An Affective Interface for Conveying Student Feedback

Thesis submitted in partial fulfilment with the requirements of the University of Liverpool for the degree of Master of Philosophy in

Experimental Psychology

by

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April 2012

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ABSTRACT

In the present information age, decision-makers and modern society in general are challenged by the need to effectively handle large amounts of interrelated data obtained via electronic means. This thesis attempts to addresses the need for more effective data analysis and interpretation for decision-making. In particular, the study investigates whether virtual facial expressions (FEs) can be effectively applied as a non-verbal means to convey student feedback 'at-a-glance' and accurately with regard to affective content.

This research has a threefold aim: (i) to handle the complex nature of *multi-criteria type feedback data*; (ii) map the feedback data into *appropriate FEs* and (iii) represent the data using a *non-verbal affective interface*.

The approach adapted is such that the two-dimensional Kano model of satisfaction is established to evaluate feedback data in accord with multiple criteria; based on this, an aggregate score is generated that best represents the student feedback. Facial expressions of emotion are mapped to one-dimensional scales and the two-dimensional satisfaction space using psychophysical methods; mappings used to convert multi-criteria based student satisfaction ratings onto a pictorial representation in the form of cartoon facial expressions.

A proof-of-concept prototype of an affective interface is developed and evaluated in terms of accuracy of the proposed non-verbal feedback analysis approach.

The main findings of this study are that multi-criteria evaluation that takes into account two-dimensional quality can produce measures of satisfaction significantly correlated with manual rating. Student feedback can be conveyed accurately using virtual FEs provided that the multi-criteria analysis has been successful. Use of FEs to convey student feedback is faster than conventional feedback display modes.

Acknowledgements

First of all I would like to thank my supervisors Prof. Galina and Dr. Hissam for providing me with this opportunity and putting up with me. I would like to thank Prof. Galina for being the best teacher I have ever had and for all the support, guidance and help she provided me with all aspects of my life. Also a special thank you to Dr. Hissam for believing in me and pushing me to reach my goal.

I would also like to thank Slawomir Skwarek for introducing me to the Kano model, which plays a major role in my research. Also thank you to and all my colleges at the IDS laboratory for pushing me to work harder and motivating me.

I would like to thank my parents for their constant prayers, love and support. I could never have come on this journey if it wasn't for you both. I am so blessed and grateful to have been born as the daughter to such a god and goddess. Ammi, thank you for helping me hold my head-up always, and Thathi thank you for carrying my weight no matter how big I got.

I would also like to thank all my friends for the help, support, food and laughter they provided me in distressful times. A big thank you to Cris for being my assistant and being by my side during the home stretch. You are greatly appreciated. Thank you to everyone who said a prayer for me and was thinking of me. Of course, thank you to CC for being the silver lining in my life.

Last but not least, I would like to thank the forces of nature that have always been there with me in my life and during this journey, guiding me in the right direction and supporting my every move. Especially a big thank you to the Angel that was sent from above to make sure I submitted my thesis.

Thank you. I couldn't have done this without you all.

In loving memory of Appachchi

ma nivatta, abhikkhama

“Falter not; advance.”

-Lord Buddha-

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Chapter 1

Facial Expressions as a means of non-verbal feedback

"Every time you smile at someone, it is an action of love, a gift to that person, a beautiful thing", Mother Teresa

1.1 Background and Motivation

Feedback plays a vital role in the planning and development of organisations as well as public decision-making. Decision-making involves a cognitive process that leads to the selection of a course of action among alternatives that produces a decision outcome (Libby, 1981). This process includes three stages: input, processing and output. Since the decision-making process relies first and foremost on the nature and content of information being inputted, the presentation of this information can strongly influence the decision-making process (Evans & Averbeck, 2010; Libby & Lewis, 1977). Most research on decision-making has primarily focused on information content. However, some studies have also examined the importance of presentation format and its linkages to decision-making performance. A number of these studies have provided an indication of the importance of presentation format on decision-making (for reviews see Ghani, Laswad, Tooley & Jusoff, 2009). Insights from such studies have been used to support decision-making processes and help decision-makers overcome human information processing limitations.

With the ever increasing reliance on electronic means in delivering feedback solutions for governmental, communal, educational, and business applications, on the one hand, and the immensely growing volume of data produced per time unit, on the other hand, the business, decision makers and modern society in general, are challenged by the need to effectively handle interrelated and large amount of feedback data, while at the same time by the necessity to efficiently perform in human processing of these information. In a study relating to financial information presentation, Libby (1981, p. 101) identified three available options for the improvement of decision-making: changing the content or presentation of the available information; education of the decision maker; and/or replacing the decision maker

with a model. The present study adopts the first of these options and addresses the need for more effective data analysis and comprehension for decision-making.

A desired characteristic of a data presentation format is its ability to demand attention and at the same time be clear enough to make interpretation possible 'at-a-glance' without detailed explanation. To achieve this and overcome human information processing limitations, data must be displayed in a manner that optimally fits the channels of human visual information processing. Findings of Gestalt psychology have shown that organisms perceive in meaningful wholes rather than in parts. Psychologists have further proposed that acquisition and organisation of information within dimensions, by decision makers, is perceived as a Gestalt so that stimuli are processed in a holistic manner (Reed, 1972; Smith & Nielsen, 1970). Research in cognition and categorisation has provided empirical support for the human face being regarded as a spatial interrelationship of features capable of being perceived as a gestalt (Garner, 1978; Sergant, 1984).

Traditional graphical data presentation formats have been limited to charts, histograms, and scatter diagrams (Beniger & Robyn, 1978). Although these traditional displays are effective in providing a simplistic mode for conveying certain data features, they have been found ineffective in displaying multidimensional data (Huff, Mahajan & Black, 1981). Many alternative pictorial methods have been employed in an attempt to facilitate this type of data communication. Of these, the pie chart, bar chart and trend graph have become familiar and acceptable for most organisations and individuals as alternatives to narrative and numerical data presentation formats (Smith & Taffler, 1984). Huff, Mahajan and Black (1981) remarked that the use of graphic displays represents an important and underutilised medium for transmitting information and for exploratory data analysis. Such displays are thought to have the ability to evoke impressions of underlying relationships that might not be detected readily using mathematical techniques.

In the field of Human Computer Interaction (HCI) an interface can be envisioned as a periphery linking two entities, whose main goal is to enable efficient communication between the entities. Thus interfaces in HCI serve as the bridge between human and computer. Research in user interface design continuously attempts to improve interfaces to enable effective communication. It can be presented that increasing the richness of the information-transferred will in turn improve the communication efficiency of the interface. Considering that the general function of feedback data is to provide useful information for decision-making, it is imperative that the communication of this information should be effective.

Research from the interaction design community has found that people tend to behave differently in the presence of others compared to when they are alone. As face-to-face communication is inherently natural and social for human-human interactions, substantial evidence suggests that people may also behave differently when designers introduce more human-like features into computer interfaces (Sproull, Subramani, Kiesler, Walker, & Waters, 1996). Mehrabian (1967) declared that facial expressions (FEs) account for 55% of the meaning of interpersonal message conveyed during human face-to-face interactions. Thus the face has frequently been regarded as the most expressive area of the body (Argyle, 1969). As a result face processing has become a field of intensive research since the 1970's (Bruyer, 2003). Leathers (1997, p. 24) commented that ''the face has long been a primary source of information in interpersonal communication, it is an instrument of great importance in the transmission of meaning''. This has classed FEs as a rich source of information and the efficient mode of human non-verbal communication. Therefore, inside the human visual environment, faces are fascinating stimuli. And due to the amount of information they convey, they are an important substrate of nonverbal communication and a possible non-verbal presentation format candidate for feedback data.

1.2 Facial Expressions of emotion as non-verbal feedback: Rationale of the present study

The ability of facial expressions of emotion to convey vital non-verbal signals that allow for inferences about the motivations and intentions of others have made them foundations of social interaction (Darwin, 1872). Consequently, the face has been identified as the primary site for communication of emotional states and hence the primary signalling system for communication of affect (Knapp, 1978). This success of FEs in-nonverbal communication is not exclusively based on the transmission of the interpersonal message, but is in fact dependent on the interpretation of the transmitted message by the receiver. People are very skilled at understanding others FEs. Even babies have the ability to precociously respond to different facial expressions (Field, Woodson, Greenberg & Cohen, 1982). Ekman, Friesen and Ellsworth (1972) remarked that this ability to accurately recognise emotions of others is essential for any successful social interaction. Evans and Averbeck (2010) suggested that since humans are highly social beings, and most real-world decisions are made within a social context, one would also expect social cues to influence decision making.

Evidence in support of the face as a social cue for decision making has been provided by brain imaging studies. Smiling faces have been shown to act as positive reinforcers, activating the orbitofrontal cortex (OFC) which is said to have a clear role in guiding decision-making behaviour. Conversely, viewing sad or angry FEs have been shown to elicit activity in anterior cingulate cortex (ACC**)** which is an area associated with error detection. These findings suggest that smiling faces are taken as representing the reward value of stimuli while sad or angry faces are taken as an indication of disapproval, reinforcing or encouraging a change in behaviour (Evans & Averbeck, 2010).

The universality and familiarity of FEs of emotion provide a platform for conveying information on the magnitude of underlying data structures without the need for detailed explanation or education to decision-makers. Thus presenting feedback data in a holistic manner using a FE of emotion has potential to provide a clearer and more efficient representation that can complement existing presentation formats. Chernoff (1973) was the first to suggest that schematic faces would be a useful format for presenting multivariate data graphically. His aim was to capitalise on the communication potential of the face.

> "I believe that we learn very early to study and react to real faces. Our library of responses to faces exhausts a huge part of our dictionary of emotions and ideas. We perceive the face as a gestalt and our built-in computer is quick to pick out the relevant information and to filter out the noise when looking at a limited number of faces." (Chernoff, cit. in Huff et al., 1981).

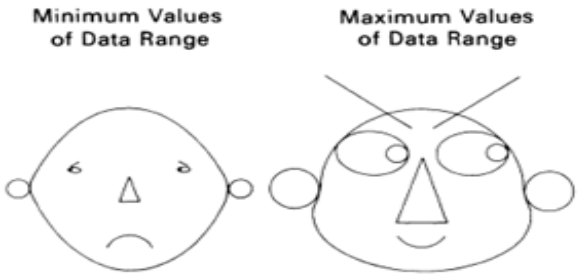


Figure 1.1. Representation of extreme data points of a multivariate dataset using Chernoff Faces (Abrahams, 2010).

His proposed method, widely known as 'Chernoff Faces', represents a point in *K*-dimensional space as a schematic face as seen in Figure 1.1. In Chernoff's method, the different variables in a data set are mapped to facial features such as the eyes, ears, mouth and nose to represent values of the variables by their shape, size, placement and orientation.

Although many researchers have built upon Chernoff's initial idea the method has been criticised based on a number of limitations (Huff et al., 1981; Loizides & Slater, 2002). Firstly the arbitrary mapping of data variables to facial features treats the variables equally and does not take into account the impact it has on the emotions of the observer. An observer may assign emotional significance to a variable depending on their perceived importance of the facial feature used to display it, even though the Chernoff face conveys no such affective meaning.

Another limitation of Chernoff's method is that as the dimensionality of the data increases the complexity of the representation also increases, overloading the display with excessive information giving rise to unrealistic faces. Additionally when presenting time dependant data, no meaning can be attributed to any discrepancy between faces or sudden change in the anatomical parameters (Muslerle & Rossler, 1986). The use of this method requires users to have an understanding of the mappings (which variable refers to which feature in the Chernoff face) to be able to manipulate such displays effectively (Huff et al., 1981; Loizides & Slater, 2002). However it is worth noting that Chernoff type schematic faces have been widely used for the presentation of financial information in order to find out if a company 'failed' or not. In these cases schematic faces have been processed faster and more accurately than traditional methods of financial information presentation and have been found to aid in decision-making (Smith & Taffler, 1996).

Although Chernoff intended to utilise the communication potential of the face, his method used only the familiarity of the face but not the ability to convey non-verbal affective cues. In addition to their ability to be perceived as a whole, the familiarity of faces commands attention and is said to trigger an affective response (Reed, 1972; Smith & Nielsen, 1970). Here an affective response refers to a change in a person's mood or decision as a result of influence from certain objects (Rose, 2002). Studies on presentation format and decision making have suggested that ultimate decisions are framed according to the recall of affective responses caused by the presentation format. It is thought that comparisons between decision alternatives may often be made between differences in the recall of affective responses rather than accurately recalled information (Rose, 2002). The human face has the natural ability to deliver an affective impact, which cannot be achieved by any other graphical presentation format. Furthermore experimental studies have shown that when people were asked to make quick judgments of emotional expressions, reaction times were equal for familiar and unfamiliar faces (Bruce, 1988). Therefore a solution would be to represent the data in a more naturalistic manner such that the display can be readily interpreted 'at-a-glance'.

