number after the hyphen is the configuration number starting from the left one.

	Total Solutions for Approach "aa_cal"	Cases	Sol. Cov.	H. Uniq. Cov.	Sol. Cons.
	ARNB Grouped Data				
C	$\sim vc_cal*ce_cal + \sim aro_cal*ce_cal + \text{vn_cal}*ce_cal$	44	0.84	0.14-3	0.90
P	ce_cal	44	0.87	0.87	0.89
	ARNB Isolated Data				
AC	$aro_cal*ce_cal + \sim vn_cal*ce_cal + \sim aro_cal*\sim vn_cal*\sim vc_cal$	23	0.84	0.25-1	0.91
LC	$\sim aro_cal*ce_cal + \sim vc_cal*ce_cal + \text{vn_cal}*ce_cal$	30	0.82	0.11-3	0.91
AP	$ce_cal + \sim vn_cal*\sim vc_cal$	23	0.92	0.37-1	0.84
LP	ce_cal	30	0.87	0.87	0.91
	ARNB VidType				
C	$\sim vc_cal*ce_cal + \sim aro_cal*\sim vn_cal*ce_cal + \sim vidtype*\sim aro*ce_cal + \sim vidtype*\sim vn_cal*ce_cal + \sim vidtype*\sim vn_cal*ce_cal + \sim vidtype*aro_cal*ce_cal + aro_cal*\sim vn_cal*ce_cal$	52	0.83	0.04-1	0.90
P	ce_cal	52	0.88	0.88	0.89

Source: Own.

Configurations with the highest unique coverage values for the complex solutions are highlighted in blue. ARNB Grouped Data and ARNB Isolated Data (LC: lecture data) analysis coincide to present “vn_cal*ce_cal” as a sufficient combination to provoke approach. Although ARNB VidType analysis shows the same configuration for lecture data ($\sim vidtype*\sim vn_cal*ce_cal$) it fails in making it evident to the eyes of the researcher since its raw and unique coverage value are low. The absence of this configuration in ARNB VidType complex solution for animation data (AC) suggests that the results in solution ARNB Grouped Data need to be analyzed carefully and in conjunction of the isolated data analysis. A similar situation occurs for the configuration “aro_cal*ce_cal” in ARNB Separated animation data and ARNB VidType analysis ($vidtype*aro_cal*ce_cal$).

The condition “vn_cal” shows to be highly related to cognitive engagement “ce_cal”. This result is coherent with the obtained by PLS analysis where the variable perceived visual novelty is significantly related to cognitive engagement (Path coefficient = 0.76***).

Table 5.7: Full Solutions for the outcome avoidance. Letters in the left column represent the type of solution. C: complex solution, P: parsimonious solution, A: animation data and L: lecture data. ARNB – Average Data Treatment Natural Break Consistency Cut-Off Point. H. Uniq. Cov.: the highest unique coverage value from among all the configurations, the number after the hyphen is the configuration number starting from the left one.

	Total Solutions for Avoidance "~aa_cal"	Cases	S. Cov.	H. Uniq. Cov.	S. Cons.
ARNB Grouped Data					
C	~vn_cal*~ce_cal + ~aro_cal*~ce_cal + vc_cal*~ce_cal + ~aro_cal*~vn_cal*vc_cal	59	0.89	0.03-1,3	0.88
P	~ce_cal + ~vn_cal*vc_cal	59	0.91	0.40-1	0.85
ARNB Separated Data					
AC	~aro_cal*~ce_cal + vc_cal*~ce_cal	29	0.85	0.16-1	0.84
LC	vc_cal*~ce_cal + ~aro_cal*~vn_cal*~ce_cal	26	0.84	0.25-1 0.12-2	0.90
AP	~ce_cal	29	0.88	0.88	0.90
LP	~ce_cal	26	0.91	0.91	0.88
ARNB VidType					
C	vc_cal*~ce_cal + ~aro_cal*~vn_cal*~ce_cal + vidtype*~aro_cal*~ce_cal	57	0.84	0.12-2	0.91
P	~ce_cal	57	0.90	0.90	0.89

Source: Own.

Table 5.7 shows that high consistency and coverage (>0.84) is common among the different solutions. The condition “~ce_cal” (green highlights) with the highest unique coverage value and as a single condition for a configuration is common in all the parsimonious solutions. These results suggest the condition to be necessary for the outcome avoidance.

ARNB Grouped Data analysis happens to cover most of the configurations found by ARNB Isolated Data analysis. The configuration “vc_cal*~ce_cal” is present in all solutions, however, they have stronger influence in ARNB Grouped Data and ARNB Isolated Data (LC: Lecture data) solutions. The configurations highlighted in blue represent the ones with the highest unique coverage value. Low levels of condition “aro_cal” and “ce_cal” combined and low levels of “aro_cal” and “vn_cal” and “ce_cal” combined cause avoidance in animation and lecture data respectively. Woodside et al. (2011) uses data divided by age group and also grouped data in order to contrast findings.

Regression-like analyses focus on the main effects of various antecedents on one or more dependent variables, while neglecting the interdependencies of interconnected casual structures between the variables (Woodside, 2014 in Pappas et al., 2016). This is the case of Chou’s study as well.

VI. Conclusions

FsQCA analysis of SEM modeled survey data unveiled causal relations not seen in the solutions using SEM analysis, namely “aro_cal*ce_cal”. Using fsQCA evidenced how different paths can lead to the same outcome (equifinality) and also how cases are distributed inside these multiple configurations allowing for more empirically supported conclusion. **(GO)**

A clear pattern of causal relations were found in the three paths – AD80, ARNB and ASNB. However, the use of the natural break of data for deciding the consistency for sufficiency threshold showed neither a loose (AD80) nor a tight solution (ASNB). Moreover, the fact that the most parsimonious empirical interpretations was not contradictory with the complex empirical interpretations was the decisive rule for choosing the most suitable calibration criteria for the data – ARNB in this study. **(SO1)**

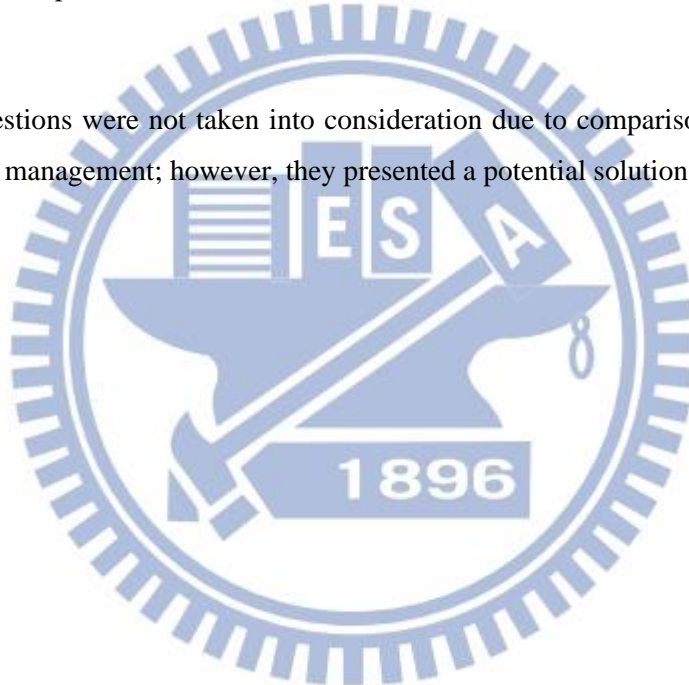
For the analysis of a dummy condition with fsQCA, all of the ways of grouping data contributed to the final interpretation of the causal recipes. Adding the crispy condition to the analysis complicated the outcome interpretation, but facilitated a general view while an isolated analysis consolidated the results. **(SO2)**