In an approach named Computer Faces, suggested by Musterle and Rossler (1986) used a better, more naturalistic approach to facial expression generation based on ethological interpretations of the human species. The basis behind their approach was the rational graphical method of display introduced by Lorenz (1953) who visualised the dynamics of the wolf's face on a two-dimensional matrix along the dimensions *Attack readiness* (abscissa) and *Flight readiness* (ordinate). These dimensions were based on the ethological understanding that animals poses a system of action specific readiness, relevant to be displayed, and a network of information channels (involving innate releasers on the transmitting end and innate releasing mechanisms on the receiving end), implementing the communication (Musterle & Rossler ,1986). Based on this, Musterle and Rossler (1986) proposed the first accounts of an automated method that uses the enhanced versatility of the computer to generate realistic looking faces. Musterle and Rossler used these outlines of FEs to represent a meaningful succession of points in an *n*-dimensional space as shown in Figure 1.2 below.

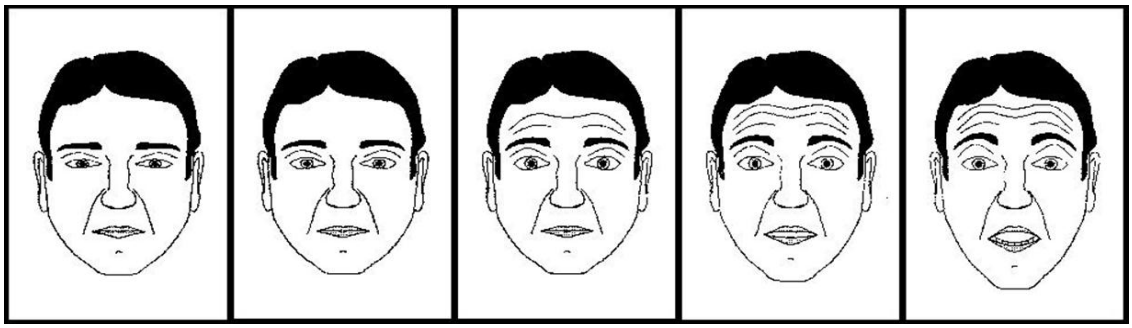


Figure 1.2. First computer generated faces based on the FACS (Musterle & Rossler, 1986)

Computer faces are highly attractive as a means of mass communication due to the efficiency of their counterpart in human face-to-face interactions (Musterle & Rossler, 1986). Provided that a suitable mapping is made between the numerical data parameter, and the FE depictions, it is possible to convey numerical data using a meaningful and realistic facial expression depiction like that proposed by Musterle and Rossler (1986). A study by Paramey, Schneider, Josephs, and Slusarek (1994) provided further evidence that such outlined faces have the ability to retain in general the emotional distinction of naturalistic faces. Therefore it can be hypothesised that outlined faces depicting FEs of emotion have the potential to convey feedback data non-verbally 'at-a-glance'.

There has been limited study to date of the effectiveness of alternative methods of presenting feedback data for organisational decision-making. The present research explores the usefulness of pictorial feedback in the form of FEs as a communication device that aims to aid in this process. Realistic looking faces have been found to provide natural and compelling computer interfaces (Kurlander et al., 1996; Lisetti & Schiano, 1999). Therefore representing numerical feedback data as a more natural human-like face could provide a means of understanding the data 'at-a-glance'.

1.3 Research Objectives

The assessment of student perceptions has become vital in determining quality of HEIs. As a result HEIs across the UK consider inclusion and participation in the NSS to be highly desirable (Canning, 2011). Consequently, the NSS has become the UK's most widely used tool for obtaining student feedback on quality of the student learning experience. The results obtained from the NSS aims to provide information about the quality and standards of learning and teaching of an institute that would in turn be published to address the needs of students and other stakeholders in terms of quality improvement and accountability. Both these aspects are related to decision-making. Based on the rationale above the main hypothesis of the present study has been formulated as below:

Virtual FEs can be applied as a non-verbal means to convey student feedback *accurately* and '*at-a-glance'* with regard to affective content.

Addressing this thesis statement requires the consideration of two aspects. Firstly the multivariate nature of feedback data needs to be understood so that the accuracy of the feedback data can be established before the data is presented as a virtual FE. While decision-making relies on the presentation format of the data, it is imperative that the underlying feedback data is analysed efficiently in order to extract accurate and actionable information for effective decision making. Therefore the study has a threefold aim:

1. Handle the complex nature of multi-criteria type feedback data
2. Bring the data presentation to an informative form
3. Represent the data using a non-verbal affective interface.

Based on these the research sets out to develop a proof-of-concept prototype of an **Affective Interface Feedback System (AIFS)** that will represent an aggregate picture of student feedback data. The proposed AIFS will enable the facilitation of afore-named aspects by allowing for better ways to collect and aggregate relevant multi-criteria based data, and as well, for faster processing of these at the human side by relying on 'easy', legible, and emotion-appealing display. Therefore this study proposes that greater analysis and more imaginative presentation of feedback data might encourage better use to be made of student satisfaction data. The resulting system should thus provide a viable solution for effectively visualising feedback data so that HEIs and prospective students are able to readily and easily understand the data for decision-making. It is anticipated that this system, will have a positive impact on the representation mode of feedback data and make it available 'at-a-glance' and, thus, useful for improvement of HE as well as provide accurate data to help inform student choice.

Based on the above, the main aim of the research can be further decomposed into the following objectives:

- Identifying how the multivariate student feedback data can be aggregated to produce a single affective magnitude variable that can be displayed as a FE.
- Identifying the underlying relationship between the student feedback data variable and FEs of emotion to determine the control architecture of the system output generation.
- Determining the accuracy of the feedback conveyed by the affective interface.
- Determining the effectiveness of the affective interface in conveying student feedback 'at-a-glance'

1.4 Thesis Outline

The overall structure of the research study takes the form of six chapters, including this introductory chapter.

Chapter 2 highlights the importance of consumer feedback for organisations and identifies consumer satisfaction as the most abundantly obtained outcome measure of organisation

performance and quality. Satisfaction data is essentially multivariate and its assessment depends on the simultaneous effect of several variables in different spheres of activity. The literature looks at two widely used models of satisfaction: the confirmation of expectations model of satisfaction which treats satisfaction as a one dimensional construct, and the Kano model of consumer satisfaction which treats satisfaction as a two-dimensional construct. Psychometric tools used to measure satisfaction are reviewed highlighting the strengths and weaknesses of these methods in obtaining an accurate measure of Customer Satisfaction. Based on the theoretical concepts a framework is proposed that can aid in the analysis of multi-criteria type feedback data.

Chapter 3 is concerned with obtaining a suitable mapping between the numerical data parameter satisfaction and FE depictions in line with the method proposed by Musterle and Rossler (1986). Psychophysical methods are used to distinguish a set of facial expressions (FEs) that can be used to convey different levels of satisfaction based on the dimensional approach to perception of FEs proposed by Russell (1980). Categorical scaling (CS) and magnitude estimation (ME) are used in a study to map FEs onto a one dimensional Satisfaction vs Dissatisfaction scales. A second study was carried out to obtain mappings of Fes to the two-dimensional satisfaction space.

Chapter 4 highlights the importance of student feedback in managing quality in Higher Education (HE). Student feedback is recognised as multivariate construct and the role of the NSS in obtaining student feedback is discussed. A conceptual framework of how the theoretical and experimental finding will link together is proposed. The framework proposed in Chapter 1 is applied to the NSS and forms the first stage for evaluating the hypothesis. The results of the first stage of the proposed framework are compared with the traditional measures obtained from the NSS data.

Chapter 5 builds on the theoretical and experimental work from the previous chapters by describing the development process of the proposed proof-of-concept AIFS. Prototyping and Evaluation are carried out in an attempt to address the main objectives of the research project. The functional requirements of the system are highlighted and used as the basis for the system evaluation. Focus is placed on the accuracy of the system output and the effectiveness of the facial feedback in conveying student feedback accurately and ‘at-a-glance’ with respect

to affective content. The system evaluation methods and results are discussed in line with the main hypothesis.

Chapter 6 draws upon the entire thesis, and provides a summary and review of the main findings. The thesis closes with a discussion of the implication of the findings of the present study and future work avenues.

Chapter 2

Measuring satisfaction: Psychometric tools and models

"I often say that when you can measure what you are speaking about and express it in numbers you know something about it; but when you cannot measure it, when you cannot express it in numbers, your knowledge is of a meagre and unsatisfactory kind: it may be the beginning of knowledge, but you have scarcely, in your thoughts, advanced to the stage of science, whatever the matter may be.", Lord Thomas Kelvin (1883)

2.1 Understanding Satisfaction

The term satisfaction is derived from the Latin words *satis* ('enough') and *facere* ('to do / make') and is defined in the Oxford Dictionary (2011, p. 1277) as "fulfilment of one's wishes, expectations, or needs, or the pleasure derived from this". This definition implies that satisfaction is both an output of a cognitive evaluative process (fulfilment of expectations or needs) as well as an affective response (pleasurable). Satisfaction is a multifaceted construct as there are many factors that could contribute to an individual's satisfaction. When the question 'Are you satisfied?' is asked, a context is required to answer this. In line with different facets, one may refer to life satisfaction, job satisfaction, patient satisfaction, customer satisfaction and so on to further narrow down the focus of an individual's satisfaction. Regardless of the focus, the driving force is a quest for fulfilling one's needs. Whether true satisfaction is this fulfilment, or the resulting affective response, or a combination of both is still not fully clear.

Customer satisfaction is the most widely used concept in the commercialised world today and is considered fundamental to the marketing process. The marketing concept—the foundation of modern marketing—is built on satisfying the customer's wants and needs (Cooper, Cooper & Duhan, 1989). The term *customer* refers to an individual who purchases a product or service for consumption. In comparison, the term *consumer* refers to an individual who consumes the product or service but may not have purchased it. In this sense, being a

customer or a *consumer* could be a factor affecting satisfaction (in terms of value for money). In the present study for simplification, only the term *customer* will be used, to designate both categories, the customer-purchaser and the consumer. It is worth noting though that increasing growth of service industries, compared to the rate of growth of manufacturing industries, and the demand for total quality management for both industries has put satisfaction of the customer at the forefront of organisation mission statements today (Danaher & Haddrell, 1995). As Peterson and Wilson (1992, p. 61) comment, "it is not possible to argue against the goal of customer satisfaction. For a business to be successful in the long run, it must satisfy customers, albeit at a profit. Indeed, it can be argued that satisfying customers is the primary *obligation* of a company. Hence, customer satisfaction is a defensible and appropriate company objective–the glue that holds various corporate functions together and directs corporate resource allocation. Conceptually, virtually all company activities, programs, and policies should be evaluated in terms of their contribution to satisfying customers". As a consequence, business practitioners and academics alike have embraced customer satisfaction as one of the main goals of any commercial organisation.

2.2 Models of Customer Satisfaction

The broadly used definition of customer satisfaction is put forward by Oliver (1980) where satisfaction is defined as pleasurable fulfilment, meaning that customers perceive consumption of the product or service as fulfilling a certain need, desire or goal, whereby this fulfilment is pleasurable. This definition differs from one of the first definitions of satisfaction proposed by Hunt (1977, p. 459): "Satisfaction is a kind of stepping away from an experience and evaluating it... Satisfaction is not the pleasurableness of the experience, it is the evaluation rendered that the experience was at least as good as it was supposed to be". Westbrook and Cote (1980) argued that intrapersonal factors could influence customer satisfaction. Bringing these definitions together, customer satisfaction is an evaluative response to the perceived outcome of a particular consumption experience (Westbrook & Oliver, 1981).

A critical review of customer satisfaction literature showed that customer satisfaction influences re-purchase intentions as well as post-purchase attitudes and behaviours (Yi, 1990). This has resulted in the growing trend of using customer satisfaction as a means of evaluating organisation performance. Kotler (1991) suggested that high customer satisfaction

ratings are considered to be the best indicator of a company's future profits. In order for an organisation to gain optimal level of customer satisfaction, it is necessary to fully understand the relationship between the antecedents of satisfaction and the resulting behavioural and economic consequences (Anderson & Sullivan, 1993).

Over the past three decades there has been an influx of academic and trade articles published on the topic. Yet a consensual definition of customer satisfaction is still lacking (Peterson & Wilson, 1992). Without a uniform definition of satisfaction it is difficult to develop valid models and methods of measuring satisfaction and comparing the measurements across empirical studies (Giese & Cote, 2002).