FsQCA could successfully assess mediator variables. The continuous presence of a condition in more than one configuration of the solution; the intensified presence of it in the parsimonious solution; and the high values of unique coverage for this condition were signs of this mediator condition. Said differently, necessity of a condition for an outcome could potentially represent mediation in regression-like analysis; in this study under the name of “ce_cal”. **(SO3)**

Contrary, conditions that appeared in combination with a necessity condition to form a configuration; with lower unique coverage values and no presence in the most parsimonious solution represented the explanatory variables of mediator conditions; in this study under the name of “vn_cal*ce_cal” or “aro_cal*ce_cal” or “vc_cal*~ce_cal”. Paraphrasing, INUS conditions could possibly be seen as explanatory variables in SEM modeled data. **(SO3)**

VII. Study Lines

1. In this study 183 surveys were analyzed in the grouped data but for the separate data analysis only 88 and 95 respectively. It is possible that stronger evidence could be reached with bigger sample sizes.
2. Processing 7-Scale Likert questions by using the average to reduce questions caused a great number of cases with values matching the cross-over point (0.5) value; this is known as the principle of the excluded middle.
3. In order to keep this thesis into a reasonable length some analysis of variables were taken apart, for example the influence of “vc_cal” and “vn_cal” on “ce_cal” and “aro_cal” separately.
4. Reverse questions were not taken into consideration due to comparison with the PLS model and for data management; however, they presented a potential solution for analysis.



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IX. Appendixes

9.1 Appendix A

Table A: Animation Data used for the analysis.