Several definitions of satisfaction exist in the services and consumer marketing literature (for a review, see Giese & Cote, 2002). These authors explored relevant literature and customer perceptions in order to build a uniform definition for the construct. They identified three basic components of satisfaction: a *response* pertaining to a particular *focus* determined at a particular *time*. While in earlier studies, a *response* was typically conceptualised as either an emotional or cognitive, more recent satisfaction definitions emphasise an emotional response, a general affective response of varying intensity (Giese & Cote, 2002). The *focus* of customer satisfaction was found to usually entail a comparison of performance to individual's standard or expectation although this focus varies from context to context. The following subsections look at two distinct models of customer satisfaction, which aim to define satisfaction as a one-dimensional and two-dimensional construct respectively.

2.2.1 Disconfirmation of Expectations Model of Customer Satisfaction

The dominant model in customer satisfaction research is the Disconfirmation of Expectations Model proposed by Oliver (1980). This model stems from Helson's adaptation level theory suggesting that one perceives stimuli only in relation to an adapted standard (Helson, 1964, cit. in Yi, 1993). The Disconfirmation Model uses customer expectations as the adapted comparison standard (Figure 2.1). It has received abundant empirical support over the years (for a review, see Yi, 1990). The model has also served as the foundation for most research into the antecedents and consequences of customer satisfaction.

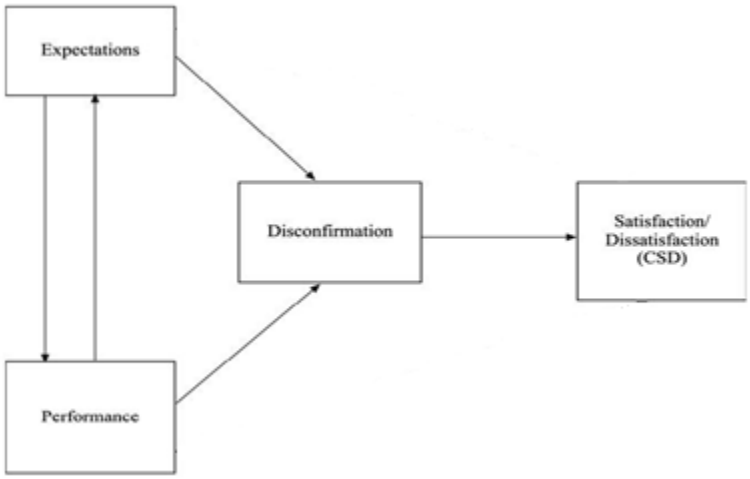


Figure 2.1. Disconfirmation of Expectations Model of Customer Satisfaction (Oliver, 1980).

Disconfirmation is defined as being negative when performance is perceived as being worse than the customer's expectations and positive when performance is perceived as being better than customer's expectations (Figure 2.2). This model is fundamentally a linear model of cognitive processes where the stimulus is the product or service and the outcome of the disconfirmation process is a perception of the degree of pleasure that is thought to suggest satisfaction or dissatisfaction. Thus, in this model, customer satisfaction is hypothesised primarily as a function of disconfirmation (Yi, 1993). The model does not incorporate affective outcomes as separate factors and if considered, these are defined as parts of the satisfaction construct itself (Wirtz, 1994).

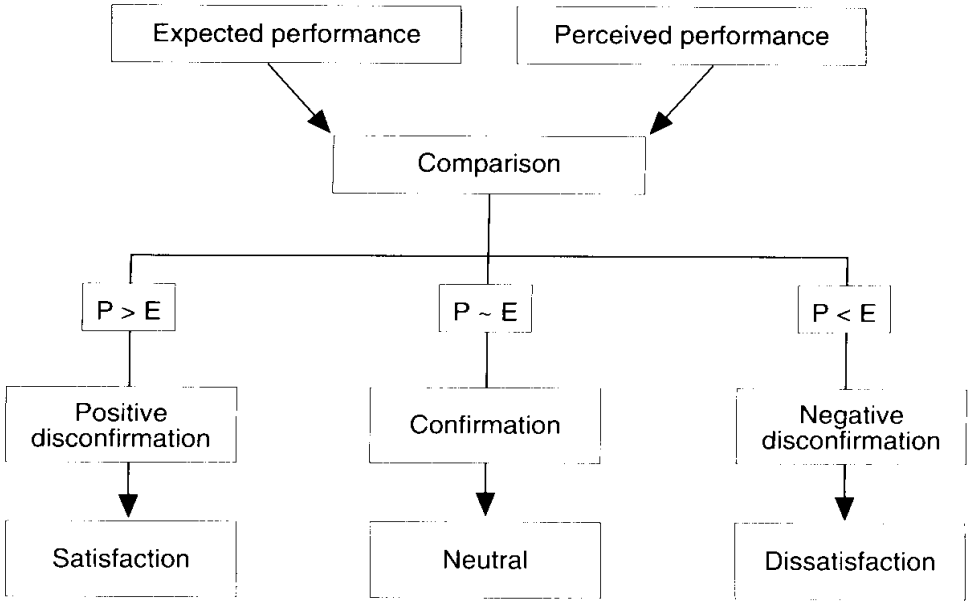


Figure 2.2. Process of Disconfirmation and links to Customer Satisfaction (Walker, 1995).

In the review on customer satisfaction and its main antecedents, Yi (1990) reported that while there was a general consensus that disconfirmation is an important antecedent of satisfaction, there is mixed evidence as to whether expectations directly affect satisfaction as well. While some studies showed a direct link between expectations and customer satisfaction, others showed little or no significant effect of expectations on customer satisfaction. Nevertheless a clear link between expectations and disconfirmation was found in virtually all studies (for a review, see Yi, 1990).

Perceived performance is thought to have a direct effect on customer satisfaction in addition to the indirect effect through the disconfirmation process (Yi, 1993). A further modification of the above model by Oliver (1993a) assumed that performance drives "ideal disconfirmation" which is considered to be the perceived quality of the product or service. The perceived quality is thought to be an intermediary between disconfirmation and satisfaction implying that customer satisfaction could be increased not only by minimizing disconfirmation, but also by increasing performance or quality of the product or service (Oliver, 1993a). This model depicted in Figure 2.3 was labelled the Expectancy Disconfirmation with Performance Model (Oliver, 1993a).

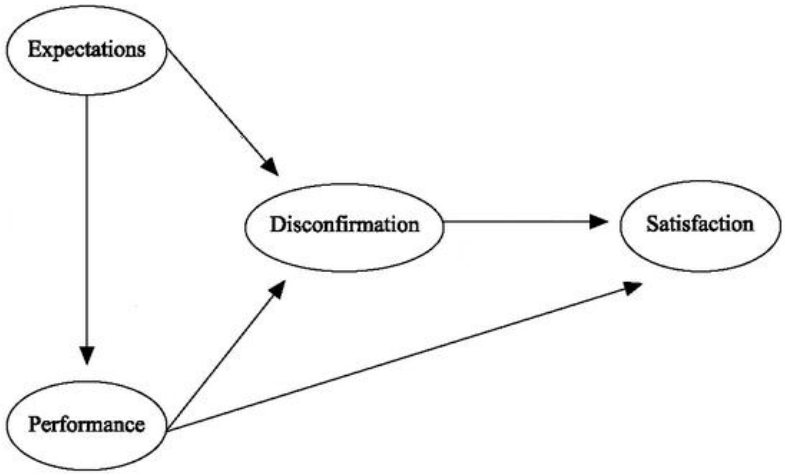


Figure 2.3. The Expectancy Disconfirmation with Performance Model (Oliver, 1993a).

Anderson and Sullivan (1993) developed a model to link explicitly the antecedents and consequences of satisfaction in a utility-oriented framework. They found that satisfaction is best specified as a function of perceived quality and disconfirmation as often suggested in the satisfaction literature. Their model suggested an asymmetric gain–loss framework for understanding the relationship between disconfirmation and satisfaction where quality that

fell short of customer expectations had a greater impact on satisfaction than quality that exceeded expectations.

Studies from a different school of thought, service quality literature, also emphasize the importance and relationship of quality perceptions and satisfaction. In services marketing literature, perceived quality is defined as the customer's judgment about an entity's overall experience or superiority (Zeithaml, 1987). More precisely, service quality has been postulated as a comparison between expectations and performance (Parasuraman, Zeithaml & Berry, 1985). This definition has been reiterated as "the discrepancy between customers' expectations and perceptions" (Parasuraman, Zeithaml & Berry, 1994, p. 111). In the services marketing literature this is referred to as the Gap Model of Service Quality and is very similar to the Disconfirmation of Expectations model of customer satisfaction. Thus the formations of the constructs of customer satisfaction and service quality are theoretically structurally similar with both sharing the antecedent's expectations and performance (Figure 2.4). Sternthal, Tybout, and Calder (1987 cit. in Iacobucci, Ostrom, and Grayson (1995) commented that concepts are separable theoretical constructs if they occupy unique positions in a nomological network, with unique sets of antecedent causes, consequential effects, or both. On the other hand, network concepts that share all theoretical antecedents and consequences are said to be "structurally equivalent" or logically isomorphic, making attempts to discuss them as unique concepts indefensible and empirically untestable. It is generally considered that "what is thought of as marketing issue when termed 'customer satisfaction' becomes an operational and personal management issue when termed 'service quality assurance' (Czepiel, 1980 cit. in Iacobucci et al., 1995). Thus the terms satisfaction and service quality are used interchangeably in service quality literature as if the two are principally one evaluative construct (Iacobucci et al., 1995).

Figure 2.4. Customer evaluation Judgements: Service quality and customer satisfaction (Iacobucci et al., 1995)

However there has also been considerable effort in services marketing literature to determine any distinctions between the two concepts. Oliver (1993a) considers perceived quality as the more specific judgment and a component of satisfaction, while some service quality researchers describe satisfaction as a more specific, short-term evaluation, and quality as a more general and long-term evaluation (Bitner, 1990; Cronin & Taylor, 1992). Thus the most common distinction between the two is that perceived service quality is considered a form of attitude, a long-run overall-evaluation, whereas customer satisfaction is considered a short-term transaction specific measure (Wong. 2004). Though, it has been noted by satisfaction and service quality researchers that satisfaction soon decays into an overall perception of quality (Berry, Zeithaml & Parasuraman, 1985; Oliver, 1981).

Iacobucci et al. (1995) pointed out that another means of looking at concepts with unique antecedents and effects is to consider whether the two constructs can be conceptualized as orthogonal. Iacobucci et al. (1995, p. 280) suggested, "if two concepts shared all causes, they could not vary independently. Thus quality and satisfaction can be distinguished if one can hypothesize circumstances for which say a high quality product can result in customer satisfaction or dissatisfaction". However most research in satisfaction and service quality literature have mainly questioned the sequential order of quality and satisfaction which has given rise to an unresolved debate between two camps of 'quality-influences-satisfaction' as opposed to 'satisfaction-influences-quality' (for a review, see Ruyter, Bloemer, & Peteers, 1997). As a result, research on both customer satisfaction and service quality literature have not reached conclusive results as to whether one construct is subsequent to the other or whether the relationship between these constructs are truly reciprocal.

The aforementioned models primarily focus on people as cognitive beings whose mental processes lead to the organisation of information into knowledge (Wirtz, 1994; Wirtz & Bateson, 1999). Thus early research viewed customer satisfaction as an outcome of a highly personal cognitive evaluation whereby (dis) satisfaction arose as a result of discrepancies between actual performance and expected performance. However, developments in the field of customer satisfaction suggest that emotion or affect is a fundamental attribute in satisfaction (for a review, see Wong, 2004). While cognitive processes require conscious processing of information, affective processes are thought to be partly outside the customer's conscious control. The product or service consumption experience is thought to give rise to positive and negative emotions, which will influence the degree of satisfaction/dissatisfaction (Westbrook, 1980). Westbrook (1987) examined the

influence of affect, expectations and disconfirmation on satisfaction of automobile owners and cable TV subscribers. Two distinct affective dimensions were identified, negative and positive affect. For both products—in addition to the disconfirmation process—positive affect was positively and negative affect negatively related to satisfaction. Oliver (1989) remarked that cognitive and affective responses can thus be seen as distinct, and having a separate influence on satisfaction formation.

Oliver (1993b) proposed a composite Cognitive-Affect Model of Satisfaction to include affect in addition to the cognitive antecedents expectations, performance, disconfirmation, attribution and equity/inequity (fairness) (Figure 2.5). Here affect, both positive (interest and joy) and negative (anger, disgust, contempt, shame, guilt, fear, sadness), is seen as an intermediary between both performance and attribute satisfaction (attribution).

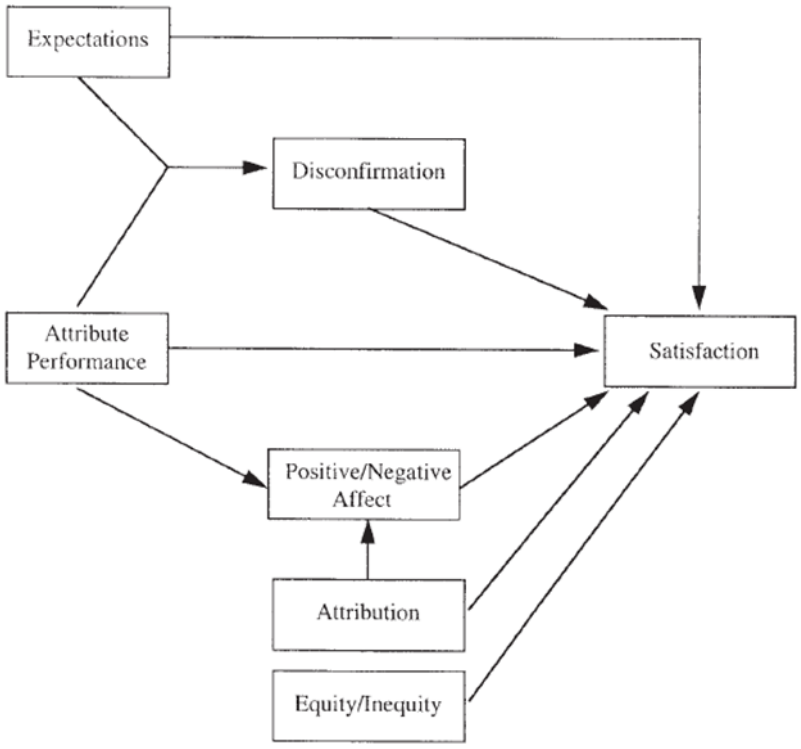


Figure 2.5. Combined Cognitive and Affect-Augmented Satisfaction Model (Oliver, 1993b)

According to this model, performance or perceived quality is considered to influence satisfaction either directly or indirectly through positive/negative affect. In addition it is suggested that perceived positive/negative emotions are affected by the attributions made by the customer. Therefore affect is introduced to cognitive models of satisfaction as a mediator

between cognitive evaluations and satisfaction, and as an independent contributor to customer satisfaction. Furthermore customers are thought to respond with negative emotions if a product or service does not meet their expectations while desired outcomes will result in positive emotions (Oliver, 1993b; Oliver & Westbrook, 1993).

From the above sections it is evident that customer satisfaction is not an isolated concept and has several antecedents that could result in different consequences. All models of customer satisfaction are based on some sort of comparison process of which a majority is based on a comparison between perceived performance and a pre-consumption comparison standard (Wirtz, 1994). For example, Kotler (1991) characterised satisfaction as a post-purchase evaluation of a product or service quality given pre-purchase expectations. It is apparent that in customer satisfaction literature, different researchers use different standards for the comparison process that is ultimately thought to result in satisfaction/dissatisfaction. As addressed in this section, this pre-consumption comparison standard could be based on customer expectations, ideal performance and/or experience-based standards. Furthermore it is now generally agreed that affect is an important aspect of consumption and will influence quality evaluation and satisfaction (Jiang & Wang, 2006). Thus the links formulated by the original Disconfirmation of Expectations Model between expectations, perceived quality and customer satisfaction may be more complex than envisioned.

2.2.2 Kano Model of Customer Satisfaction

As discussed in section 2.2.1, the traditional view on customer satisfaction assumes a linear, or one-dimensional, relationship between customer satisfaction and its antecedents where an increase in performance/perceived quality is thought to result in increased customer satisfaction (Oliver, 1993a). However, the aforementioned models have limited the understanding of quality to objective and physical properties of the thing or process being studied. Historical studies on the theory of quality have pointed out that quality is composed of two common aspects: “an objective reality independent of the existence of man” and “a subjective reality where we think, feel or sense as a result of the objective reality” (for a review see Kano, Seracu, Takahashi, & Tsuji, 1984). Furthermore, the “goodness of a thing” is considered to relate to the subjective, not the objective, aspect of quality (Schewart, 1931, cit. in Kano et al., 1984).

Quality Management is an organisation's practice of understanding customer needs in order to develop products or services that meet these needs. Through the years several definitions of quality have emerged from the quality management literature: definitions from users [customers] point of view; definitions from the producer's point of view; and combinations of users [customers] and producer's point of view. Based on these definitions, Kano et al. (1984) pointed out that despite difference in expression, discussions of quality have revolved around the two aspects of subjectivity and objectivity. Here definitions from users [customers] point of view related to subjective quality and definitions from producers' point of view related to objective quality as originally suggested by Schewart (1931). Kano et al. (1984, p. 167) further remarked that "embedded in this objective-subjective split is the idea that objective quality pertains to *conformance to requirements* (expressed by a state of physical fulfilment), while subjective quality pertains to the *satisfaction* of users [customers]". Based on this Kano et al. (1984) proposed the first two-dimensional quality model where perceived quality and satisfaction were conceptualised as orthogonal rather than relating to each in a sequential manner.

The Kano model was developed by adapting Herzberg's 'Motivation-Hygiene theory' (M-H theory, Figure 2.6) that was proposed to explain the way employees feel about their work (Herzberg, Mausner, & Snyderman, 1959, cit. in Lewis, Goodman & Fandt, 2004). Herzberg identified that the set of factors that produced job satisfaction were separate and distinct from the set of factors that produced job dissatisfaction. He proposed two independent axes for satisfaction and dissatisfaction in contrast to a single hedonic continuum (CQM, 1993). This theory suggests that the absence of satisfaction is not dissatisfaction but 'no' satisfaction, while the absence of dissatisfaction is not satisfaction but 'no' dissatisfaction.

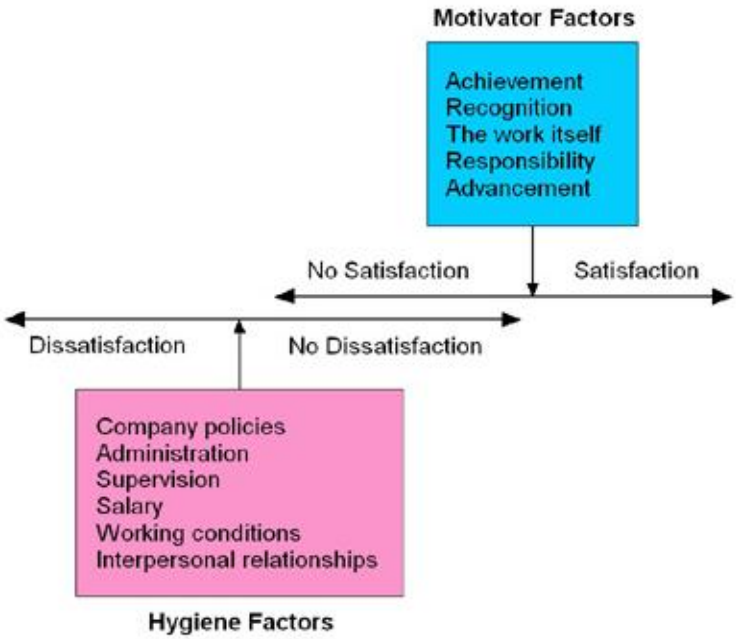


Figure 2.6. Herzberg's Two-factor Theory (Herzberg et al. 1959, cit. in Lewis et al., 2004).

Building on Herzberg's M-H theory, Kano et al. (1984) proposed that different product or service quality elements impact customer satisfaction in different ways (not necessarily in a linear manner). Kano et al. (1984) classified the quality elements based on correlations between physical fulfilment (objective) and customer satisfaction (subjective). Their research showed that for some product or service attributes, customer satisfaction is dramatically increased by only a small improvement in performance, while for other product or service attributes, customer satisfaction is increased only a small amount even when the performance is greatly improved (Tan & Shen, 2000). This finding opposes the traditional assumption that consumer satisfaction could be increased not only by minimizing disconfirmation, but also by increasing performance.

In the Kano model, quality elements are divided into three main categories based on their effect on customer satisfaction: *Must Be* or Basic elements, *One Dimensi*onal or Performance elements and *Attractive* or Excitement elements. Kano et al. (1984) depicted the relationship between customer satisfaction and the above quality elements in the two-dimensional model shown in Figure 2.7. Here the level of customer satisfaction is represented on a vertical axis, and the fulfilment of customer requirements (functional-dysfunctional) on the horizontal axis.

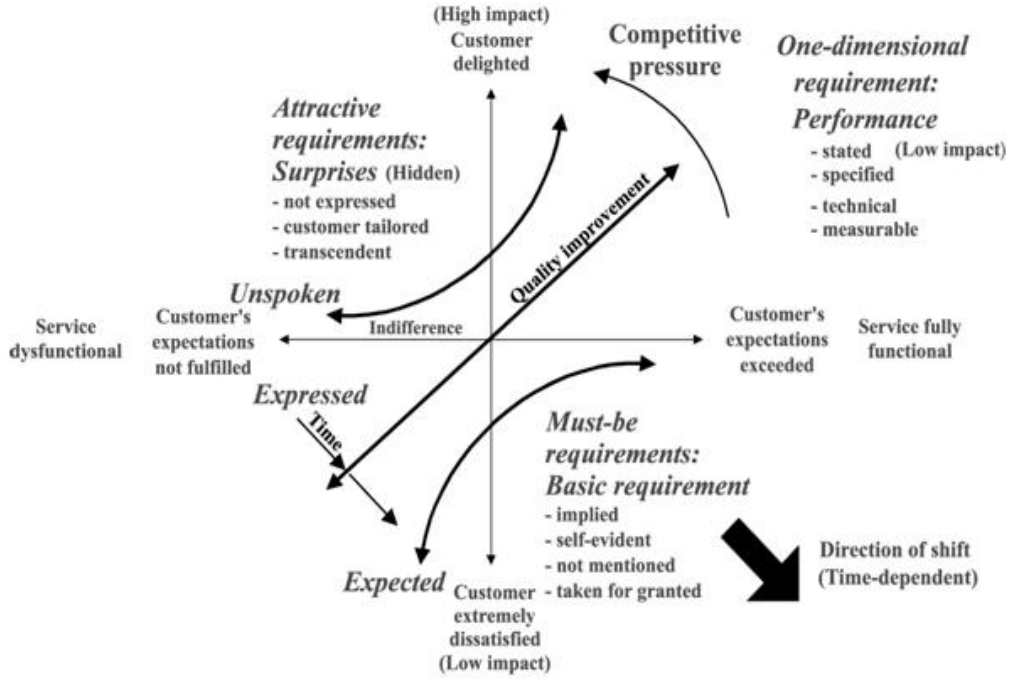


Figure 2.7. The Kano Model of Customer Satisfaction (Sireli, Kauffman, and Ozan, 2007).

The model illustrates how the latent properties of customer requirements have an effect on customer satisfaction and these properties correspond to the Kano quality categories that are explained in detail below.

Must be (M) or basic quality elements are attributes that a customer expects the product or service to have and are represented by the lower right curve of the Kano diagram (Figure 2.7). These expectations could be a result of the customer's general knowledge of the product or service (e.g. four tires in a car; colour display on a modern mobile phone). The fulfilment or good performance of these attributes will not increase satisfaction greatly as they are 'taken for granted'. However their absence or bad performance will result in dissatisfaction as they are expected to be present and functional in the product or service. As a result these features are also described as "*monovalent dissatisfiers*". Kano et al. (1984) used the example of a ballpoint pen to demonstrate this where the ballpoint pen user is dissatisfied when the ink flow (quality element) is insufficient but, conversely, is not satisfied when the flow is sufficient because this is expected.

One-dimensional (O) or performance quality elements are attributes whose performance can increase or decrease satisfaction with the product or service similar to the manner proposed by the one-dimensional models of satisfaction (e.g. good gas mileage in a car; user friendly menu on a mobile phone). The diagonal line in Figure 2.7 depicts these attributes. Absence of

these attributes will result in customer dissatisfaction while their fulfilment will result in satisfaction. Therefore these features are described as "*bivalent satisfiers*".

Attractive (A) or exciting quality elements are attributes of a product or service that the customer is not aware of and does not expect. Therefore not having these features will not decrease customer satisfaction whereas fulfilling these requirements will lead to a lot more than proportional satisfaction (Kano et al., 1984). These attributes are depicted as the curved line in the upper left portion of Figure 2.7 and are described as "*monovalent satisfiers"*.

Indifferent (I) quality elements are attributes of a product or service whose quality does not affect the level of consumer satisfaction (depicted in Figure 2.7 as the mid-point between satisfaction and dissatisfaction).

Another important feature of the quality elements highlighted by Kano et al. (1984) is that they are time dependent as seen by the direction of shift arrow in Figure 2.7. This means that with time the one-dimensional attributes become must-be attributes and the exciting attributes become one-dimensional. There are many factors that could affect this shift such as process improvements, the arrival of new technology, changes in customer's priorities and improved quality of service provided by competitors that can change the customer's perception of the product or service attributes (Bhave, n.d.).