Variable	Arousal				Approach/Avoidance				Visual Novelty			Visual Complexity					Cognitive Engagement											
	ARO1	ARO2	ARO3	ARO4	AA.0	AA.1	AA.2	AA.3	VN.0	VN.1	VN.2	VX.0	VX.1	VX.2	VX.3	VX.4	AF.0	AF.1	AF.1	AF.3	II.0	II.1	TD.0	TD.1	TD.2	Curiosity		
Cases																										CU.0	CU.1	
1	4	1	4	7	4	4	4	4	4	4	4	1	1	1	1	7	7	7	7	7	7	7	7	7	7	4	7	
2	4	3	4	4	4	4	3	3	4	3	3	4	3	4	4	3	3	4	3	4	4	3	4	4	4	4	3	3
3	6	5	2	2	6	2	6	6	5	5	5	5	5	5	5	5	6	2	6	6	6	6	5	6	6	6	6	
4	4	4	1	1	1	1	7	1	1	1	4	4	5	5	5	5	5	1	3	2	4	2	2	2	2	4	2	2
5	4	5	5	2	3	2	4	5	6	7	7	6	4	6	6	6	5	3	4	3	5	5	3	3	3	5	4	
6	7	7	4	7	7	7	7	7	7	7	7	7	1	1	1	1	1	7	7	7	7	7	1	1	7	7	7	
7	4	4	4	5	3	3	4	4	5	5	6	5	5	5	5	5	3	5	3	3	3	3	3	3	3	2	2	
8	5	2	7	4	3	2	4	2	2	7	5	7	4	7	7	6	3	3	3	3	4	3	2	2	2	2	2	
9	1	4	4	7	4	3	4	6	4	6	7	4	1	5	4	6	6	7	6	6	4	6	6	6	4	6	6	
10	6	6	5	7	7	7	7	7	7	7	7	6	6	1	1	4	7	7	7	7	7	7	7	7	6	7	7	
11	4	5	4	5	4	4	4	4	5	5	2	3	4	5	4	4	5	5	5	5	4	4	3	2	4	5	4	
12	4	3	4	4	4	5	5	4	3	5	6	6	4	4	3	4	4	4	3	4	3	4	4	3	3	4	4	
13	5	5	6	7	1	1	1	1	1	4	4	7	5	5	6	5	6	5	6	5	7	2	1	1	1	2	2	2
14	3	1	1	1	1	1	1	1	1	1	1	6	6	6	6	6	1	1	1	1	1	1	1	1	1	1	1	
15	4	1	1	1	1	1	1	1	1	4	2	4	1	7	7	2	2	1	2	4	4	2	4	4	4	3	4	
16	1	1	4	7	6	6	5	5	6	6	6	2	4	2	2	5	6	6	6	6	6	6	5	5	5	6	6	
17	5	5	5	6	5	6	5	5	6	6	6	5	7	7	7	7	6	6	6	6	6	6	7	7	7	6	6	
18	4	4	1	1	1	1	1	1	4	3	2	6	4	6	4	2	6	6	6	6	1	4	2	1	1	1	2	2
19	3	2	3	3	2	2	2	2	4	6	7	5	6	3	6	5	5	2	3	1	3	5	5	2	2	1	2	2
20	4	4	3	4	4	5	5	4	4	4	4	4	3	3	4	4	4	4	4	4	4	4	2	2	2	2	2	
21	5	6	5	7	6	6	6	6	7	6	7	6	5	3	4	7	7	6	7	6	7	7	7	7	7	6	5	
22	5	5	5	5	5	5	5	5	5	2	5	5	6	7	6	3	5	5	5	6	5	5	4	3	4	5	5	
23	3	4	4	3	4	4	4	4	5	5	5	4	3	3	3	5	4	4	4	5	4	4	4	4	3	4	4	
24	4	4	4	4	4	5	5	5	4	5	5	5	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4	
25	1	4	4	4	4	1	7	4	4	1	1	1	1	1	1	7	4	7	7	7	4	4	7	7	7	4	7	