The major contribution of the Kano model for quality management is the identification of these different relationships between objective quality (customer requirement fulfilment) and subjective quality (customer satisfaction). From a management point of view, customer satisfaction is more strongly linked with sales than objective requirement fulfilment (Kano et al., 1984). Therefore managers need to know into which category product or service attributes fall in order to set the right priorities for managing customer satisfaction. Only then can effective managerial decisions be made.

The Kano Model provides a unique method for classifying product or service attributes based on how they are perceived by the customer and their effect on customer satisfaction (Sauerwein, Bailom, Matzler & Hinterhuber, 1996). A detailed explanation of the Kano method is provided in section 2.4. Currently this method is used extensively in organisation quality management and product innovation practices to identify the relationship between the Kano quality categories and satisfaction. As a rule of thumb, organisations aim to fulfil all basic factors, be competitive with regard to performance factors, and stand out from competition regarding excitement factors in product/service improvements and developments (Matzler, Bailom, Hinterhuber, Renzl & Pichler, 2004). As a result, the Kano model of customer satisfaction is widely accepted and effective tool for understanding the

voice of the customers and factors that lead to their satisfaction (Lee & Huang, 2009; Wang & Ji, 2010). Oliver (2010) also commented that such need-fulfilment methods can provide additional information about the causes of customer satisfaction. Thus the Kano model has the potential to be used in consumer marketing for effectively monitoring the influence of product or service attribute performance on customer satisfaction.

2.3 Psychometric tools for Measuring Customer Satisfaction

Over the past decade customer satisfaction has been studied extensively from the perspective of the individual customer and what drives their satisfaction (Spreng, MacKenzie & Olshavsky, 1996). While the construct itself is considered highly beneficial to organisations, methods of accurately measuring it are less clear. In Psychology, the area of psychometrics specialises on how to measure psychological constructs such as satisfaction. The challenge of psychometrics is to assign numbers to observations in such a way that best summarises the underlying construct (Revelle, 2011). While overall customer satisfaction is referred to as a summary evaluation of a consumption experience, the existence of a multitude of factors that influence customer satisfaction make it a challenging task to quantify this construct accurately.

Customer satisfaction is typically measured using customer surveys although indirect measures such as sales, profits and complaints are also sometimes used (McNeal & Lamb, 1979). Peterson and Wilson (1992) remarked that the directness, ease of administration and interpretation, clarity of purpose and face-validity makes these surveys the preferred tool for measuring satisfaction. Organisations have the challenging task of making these surveys simple and less time consuming on behalf of the customer, while ensuring the capture of accurate data to monitor the organisations performance. A recent study showed that only 15%-30% of the customers actively responded to satisfaction surveys (Bhave, n.d.). While some surveys are designed with the potential to yield valuable qualitative data using open-ended questions, most surveys tend to focus on capturing quantitative data in an efficient and periodical manner using psychometric scales. More and more organisations use satisfaction ratings as an indicator of organisation performance and consequently an indicator of the company's future (Matzler & Hinterhuber, 1998). This means that decision making in these organisations depend on these satisfaction ratings making it imperative that the measure is accurate.

Psychometric scales are generally evaluated in terms of their reliability and validity in measuring the underlying construct. Reliability in psychometrics is defined as the "extent to which a measurement is free of variable errors" (Tull & Hawkins, 1987, p. 272). The most popular measure of reliability is Cronbach's alpha coefficient, which provides a value for the quality of measurement (Peter, 1979). In the case of measuring satisfaction, reliability refers to the consistency among the scales used to evaluate customer satisfaction. Validity of a measurement scale in psychometrics is defined as "the extent to which difference in scores on it reflect true differences among individuals on the characteristic we seek to measure, rather than constant or random errors" (Sellitz, Wrightsman & Cook, 1976, p. 169, cit. in Danaher & Haddrell, 1996). Generally organisations carefully device questions and chose an appropriate psychometric scale that meets their needs when measuring customer satisfaction. These satisfaction surveys are then administered to customers post-consumption to obtain their perceptions. To develop a successful customer survey, expertise and user inputs are essential information that should be taken into account. With these valuable inputs, it is thought that a survey can be produced which offers reasonable questions to customers and provides valid and accurate data for survey analysis (Wang & Ji, 2010).

A review of literature by Haddrell (1994) revealed over 40 different scales used to measure customer satisfaction with products or services. These scales included rank order, constant sum, graphical, Likert, semantic differential, paired comparison and stapel scales. Customer ratings obtained from these surveys are believed to aid organisations gain insight into their customer perspectives. These are in turn considered an important source of information for an organisation to judge and improve its performance in order to achieve maximum customer satisfaction in the future (Klawonn, Nauck, & Tschumitschew, 2010). The customer ratings, if favourable, are also included in an organisations marketing and advertising campaigns as indicators of product or service quality to attract potential customers. Hence it is necessary to make sure that the ratings portray the underlying construct accurately so that correct information is conveyed to potential customers. The following sections provide a review of the most widely used psychometric scales for measuring customer satisfaction in terms of their reliability validity. The challenges faced by such methods are discussed with focus on scales that attempt to measure satisfaction as a summary attitude.

2.3.1 Customer Satisfaction Measurement

Along with the increased research into customer satisfaction there has also been a corresponding increase in the diversity of measurement scales used in customer satisfaction surveys. Initial theoretical understanding of satisfaction indicated that the construct was closely related to the concept of attitude (Howard & Sheth 1969 cit. in Cooper, Cooper, & Duhan, 1989). Consequently, earlier measurements of satisfaction with products or services were typically based on direct subjective estimation of the intensity or frequency of overall satisfaction experienced by customers (Westbrook & Oliver, 1981). Oliver (1989) proposed that satisfaction involved two dimensions of valence (positive and negative) and intensity. Accordingly, the satisfaction judgment is typically assumed to vary along a hedonic continuum from unfavourable (dissatisfied) to favourable (satisfied) (Westbrook & Oliver, 1991).

Psychometric scales aimed at measuring satisfaction as an attitude intend to obtain a measure that corresponds to this continuum. Most often single-item satisfaction scales are employed. These scales are very simple and assess the overall level of satisfaction (*very satisfied – very dissatisfied*) using a scale of 3- to 11- point variants. These scales have also been reported to range from 3-point fully labelled rating scales to 10- and 11-point variants labelled only at the extremes and midpoint (Westbrook & Oliver, 1991). To indicate satisfaction as an affective response, Westbrrok (1987) used a single-item scale with anchors representing affective states (*delighted – terrible*).

The popularity of single-item scales has been mainly due to this simplicity, which makes them quick and easy to administer to large customer samples. Although this property makes these scales desirable for measuring customer satisfaction, single-item scales have also been criticised for its over-simplicity and reliability (Yi, 1991). Specifically, Wanous, Reichers, and Hudy (1997) stressed that measures from these scales cannot yield estimates of internal consistency reliability, nor can they be used in structural equation models. Thus, it has been long held in psychometrics that single-item measures cannot provide a reliable measure of relatively complex constructs such as satisfaction (Loo, 2001).

As highlighted in the sections above, customer satisfaction is a multifaceted construct. Single-item scales can be seen to lack the ability to provide information about different facets or dimensions that might be affecting the customers overall level of satisfaction. Therefore, there is doubt as to how well the cognitive-evaluative, affective, and conative elements of satisfaction can be captured using a single *x*-point '*extremely satisfied – extremely*

dissatisfied' rating scale (Westbrook & Oliver, 1981). On the contrary, multi-item scales have been used to assess the customers overall level of satisfaction as well as their satisfaction with key components of a product or service. Still, Westbrook and Oliver (1981) reported that they have not been widely used mainly due to the uncertainty of the functional form in which the product or service attributes should be combined into overall satisfaction judgments. From a job satisfaction point of view, Scarpello and Campbell (1983) commented that this summative method could arrive at a misleading overall satisfaction score due to the exclusion of important factors that probably have an impact on satisfaction or the summing up of factors that are not important to overall satisfaction. For this reason, many researchers have suggested that a single-item scale measuring overall satisfaction can be assumed as being superior to summing up individual item scores from a multi-item scales (Nagy, 2002).

While earlier methods attempted to measure satisfaction as an attitude, other methods have attempted to measure confirmation or disconfirmation, which is recognised as the cognitive process leading to satisfaction. As described earlier, satisfaction is generally thought of as a post-consumption evaluative judgement based on some sort of comparison. The comparison standard is typically considered to be customer expectations. Researchers have proposed two basic methods of investigating confirmation or disconfirmation of expectations: the inferred approach and the direct approach.

The inferred approach involves computing the discrepancy between expectations and post-purchase performance outcomes. Here the expectations and perceived performance are measured separately and the scores for performance (obtained post-purchase) are subtracted from those of expectations (obtained pre-purchase) to form a value of (dis) confirmation. Studies that used this method have found positive correlations between disconfirmation scores and satisfaction as well as significant negative correlations between expectations and disconfirmation. However none of these studies have reported on the reliability measures of the difference scores meant to compute disconfirmation (Prakash & Lounsbury, 1983). It has been discussed in psychometric literature that anytime the score on one variable is subtracted from the score on another variable to form a difference score, there is a potential risk of low reliability of the difference score variable (Prakash & Lounsbury, 1983). In addition to the use of difference scores, this method has also received criticism for including expectations—a highly unstable, subjective construct with high possibility of bias—for assessing customer satisfaction (for a review see Yüksel & Rimmington, 1998).

The direct approach, on the other hand, uses summary judgement scales to measure confirmation or disconfirmation. Oliver (1980) established a scale ranging from '*better than*

expected—worse than expected' to measure disconfirmation directly. This scale typically consists of three rating points: *better than expected* (positive disconfirmation), *the same as expected* (confirmation) and *worse than expected* (negative confirmation). Compared to the inferred approach, a calculation of a difference score is not required as the customers directly report the extent to which the product or service exceeds or falls short of their expectations. Most studies that have used this scale were found to measure disconfirmation at the overall level and not with the underlying product or service attributes (for a review see Prakash & Lounsbury, 1983). As a result, this method is said to be to be of little use for organisations that wish to find out which product or service attributes are not meeting customer expectations. In this case the inferred method is considered to be superior as it involves actual comparison of expectations and disconfirmation and has the potential to yield more insight about the product or service attributes. However the negative correlations identified between expectations and disconfirmation in studies that adopted the inferred method has resulted in the method being dismissed by critics (Prakash & Lounsbury, 1983).

Given these doubts about the validity of using disconfirmation as a measure of customer satisfaction, researchers have proposed perceived performance to be a better predictor of satisfaction (Yüksel & Rimmington, 1998). This is based on the Oliver's (1993a) statement that performance drives 'ideal disconfirmation'. This means that when a product or service performs well, the customer will be satisfied implying that performance has a preeminent role on satisfaction regardless of the effect of the disconfirmation process. Furthermore, performance is also considered the main feature of a consumption experience (Yüksel & Rimmington, 1998). Meyer and Westerbarkey (1996 cit. in Yüksel & Rimmington, 1998) commented that perceived performance could also be more straightforward, convenient and typical of the human cognitive process.

Performance is generally measured using Behaviourally Anchored Rating Scales (BARS) with anchors that correspond to performance indicators such as *poor*, *fair*, *good* and *excellent*. However measuring performance in this manner requires the identification of a set of 'performance dimensions' and a set of 'incidents' that can represent the wide range of actual functional qualities of the product or service in consideration (Atkin & Conlon, 1978). If the correct performance indicators are not used, this method holds the possibility of providing wrong conclusions about the performance of a product or service.

Perceived quality is considered to be a vital element in creating customer satisfaction with the dominant literature in services and consumer marketing suggesting that quality is the main antecedent of customer satisfaction (Anderson & Sullivan, 1993; Cronin & Taylor,

1992; Oliver, 1993a). Quality is also known to play an important role in sustaining profit levels of companies. As a result, the measurement of perceived quality has had special attention in the consumer marketing and services literature as an indicator of customer satisfaction. Perceived quality has been described as a form of attitude that results from the comparison of expectations with performance similar to the disconfirmation process (Parasuraman, Zeithaml & Berry, 1985). However, perceived quality is measured mainly using Likert scales. Rensis Likert introduced Likert scales in an attempt to find an effective and systematic psychometric tool for studying human attitudes and the factors that influence them. His research led him to develop a summative scale for attitude measurement (Likert, 1932). Likert scales typically offer a means of determining judgements for a statement along a continuum of responses. Normally five response alternatives are provided (*Strongly Agree*, *Agree*, *Neither Agree nor Disagree*, *Disagree*, *Strongly Disagree*), but sometimes go up to ten or more with some psychometricians encouraging using a greater number of levels. Regardless of the number of levels, the response categories always have a rank order.

Likert scales also allow the collection of opinions about a product or service on a number of dimensions. The dimensions evaluated can come from secondary sources and/or qualitative research or be based on the intended use or focus of the resulting data (McIver and Carmines, 1981). Likert scaling assumes the existence of an underlying continuous variable whose value characterises the respondents' attitudes and opinions (Clason & Dormody, 1991). Therefore ratings obtained from Likert scales can be collated to produce a combined rating that corresponds to perceived quality. As product or service quality is considered to be a direct antecedent of satisfaction—according to the traditional models of customer satisfaction—the individual item ratings are considered linearly related to customer satisfaction. Thus low ratings are interpreted as dissatisfaction and high ratings as satisfaction. Nevertheless there is a lot of confusion over the interpretation of results obtained from Likert scales and will be discussed further in the next section.

2.4.2 Challenges of psychometric rating scales

Research on survey design has not reached a conclusive result as to which is the best scale for measuring customer satisfaction. Yet there is significant evidence that the choice of scale for the survey can greatly impact the results (Danaher & Haddrell, 1996; Hanan & Karp, 1989; Peterson & Wilson, 1992). For the purpose of the present study the main focus will be the attitude scales used to measure customer satisfaction, namely the satisfaction scale (*extremely*

satisfied—extremely dissatisfied) and the Likert scale (*strongly agree—strongly disagree*). The popularity of these rating scales in consumer and services marketing is due to their ability to allow the management of qualitative data by ascribing attitudes to a numerical scale that make the data useful for statistical analysis. These scales can thus provide a metric that directly represents the underlying construct unlike other methods described above that measure the cognitive antecedents of the construct. However there are many challenges faced by the use of these scales, which are discussed below.

Number of scale points

It has been found that the wording of the questionnaire, scale choice, and the number of response alternatives will make a difference in satisfaction measurements (Hanan & Karp, 1989). A variety of possible response alternatives or scale points are available for psychometric rating scales that attempt to measure attitudes such as satisfaction or service quality (1-to-5, 1-to-7, 1-to-9, 1-to-10, 1-to-11 etc.). Some of these have an odd number of scale points while others have an even number of scale points. The defining feature of these two types of scales is the presence of a middle value in scales with an odd number of scale points. These are often labelled '*Neutral*' or '*Undecided*', or in the case of Likert scales '*neither agree nor disagree*' (McGreevy, 2007). Thus there is no consensus as to the optimal or preferred number of response alternatives for psychometric rating scales.

Churchill and Peter (1984) provided evidence to suggest that the more scale points used, the more reliable the scale and fusing few scale point will result in a scale that is less reliable. Groves, Fowler, Couper, Lepkowski, Singer, and Tourangeau (2004) remarked that fewer response categories on a rating scale lose information as a result of the scale failing to discriminate between respondents with different underlying judgments. On the other hand, more scale points are said to enable the customer to be more discriminating especially at the satisfied end of the scale (Churchill & Peter, 1984). This is important to organisations that are generally doing well for discriminating between different levels of good performance—which cannot be done with few rating points—which is also necessary for management decision making and performance tracking. Yet, having more categories lead to cognitive overload as respondents may fail to distinguish reliably between adjacent categories. Although it is advantageous to have many points in a scale from a statistical point of view, it is not practical when considering the ease of survey completion for the customers. Wittink and Bayer (1994) remarked that survey questions must to be easily understood by respondents in order to obtain

valid responses. Furthermore it is thought that respondents find it easy to respond using scales with 5 or more points than those with more than 10 points (Wittink & Bayer, 1994).

Cox (1980), in a review of psychometric rating scales, concluded that there is no single number of points that is appropriate for all situations. However the use of 5- to 9- point scales was recommended (Cox, 1980). Friedman and Friedman (1986, cit. in Friedman & Amoo, 1999) found that in some situations an 11-point scale may produce more valid results than a 3-, 5-, or 7-point scale. They concluded that researchers should consider using 5- to 11-point scales. Wittink and Bayer (1994) recommended that 10- point scales are best for measuring customer satisfaction. However other researchers have proposed the 7- point scale as the best scale to compromise overload (Krosnick & Fabrigar, 1997; McGreevy, 2007). Nevertheless, the 5-point scale continues to be the most widely used scale for measuring customer satisfaction. A rating scale should ideally have enough points to extract the necessary information (Friedman & Amoo (1999). However, the lack of consensus on the best type of scale provides a challenge for measuring customer satisfaction accurately and making valid inferences from the results obtained.

Interval versus Ordinal scales

While the satisfaction scale and the Likert scale allow the assignment of attitudes to a numerical scale, it cannot be ignored that the underlying construct is quantitative. Although literally it is clear that *strongly agree* is better than *agree* and *extremely satisfied* is better than *satisfied,* it is not known by exactly how much. Also it is unknown if the distance between two such points is the same as the distance between two other consecutive points on the same rating scale. In the case of the Likert scale, Cohen, Manion, and Morrison (2000) argued that it is 'illegitimate' to infer that the intensity of feeling between *strongly disagree* and *disagree* is equivalent to the intensity of feeling between other consecutive categories. Therefore such scales have been classed as ordinal scales—due to the rank order—and not interval or ratio scales which use numbers to distinguish the points on the scale (height, weight etc.). In psychometrics, the level of measurement is an important issue as the appropriate descriptive and inferential statistics are different for ordinal and interval type data (Nunally, 1978). Furthermore, using the wrong statistical techniques could result in wrong conclusions about the data being made. In customer satisfaction measurement, this could in turn have major consequences on managerial decisions.

Psychometricians report that the acceptable statistics for ordinal type data is a

frequency distribution and the median and mode (Nunally, 1978). However, a frequency distribution can only say how many respondents rated each point on the scale but not the actual degree of satisfaction with the product or service. On the other hand, if the data was of the interval type, measures such as means and standard deviations could be used to make more valid inferences from the data.

This is a major issue when taking into account the multi-criteria nature of customer satisfaction. Since psychometricians argue that it is illegitimate to generate a mean for ordinal type of data, aggregating items to generate an overall satisfaction metric becomes an issue. The alternative employed is reporting the 'percentage agreed' or 'percentage satisfied'. Interpretation of the data in this manner raises another issue as scores within two or more categories are mixed to generate one or two categories (eg. Percentage agreed= percentage *strongly agree* + percentage *agree*). Reporting results in this manner also questions the use of more than two response categories as ratings on either side of the neutral are aggregated to form two categories.

However, the presumption that the intervals between response alternatives are equal in attitude scales is a highly debated topic. Although this is the case, it is presumed that if it were possible to measure the latent variable directly, the measurement scale could be an interval scale (Goldstein & Hersen, 1984).

Distribution of Data

Another issue encountered when using satisfaction and performance rating scales is the distribution of responses. It is a general observation that commonly used satisfaction and performance scales have skewed distributions with the majority of customers rating the product or service towards the higher end of the scale (Peterson & Wilson, 1992; Westbrook, 1980b). While this skewness is exacerbated in the 5- point scale, the distribution becomes a normal with increase in scale points (Figure 2.8). While some authors suggest that this merely indicates that customers are broadly satisfied skewed distribution do raise concerns regarding the sensitivity of the scale.

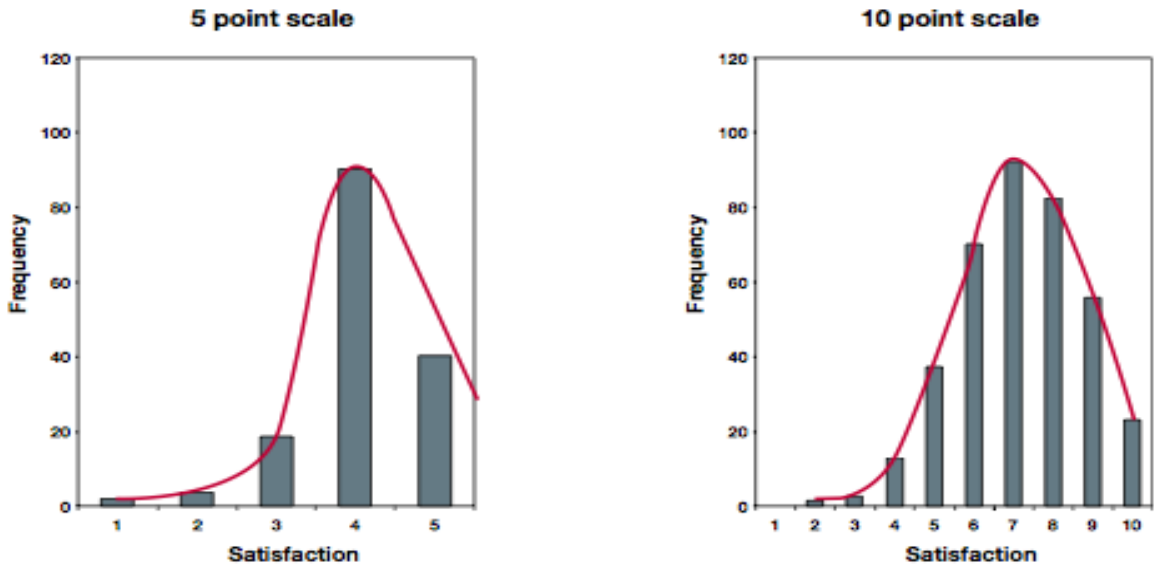


Figure 2.8. General distribution of satisfaction data for 5 response categories and 10 response categories (Hill, 2005)

Satisfaction and performance rating scales provide organisations a method for capturing quantitative data in an efficient and periodical manner. However, the use of these scales also provides many challenges when the data is analysed and interpreted. When using these scales, what organisations are really looking for is the degree of customer satisfaction with a certain product or service. The challenges discussed above make it difficult to obtain a valid measure of customer satisfaction without a trade off in the validity and reliability of the data. However, attempts should be made to ensure an accurate measure of customer satisfaction is obtained before the data is used to inform organisations as well as future customer choices. Methods that will allow sufficient discrimination between degrees of satisfaction are essential for efficient data analysis and interpretation. The next section provides a framework that aims to deduce an accurate customer satisfaction metric that takes into account all the aforementioned challenges faced in measuring customer satisfaction.

2.4 Customer Satisfaction and Multi-criteria analysis

It is evident that extensive research in consumer marketing has given rise to several alternative methods for measuring customer satisfaction. However, the goal of most of this research was to study the antecedents and consequences of customer satisfaction rather than investigate how different product or service characteristics may influence the overall measure of customer satisfaction. Many of the aforementioned satisfaction models do not consider the

qualitative form of customers' judgements, although this information is the basic satisfaction input data. Furthermore, in several cases, the measurements are not sufficient to analyse in detail customer satisfaction as results are mainly focused on a simple descriptive analysis (Grigoroudis, 1999).

Implementing a customer satisfaction metric for a product or service requires a well-planned execution. Given that the main purpose of customer satisfaction surveys is to assist management with improvement of their products or services, it is imperative that they receive consistent advice through the survey (Danaher & Haddrell, 1996). Customer satisfaction measurement has been classed a multivariate evaluation problem given that the customer's overall satisfaction depends on a set of variables representing product or service characteristic dimensions (Grigoroudis, 1999). Usually an additive formula is used to aggregate partial evaluations in an overall satisfaction measure (Siskos & Grigoroudis, 2001). Obtaining a meaningful measure relies on the completeness and accuracy of data obtained from the survey process (Malthouse, Oakley, Calder & Iacobucci, 2003). The measurement techniques described above do serve the purpose of building effective survey systems. However, these need to be supplemented with tools that capture the quality and importance of a service from the customer's perspective (Malthouse et al., 2003). Oliver (2011, p. 53) remarked, "without knowledge of the relationship between performance and satisfaction and why features are considered important or not by customers, interpretation becomes ambiguous".

Oliver (1993b, p. 421), defined attribute satisfaction as "the consumer's subjective satisfaction judgment resulting from observations of attribute performance" and that overall satisfaction and attribute satisfaction are distinct but related constructs. In addition, when a product or service is seen as consisting of several different attributes which can be evaluated by the consumer during and after consumption, each of these attributes, or evaluations of attributes, may also be seen as a potential source of negative or positive affect (Oliver, 1993b). To determine how attribute-level performance impacts overall satisfaction, organisations first identify the various attributes that comprise a product or service. Then attribute importance, which is the relative importance of each attribute from the customer's point of view, is determined. These importance scores are then used to deduce attribute weights, which are used to calculate an efficiency score (mean rating x weight) for each attribute. These efficiency scores are in turn aggregated to derive a composite satisfaction index.