26	4	4	4	4	4	4	4	4	4	7	7	7	4	4	5	2	7	4	2	4	3	4	7	5	5	3	4	4
27	4	4	4	4	4	5	4	4	4	5	5	5	5	5	4	5	5	4	5	4	4	5	4	4	4	4	4	
28	4	4	3	3	3	3	4	4	2	2	5	2	4	5	5	3	3	3	3	4	4	4	2	2	2	4	4	
29	4	4	4	4	2	2	4	4	5	4	1	7	5	7	7	1	5	7	6	7	4	3	1	1	1	5	4	
30	4	4	4	4	2	5	4	3	4	4	5	4	4	4	2	6	5	5	5	4	4	5	4	4	4	3	3	
31	4	4	4	4	6	6	6	6	6	6	7	3	2	3	2	2	6	7	6	5	5	6	5	5	5	5	4	
32	4	4	4	4	1	1	1	1	5	5	6	3	4	4	3	5	2	3	2	3	4	5	3	2	1	4	4	
33	4	1	3	1	1	1	1	2	3	4	5	6	6	6	7	7	1	1	1	2	2	2	2	1	1	2	2	
34	2	2	3	2	3	6	3	4	3	4	2	2	3	3	5	5	1	3	3	3	4	4	3	2	1	4	2	
35	4	4	4	4	4	4	5	5	3	3	6	5	4	5	5	5	4	3	4	3	5	5	3	3	3	4	4	
36	4	4	4	4	2	5	2	4	4	4	3	4	4	5	4	4	3	2	3	4	4	5	4	4	4	3	3	
37	4	4	4	4	2	3	2	2	4	3	5	6	4	6	5	4	3	3	3	3	4	5	3	3	3	4	4	
38	3	5	6	3	2	1	4	4	5	6	6	6	6	5	6	6	5	5	3	4	5	5	6	5	4	6	5	
39	5	4	5	5	4	4	4	4	5	5	6	6	6	6	6	6	5	5	5	5	5	5	3	3	3	5	5	
40	4	4	4	4	1	2	2	4	6	6	4	2	5	5	4	4	4	5	4	6	4	3	2	2	2	1	1	
41	4	4	1	1	2	3	3	3	6	6	5	6	6	6	2	5	3	4	3	3	3	5	1	1	1	5	5	
42	4	4	4	4	1	2	6	6	4	4	4	4	4	4	1	6	1	1	1	1	2	2	1	1	1	1	1	
43	4	5	4	6	5	5	5	5	2	5	6	6	4	6	6	6	6	5	6	6	3	5	5	5	4	6	5	
44	4	1	1	1	1	1	1	1	1	1	7	5	5	7	1	1	1	1	1	1	1	1	1	1	4	1	1	
45	4	4	4	4	5	6	6	6	5	4	4	4	3	3	3	3	5	5	5	5	5	5	5	4	4	4	4	
46	4	4	4	4	3	4	4	4	5	5	5	6	4	4	3	4	4	6	5	5	5	5	4	4	4	2	4	
47	4	5	4	7	6	7	6	6	5	6	7	6	6	7	6	5	7	7	7	7	6	7	4	4	6	6	5	
48	4	4	4	3	7	7	6	6	2	4	4	5	7	6	1	5	3	3	6	5	6	7	7	6	4	7	6	
49	4	4	2	1	1	1	1	1	4	2	4	4	4	4	4	4	1	1	2	1	1	1	7	7	5	1	1	
50	6	7	5	7	7	7	7	7	5	4	7	5	5	6	5	5	6	7	7	7	7	7	5	5	3	7	7	
51	4	4	4	4	5	5	5	5	5	5	7	5	5	5	3	5	4	5	5	4	4	5	4	4	3	4	4	
52	4	2	2	3	1	2	3	2	2	1	7	6	6	7	5	7	1	2	2	2	1	5	2	1	4	1	1	
53	4	1	1	7	4	1	7	4	7	6	7	6	3	6	4	3	6	6	6	5	5	4	5	4	3	3	3	
54	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	
55	4	4	1	4	1	2	3	4	4	4	4	4	7	7	4	5	6	1	1	1	1	2	1	1	4	4	4	
56	4	4	4	4	4	5	6	5	5	5	5	6	4	4	4	4	5	5	5	5	4	5	5	5	4	4	5	4

Source: Adapted from Chou, 2013.

Table A: Animation Data used for the analysis. Continuation.

57	1	4	4	7	7	7	7	7	7	7	7	5	4	6	2	7	7	7	7	7	7	5	3	6	7	7	
58	4	4	4	6	6	6	6	6	6	5	4	4	4	4	2	4	6	4	6	4	6	6	4	4	4	6	6
59	4	2	2	1	1	1	1	1	4	4	6	5	5	6	6	6	1	1	1	1	1	2	2	2	2	1	1
60	2	4	4	5	2	3	3	3	4	3	6	4	6	3	3	4	3	2	2	2	4	4	1	1	1	3	2
61	4	1	1	1	1	1	1	7	1	5	7	6	6	6	6	6	1	1	1	1	1	1	1	6	1	1	1
62	4	1	1	1	1	1	1	1	4	4	4	6	6	6	1	6	1	4	1	1	1	1	1	1	2	1	1
63	3	5	5	5	7	7	6	6	5	6	6	7	7	7	6	6	6	6	6	7	7	7	6	6	7	7	7
64	5	4	4	6	7	7	7	7	6	7	7	7	1	5	2	7	7	7	7	7	7	6	5	5	5	6	
65	4	3	3	3	2	2	4	3	6	6	6	5	3	5	6	5	3	3	2	3	5	5	3	2	2	3	3
66	4	5	5	2	3	5	4	5	5	6	4	2	2	3	4	5	6	5	6	2	5	7	1	1	5	4	4
67	4	4	4	5	2	3	3	3	5	5	5	5	3	5	4	5	5	5	5	4	5	4	3	3	5	3	
68	5	5	5	4	3	3	3	3	5	4	5	5	6	6	5	5	3	5	5	5	3	5	3	3	3	5	3
69	4	4	4	7	7	7	7	7	7	4	4	1	5	4	1	7	7	7	7	7	7	7	7	7	7	6	
70	4	5	4	6	5	7	5	5	6	6	6	3	4	1	3	5	6	6	6	6	6	5	4	4	5	4	
71	4	4	1	1	1	1	1	1	1	1	6	7	7	7	7	7	1	1	4	7	4	4	1	1	1	4	4
72	5	5	6	5	3	3	4	3	5	5	5	6	6	7	6	6	5	5	5	5	5	3	2	4	5	4	
73	4	4	1	1	4	2	2	2	2	4	4	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
74	4	4	4	4	2	2	4	4	2	2	4	2	2	2	2	2	2	2	3	5	5	6	6	6	5	5	
75	4	4	4	4	3	3	4	4	4	4	4	4	4	5	5	4	4	4	4	4	4	5	5	4	4	4	
76	1	4	1	1	1	1	1	4	1	5	6	7	7	7	4	7	4	1	1	1	1	4	1	1	4	1	4
77	2	1	1	3	2	2	2	2	2	5	5	4	4	4	3	5	1	2	2	2	6	6	1	1	1	4	3
78	5	5	4	5	5	6	6	6	7	5	4	4	4	2	2	6	6	6	7	7	6	7	7	7	6	6	
79	4	7	4	4	7	7	6	6	6	4	6	4	4	7	7	7	7	4	7	6	7	7	7	7	7	6	
80	6	6	4	6	5	6	6	6	6	6	6	2	2	2	2	5	6	6	6	5	6	6	6	6	5	6	6
81	5	5	4	7	7	7	6	6	6	5	6	2	5	5	3	4	7	6	7	6	6	7	6	6	6	7	6
82	4	4	4	4	5	6	4	4	3	3	6	3	5	5	3	3	4	3	5	5	5	4	4	4	4	4	
83	1	2	1	1	1	7	1	1	3	3	3	6	6	6	7	6	1	7	1	1	1	1	1	1	1	1	1
84	4	4	4	4	3	3	4	4	4	4	4	4	4	4	4	4	1	1	1	1	4	3	1	1	1	1	1
85	4	3	4	5	7	7	6	5	6	6	7	7	6	7	7	7	7	5	7	6	5	5	2	2	2	5	5
86	4	1	1	4	1	1	1	1	5	2	1	5	6	7	7	6	1	1	1	1	1	1	1	1	1	1	1
87	2	6	5	4	7	7	7	7	7	5	5	2	5	4	2	5	7	6	7	7	7	7	7	7	7	5	5
88	5	4	5	5	5	6	6	6	6	6	6	7	6	3	1	1	6	3	6	6	6	6	7	7	6	6	6

Source: Adapted from Chou (2013).

Table B: Lecture Data used for the analysis.