Attribute importance is generally obtained by two methods: stated importance and statistically derived importance. In the stated importance method customers rate the

importance of each attribute on a self-stated importance questionnaire. The scale typically ranges from '*not at all important*' to '*extremely important*'. Importance assessments are carried out in parallel with the satisfaction assessments (Hauser & Clausing, 1988; Hauser, 1991). Self-stated Importance questionnaires can help an organisation understand the relative importance of each requirement for customers. However several limitations of the method have been identified. Customers have been found to assign more extreme positive and negative satisfaction ratings to attributes that are more important in comparison to unimportant attributes. This is because psychologically, importance is considered already factored into attribute satisfactions and dissatisfactions. Therefore measuring importance would be similar to double counting (Oliver, 2011). It has also been found that stated importance tends to have low discrimination power due to customers finding all attributes important (Gustafsson & Johnson, 2004). Thus measuring importance and then factoring importance scores into satisfaction assessments have not been fruitful (Danaher & Haddrell, 1996). Oliver (2010, p. 51) remarks, "importance as evaluated by the customers does not add to predictability in satisfaction models and unduly adds to the survey length".

On the other hand, statistically derived importance relies on an actual assessment of how each attribute is related to satisfaction. Here customers are asked to rate their satisfaction on the performance of each of the product or services attributes as well as their overall satisfaction with the product or service. Relative importance is then derived using statistical techniques such as multiple regression, normalized pair wise estimation, partial least squares with reflective or formative attribute specification and principal components regression (Gustafsson & Johnson, 2004). The resulting empirically derived importance estimate for each attribute can be either the correlation of the attribute performance with satisfaction or the multiple regression weight (Oliver, 2011). The most frequently used method is multiple regression analysis (Danaher and Mattsson, 1994; Danaher & Haddrell, 1996). Typically, organisations collect data from a single cross-section of customers and then regress the overall satisfaction score on each attribute rating to determine attribute weights (Anderson & Mittal, 2000). These attribute weights now take into account both performance and satisfaction, with attributes having high regression coefficients considered more important than others. Garver (2002) remarked that this method has better discrimination power and eliminates the tendency of finding all attributes important. However data bias due to the response alternatives or scale format used could influence this method. In addition, multicollinearity among independent variables also tends to be a problem when multiple regressions are used (Wang & Ji, 2010).

Although stated and derived importance methods are widely used to deduce weights when computing a global satisfaction metric, both methods have their limitations. Anderson and Mittal (2000) pointed out it is possible that attributes can have different satisfaction implications for different customer and market segments. Hence factors of market segmentation such as usage context, segment population, and market environment can influence satisfaction and product use (Anderson & Mittal 2000). In addition the assumption that attribute weights determined over a single cross-section will generalise to the entire life of a customer relationship has been criticized (Mittal & Katrichis, 2000). Mittal, Katrichis, and Kumar (2001) argued, "What if the importance of an attribute in determining overall satisfaction is not constant but varies over the span of a customer's relationship with a firm? If such is the case, then firms using a single cross-section of satisfaction survey to determine attribute importance can misallocate resources". However, temporal changes in attribute importance when examining overall satisfaction have rarely been found incorporated in organisation satisfaction management practices (Mittal, Katrichis & Kumar, 2001). Thus it is necessary to use a method that takes into account the nature of the customers' subjective evaluations.

Most of the traditional techniques that aim to find out the relative importance of attributes assume that customers have previous knowledge about the product or service (Deszca, Munro, & Noori, 1999). More importantly, they assume that there is a linear relationship between attribute performance and customer satisfaction according to traditional customer satisfaction models. This assumption of the linearity between the antecedents of satisfaction and the satisfaction response neglects the possible influence of different product or service attributes on the overall level of satisfaction. Therefore it is questionable to what extent these results can be used as an accurate measure of customer satisfaction. This has the consequence of leading to wrong decisions about which attributes should be improved to increase customer satisfaction (Huiskonen & Pirttila, 1998; Matzler & Sauerwein, 2002; Ting & Cheng, 2002; Tontini & Silveira, 2007). It is in this light that the Kano model provides a more enlightening method for classifying customer needs.

In the field of quality management the Kano model of customer satisfaction is widely accepted and effective tool for understanding the voice of the customers and factors that lead to their satisfaction (Lee & Huang, 2009; Wang & Ji, 2010). As described in section 2.2.2, in the Kano model, the relationship between the product or service performance and the importance of must-be (basic) and attractive (excitement) factors is nonlinear and asymmetric. When the performance of must-be attributes is low, they have a great influence

on customer satisfaction. As the performance of must-be attributes increase, their influence on overall satisfaction decreases. Attractive factors have the opposite influence on customer satisfaction. When their performance is low, they do not have much influence on overall satisfaction. They only become important determinants of satisfaction when their performance is high (Matzler & Sauerwein, 2002). The only time the relationship between satisfaction and attribute performance is linear and symmetric is when the attributes are one-dimensional (performance) (Matzler et al. 2004). In this case high performance leads to satisfaction while low performance leads to dissatisfaction. Therefore, unlike the derived and inferred importance methods, attribute importance can be interpreted as a function of performance using the Kano model. The Kano model is generally used for understanding customer needs during the development of new products or services in the process of total quality management (TQM). However the method has substantial potential to be applied to compute a customer satisfaction metric based on multiple criteria. The following sections provide a description of the Kano method and subsequent developments by other authors. Finally, the possible application of the Kano Model for effective analysis of multi-criteria type feedback data is proposed.

2.4.1 Kano Analysis: Classification of attributes

Kano et al. (1984) devised a questionnaire-based method for classifying product or service attributes into each of the Kano quality categories: *Must-be, Attractive* and *One-dimensional*. Organisations first identify all the attributes that a certain product or service will entail. Then a Kano questionnaire is designed, which contains a question for each attribute in its functional and dysfunctional as shown in Figure 2.9a. The functional form questions ask the customer how they will feel if the product or service consists of the attribute in question. On the contrary, the dysfunctional form questions ask the customer how they will feel if the attribute was not present. The respondents are provided a 5- point Likert-like scale with the response alternatives: 1. *I like it that way*, 2. *It must be that way*, 3. *I am neutral*, 4. *I can live with it that way* and 5. *I dislike it that way*. The classification matrix (Figure 2.9b) is then used to classify each attribute into one of the Kano quality categories based on the responses for the functional and dysfunctional question. In addition to the three main product attribute types the Kano classification method also classifies the attributes as *Indifferen*t (I), *Questionable* (Q) or *Reversible* (R) attributes. Attributes classified as Indifferent are those whose performance does not have any effect on customer satisfaction. Attributes that are

classified as Reversible imply that the true relationship between the performance of these attributes and customer satisfaction is the opposite of that expected by the organisation. Attributes classed as Questionable indicate errors in the response to the questionnaire.

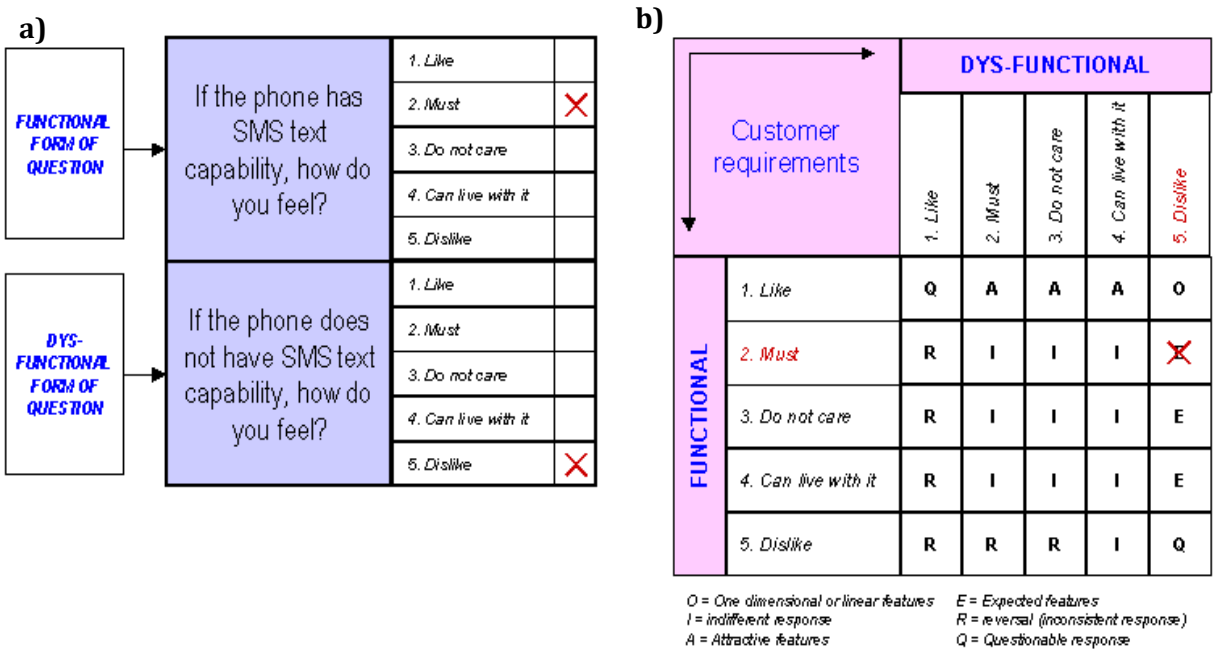


Figure 2.9. Kano Analysis a) questionnaire format and b) classification of results (CQM, 1993).

A frequency analysis of the Kano categories assigned to each attribute is carried out. Inferences based on these response frequencies are used to assign each product or service attribute to a Kano category. Typically the highest frequency category is used to label the attribute. However, as with any psychometric rating method, the distribution of responses varies with some attributes reaching a clear consensus while others show ambiguity. In such cases where a single attribute cannot be unambiguously assigned to a certain category an evaluation rule is used. This evaluation rule (M>O>A>I) ranks the Kano categories in order of their influence on product or service quality.

Figure 2.10 depicts a summary of the processes involved in a Kano analysis of a product or service. The method represents an advance in the way new products are planned and introduced to the market. In the past the emphasis of product planning was on improving the physical fulfilment of quality elements. Since the introduction of the two-dimensional quality model, satisfaction improvement and dissatisfaction elimination activities are considered more effective in this process (Sauerwein, Bailom, Matzler, & Hinterhuber, 1996). Thus from a quality management point of view, organisations try to incorporate as many quality elements that are recognised as important to increasing customer satisfaction. This method of prioritising product or service attributes is considered to make the product

planning and development process more accurate resulting in products and services that have a better chance of success in their marketplace.

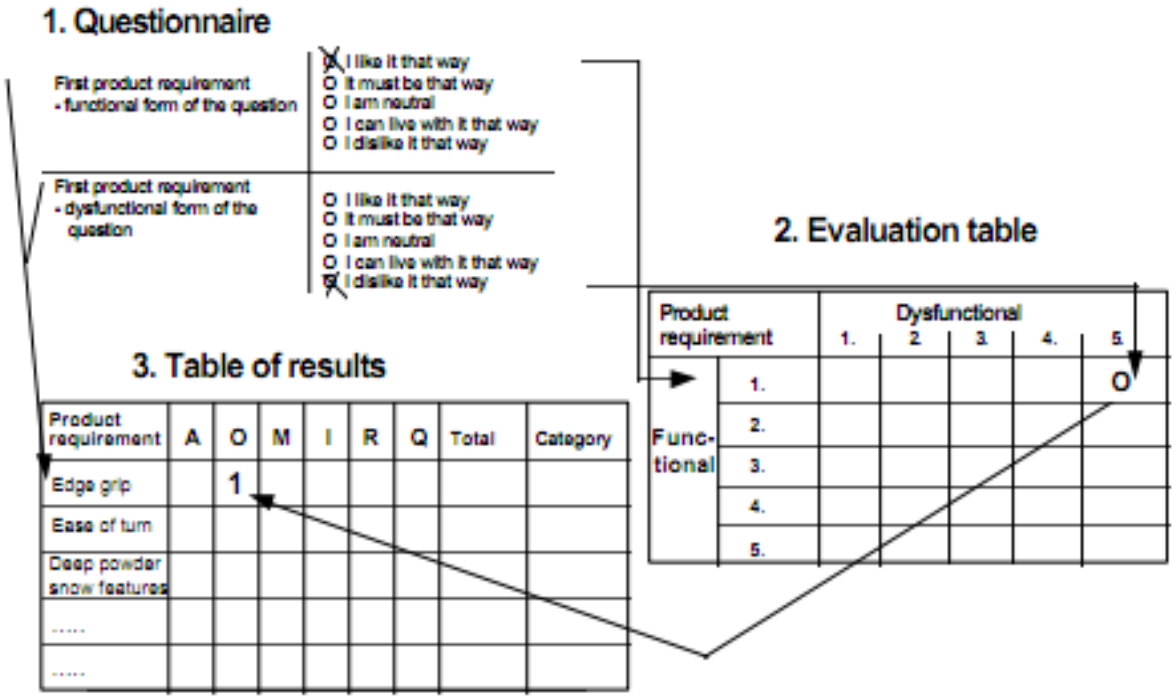


Figure 2.10. Summary representation of a Kano evaluation (Sauerwein et al., 1996).