Variable	Arousal				Approach/Avoidance				Visual Novelty			Visual Complexity					Cognitive Engagement											
	ARO1	ARO2	ARO3	ARO4	AA.0	AA.1	AA.2	AA.3	VN.0	VN.1	VN.2	VX.0	VX.1	VX.2	VX.3	VX.4	AF.0	AF.1	AF.2	AF.3	II.0	II.1	TD.0	TD.1	TD.2	Curiosity		
Cases																											CU.0	CU.1
1	3	3	4	4	5	3	4	4	5	5	4	5	4	4	4	4	3	4	4	4	5	4	1	1	1	5	3	
2	2	1	1	2	1	1	3	4	1	1	1	1	1	1	1	1	1	5	2	1	2	3	1	1	1	2	3	
3	1	7	4	4	4	5	3	5	5	6	6	5	5	6	6	6	5	2	6	6	5	5	6	6	5	5	5	
4	6	5	4	6	7	7	7	7	7	7	7	7	4	3	1	5	7	5	7	7	7	7	7	7	7	7	7	
5	4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
6	4	4	4	4	5	5	4	5	3	3	3	3	3	3	3	3	4	4	4	5	4	5	3	2	3	5	5	
7	5	4	4	4	1	1	4	4	2	3	7	4	4	6	1	3	2	4	1	2	1	1	1	1	3	1	1	
8	7	7	4	7	7	7	7	7	4	5	2	3	3	6	1	3	7	7	7	7	7	7	6	6	5	7	7	
9	4	3	3	4	3	3	4	3	4	4	3	6	5	5	3	2	2	2	3	3	3	2	3	2	3	3	2	
10	2	4	2	1	1	7	3	3	1	1	1	1	1	1	1	1	1	1	1	1	3	3	1	1	1	1	1	
11	4	4	4	3	1	1	3	4	1	1	4	4	4	1	1	1	1	1	1	1	4	2	2	1	4	1	1	
12	5	5	3	3	1	1	4	4	2	5	3	5	4	4	5	4	1	2	1	4	3	3	1	1	1	3	3	
13	4	4	4	4	3	2	4	2	2	2	2	3	3	1	1	1	2	1	2	2	2	4	1	1	1	3	3	
14	4	1	1	1	1	7	1	1	1	1	1	1	1	1	1	1	1	7	1	1	1	1	1	1	1	1	1	
15	2	3	1	2	2	2	4	4	6	3	6	4	4	3	4	2	2	4	3	2	2	3	1	4	1	1	1	
16	5	4	4	5	4	3	4	4	5	4	3	2	4	1	1	2	5	5	5	5	4	5	3	2	2	5	4	
17	5	5	4	5	5	5	5	5	4	4	4	1	1	1	1	1	4	7	5	5	5	5	4	1	4	5	5	
18	7	7	4	7	7	7	7	7	6	4	2	3	3	3	1	1	7	7	7	6	7	7	1	1	1	7	7	
19	4	4	4	4	6	7	6	6	7	7	7	5	2	2	2	6	7	7	7	7	6	7	6	6	6	6	6	
20	4	2	2	2	1	1	1	1	1	1	1	1	4	4	1	4	1	1	1	1	1	1	1	1	1	1	1	
21	4	4	4	4	1	1	1	1	1	1	7	7	7	7	7	7	1	4	1	7	1	1	1	1	1	1	1	
22	4	4	1	4	2	1	2	4	1	1	1	1	1	1	1	1	4	2	5	2	6	6	1	1	1	5	4	
23	3	3	5	5	2	2	4	4	5	4	4	3	3	3	3	2	3	3	4	3	3	3	2	2	2	2	2	
24	2	1	1	1	1	1	2	2	1	1	1	1	1	1	1	1	2	1	1	2	2	2	1	1	1	1	1	
25	3	4	3	3	3	2	4	5	4	4	5	3	3	3	3	3	2	3	4	3	4	5	4	3	3	3	4	
26	2	2	2	2	3	2	4	3	1	1	3	1	1	1	1	1	4	3	3	2	1	4	2	2	1	2	1	
27	5	5	4	5	5	4	4	5	5	3	4	1	4	1	1	1	5	4	6	5	4	5	4	3	4	5	5	

Source: Adapted from Chou (2013).

Table B: Lecture Data used for the analysis. Continuation.

28	7	7	7	4	7	7	6	7	7	7	5	6	1	4	1	1	1	7	7	7	7	7	7	7	6	4	7	7	
29	4	4	4	4	4	2	2	4	4	4	4	4	3	3	3	3	4	4	4	5	4	4	4	4	3	3	3	4	4
30	4	4	4	4	4	5	5	5	5	4	3	3	3	3	3	2	3	4	4	4	5	5	5	4	3	3	3	4	4
31	4	4	4	4	4	3	2	2	4	1	1	4	1	4	1	1	1	1	1	1	1	3	3	1	1	1	1	1	1
32	5	5	5	4	5	6	6	5	5	5	4	4	5	5	4	6	4	5	4	5	5	5	5	6	4	4	4	6	5
33	4	1	4	1	1	1	1	2	4	4	4	5	4	4	4	4	4	2	2	2	2	3	5	2	2	2	2	2	
34	4	1	1	1	4	6	6	5	5	2	1	1	1	3	4	4	2	4	4	3	4	3	4	1	1	1	1	1	
35	4	4	4	4	4	1	1	4	4	3	3	5	4	4	4	4	4	4	7	4	7	4	4	1	1	1	4	4	
36	5	4	4	4	6	6	7	6	7	5	5	4	6	3	4	2	2	6	7	7	5	7	7	6	6	6	7	6	
37	5	4	4	4	5	4	4	4	5	5	4	4	4	4	3	3	4	4	4	3	4	3	4	4	4	3	3	4	4
38	4	2	3	4	4	1	4	4	5	5	4	2	3	4	3	2	4	2	6	3	5	4	5	1	2	2	3	2	
39	4	4	4	4	4	1	1	2	1	1	1	1	3	4	1	1	1	1	5	1	3	3	1	1	1	1	2	2	
40	4	4	4	4	4	3	5	3	3	3	3	3	4	4	4	4	4	3	3	4	3	4	4	3	3	3	4	4	
41	2	1	1	1	2	2	3	3	4	1	1	1	1	1	1	4	1	1	2	2	2	3	4	4	2	1	1	1	
42	4	4	3	3	4	4	4	4	4	3	3	3	1	1	3	2	1	5	3	5	4	3	3	5	3	3	3	3	
43	5	5	4	6	7	7	7	7	7	4	5	6	1	1	1	1	1	7	7	7	6	7	7	6	6	3	7	7	
44	4	4	4	4	4	1	1	1	1	1	1	1	1	4	4	2	1	1	1	1	5	1	1	1	1	1	1	1	
45	3	4	3	4	3	3	4	4	4	3	1	1	1	1	1	1	1	3	3	3	5	3	3	3	1	1	3	3	
46	5	5	4	4	4	5	4	4	4	3	3	2	2	4	3	3	4	4	4	3	4	4	4	3	3	3	5	4	
47	4	4	4	4	4	5	6	5	5	5	4	4	3	4	4	3	4	4	4	5	4	5	6	4	3	2	4	3	
48	3	3	2	2	1	1	1	1	1	1	1	1	2	6	4	6	1	1	2	1	1	1	1	1	1	1	1	1	
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88	4	1	4	1	1	1	2	4	4	2																			

Source: Adapted from Chou, 2013.

9.2 Appendix B

Survey Questions

AROUSAL

- *This video made me feel Calm – Excited*
- *This video made me feel Unaroused - Aroused*
- *This video made me feel Jittery – Dull*
- *This video made me feel Wide-Awake – Sleepy*

COGNITIVE ENGAGEMENT

ATTENTION FOCUS

- *This video kept me totally absorbed in the presentation*
- *This video held my attention*
- *While I was watching this video, my attention got diverted very easily*
- *Whole watching this vide, I was able to block out most of other distractions*

INTRINSIC MOTIVATION

- *The video content was enjoyable*
- *The content of the video seemed interesting to me*

TEMPORAL DISSOCIATION

- *Time appeared to go by very quickly when I was watching the video*
- *Time flew when I was watching the video*
- *I lost track of time while I was watching the video*

CURIOSITY

- *This video presentation excited my curiosity*
- *This video presentation aroused my imagination*

PERCEIVED VISUAL NOVELTY

- *This video was memorable in visual presentation*
- *This video was visually unique*
- *This video was different from my expectations of a lecture presentation*

PERCEIVED VISUAL COMPLEXITY

- *This video was visually complex*
- *This video was visually dense*
- *This video was visually crowded*

- *This video was visually overwhelming*
- *This video had much visual variety*

APPROACH AND AVOIDANCE

- *I would enjoy watching more of this kind of videos*
- *I would like generally to avoid watching this kind of videos*
- *I liked this video*
- *I would like to have a positive attitude towards this kind of video*