2.4.2 Quantitative Kano Analysis

Although the Kano method has been widely recognised and used to gain a better understanding of consumer requirements, several limitations of the original method have also been identified. One of the main limitations is the qualitative nature of the Kano category. This qualitative classification lacks the ability to precisely reflect the extent to which the customers are satisfied. This could in turn result in the methods shortfall in playing a key decision-making role in product innovation and service management (Kuo, 2004). To overcome this limitation, Berger et al. (1993) proposed the customer satisfaction coefficient (CS-coefficient). This value indicates whether meeting a certain requirement can increase satisfaction or whether fulfilling this product requirement prevents the customer from being dissatisfied (Berger et al., 1993). Berger et al. (1993) pointed out that the existence of different market segments for the same product or service means customers usually have different needs and expectations. Therefore it is not clear whether a certain attribute can be assigned to the various categories. In such cases it is important to know the average impact of a product or service attribute on the satisfaction of all the customers. The CS- coefficient

achieves this by computing two values that indicate how strongly a product or service attribute may influence satisfaction when fulfilled and dissatisfaction when non-fulfilled. These values, also known as the customer satisfaction index (CSi) and customer dissatisfaction index (CDi) are calculated a follows:

$$CSi=(A+O)/(A+O+M+I)$$

$$CDi=-(O+M)/(A+O+M+I)$$

Where:

A denotes response frequency of Attractive attributes

O denotes response frequency of one-dimensional attributes

M denotes response frequency of must-be attributes

I denotes response frequency of indifferent attributes

These indexes are also referred to as ‘for better’ and ‘for worse’ indicating a positive or negative impact towards customer satisfaction. Based on the CSi and CDi, which indicate the extent of customer satisfaction and dissatisfaction respectively, quality attributes are selected in a manner that can optimize the outcome (Lee, Lin & Wang, 2011).

Wang and Ji (2010) further built on these indexes to provide a more accurate indication of satisfaction. Their method is based on the suggestion that it is more appropriate if the CSi and DSi values above can be defined together with their corresponding quantified level of fulfilment for each CR. In order to solve this problem Wang and Ji (2010) made the following two assumptions:

(1) If a product can offer a certain CR (existence) or its sufficiency, the level of fulfilment of that CR is assumed to be 1 (i.e. Fully fulfilled)
(2) If a product fails to deliver a CR, the level of fulfilment of that CR is set to be 0 (i.e. complete non-fulfilment)

These values along with the CSi and DSi were used to derive the relationship curves shown in Figure 2.11.

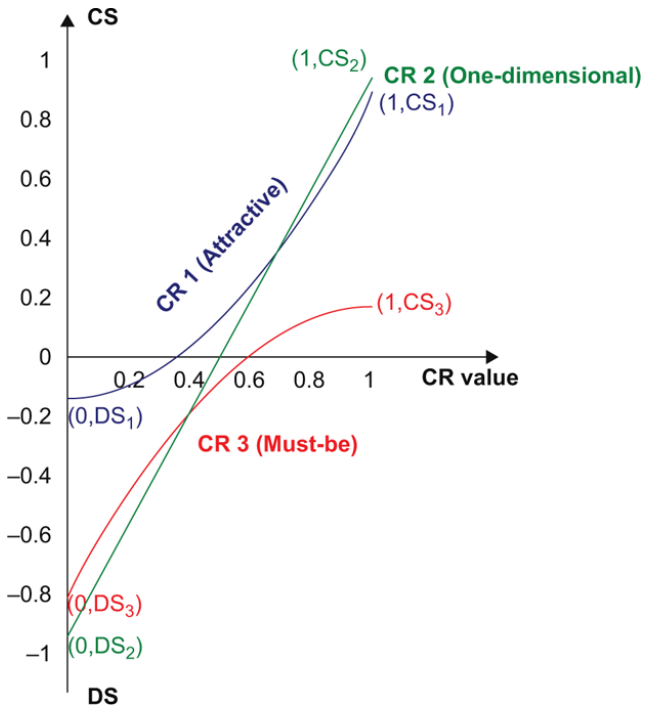


Figure 2.11. Relationship curves between Customer Satisfaction and Customer Requirement fulfilment (Wang & Ji, 2010).

It can be observed from the Figure 2.11 that the relationships between CS and CR fulfilment can be approximately quantified by an appropriate function. This function is expressed simply as $S = f(x, a, b)$, where S denotes the degree of CS, x denotes the fulfilment level of CRs ranging from 0 to 1, and a and b are adjustment parameters for different Kano categories of CRs (Wang & Ji, 2010). Wang and Ji (2010) further deduced the three S-CR fulfilment functions for the three main Kano categories. These functions assume that: for the one-dimensional attributes satisfaction increases linearly with requirement fulfilment; for the attractive attributes satisfaction increases exponentially with requirement fulfilment; and for the must-be requirements satisfaction decreases exponentially when requirements are not met. As satisfaction increases linearly with requirement fulfilment for the one-dimensional attributes, the relationship between satisfaction (S) and customer requirement fulfilment (CR) follows the function of a straight line. On the other hand, for the attractive and must-be attributes, the relationship between satisfaction (S) and customer requirement fulfilment (CR) follows the function of and exponential curve. The functions derived by Wang and Ji (2010) are shown below.

One-dimensional:

$$S_i = (\mathrm{CS}_i - \mathrm{DS}_i)x_i + \mathrm{DS}_i.$$

Attractive:

$$S_i = \frac{\mathrm{CS}_i - \mathrm{DS}_i}{e-1} e^{x_i} - \frac{\mathrm{CS}_i - e\mathrm{DS}_i}{e-1}.$$

Must-be:

$$S_i = -\frac{e(\mathrm{CS}_i - \mathrm{DS}_i)}{e-1} e^{-x} + \frac{e\mathrm{CS}_i - \mathrm{DS}_i}{e-1}.$$

(Wang & Ji, 2010)

These S-CR functions have been proposed to help understand customer needs in a more accurate way to aid product development and innovation in quality management.

2.4.2 Application of the Kano model for multi-criteria data analysis

While the Kano model and its recent developments are currently used for understanding customer needs in quality management, the model is rarely incorporated into consumer marketing literature. When handling complex multi-criteria type data it is essential to first find out the effect of each criterion on satisfaction. In this study, the Kano model is proposed as a method that can allow better understanding and enable better analysis of multi-criteria type feedback data. Figure 2.12 presents the theoretical framework proposed for handling multi-criteria type data. The method aims to obtain a value of satisfaction, which takes into account the influence of different evaluation criteria on satisfaction. In addition, categorising product or service attributes as monovalent satisfiers (A), bivalent satisfiers (O) and monovalent dissatisfiers (M) enables the identification of actionable problem areas. This can in turn aid effective decision-making by directing actions that attempt to reduce dissatisfaction by focusing on monovalent dissatisfiers and bivalent satisfiers.

Firstly, the multiple criteria addressed in the feedback data needs to be identified. A Kano analysis can then be carried out on these criteria to find out the relative importance of each criterion on satisfaction. Based on the original Kano method, a qualitative category (One-dimensional, Must-be and Attractive) can then be assigned to each criterion. A quantitative measure of the impact of each criterion on satisfaction can be obtained by

calculating the Customer Satisfaction coefficient (CSi) and Customer Dissatisfaction coefficient (DSi). For measures of satisfaction that were obtained using satisfaction scales, the CSi and DSi can be used as for adjusting criteria weights in comparison to the importance ratings described above.

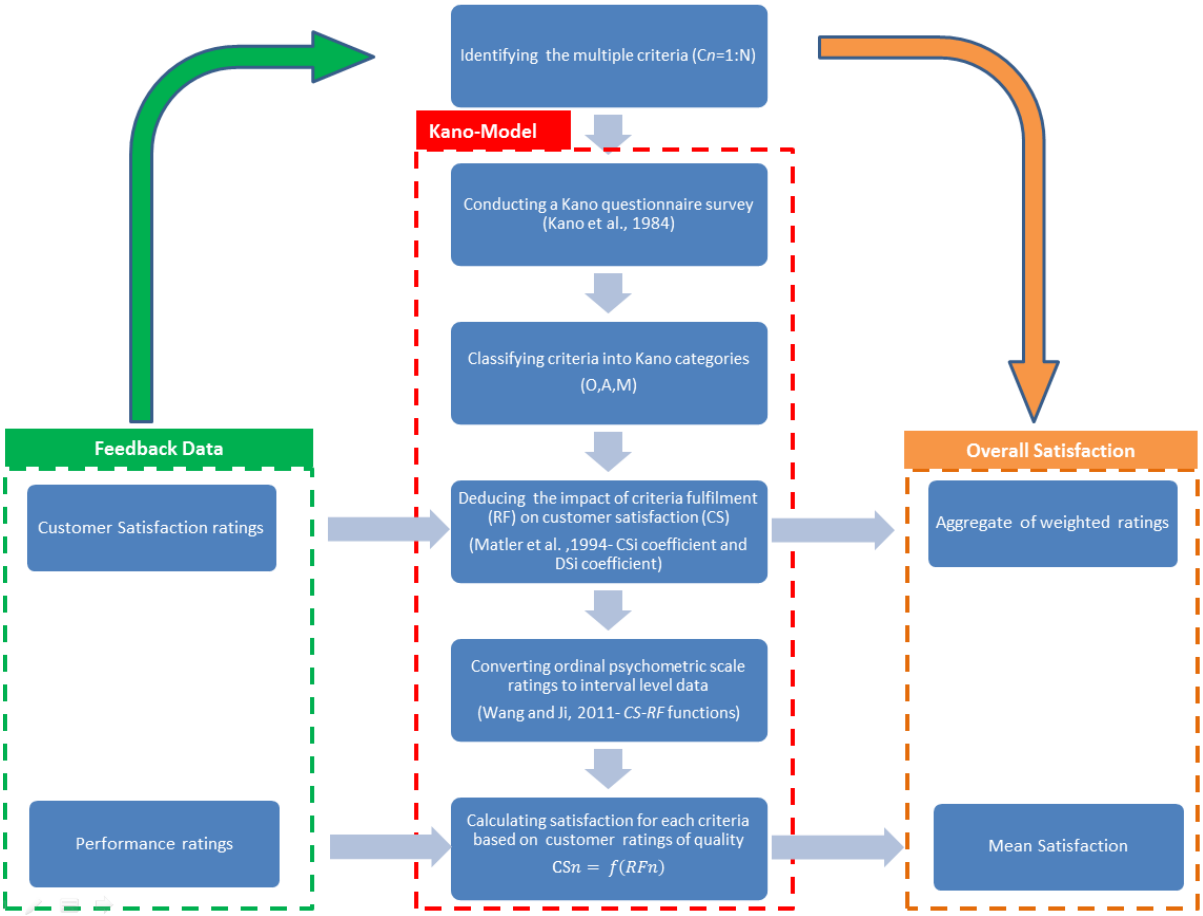


Figure 2.12. Theoretical Framework for applying the Kano model for multi-criteria type feedback data analysis

In cases where the feedback data is obtained using performance scales, application of the Kano model can be extended to incorporate the analysis proposed by Wang and Ji (2010). The method enables the conversion of ordinal type data into interval level data based on the assumption that the underlying *Performance (*requirement fulfilment*)* and *Satisfaction* scales are interval level measurements. The S-CR functions deduced using this method could be used to calculate the level of satisfaction for each criterion using performance ratings obtained from the feedback data. The measurement of satisfaction can now be described as interval level. This allows the computation of a mean of all the criteria, which can be used to

denote overall satisfaction. Analysing multi-criteria type data in this manner can be proposed to provide better insight of underlying factors the output is a measure of subjective quality compared to conventions measure of objective quality. It is this subjective quality (customer satisfaction) rather than objective quality (requirement fulfilment) that is considered to result in the success of organisations.

Chapter 3

Facial Expressions as the Means of Conveying Satisfaction

"The n equal parts that can be thought of as composing a total magnitude of course have the same magnitude as the n equal parts into which the total magnitude can be thought to be decomposable. All physical measurement is based on this principle. All mental measurement will also have to be based on it. ... In general, mental measurement is not particularly relevant to practical life. But it has enormous scientific importance and far-reaching implications. First, because of the common subordination of both the mental and the physical realms to the principle of mathematical determination; and second, because of the lawful relation between mental and physical magnitudes which automatically obtains when a mental measure is found.", Gustav Theodor Fechner (1887, p. 213)

3.1 Conveying Satisfaction

As highlighted in Chapter 2, satisfaction—which is a multifaceted construct—has received substantial attention in the area of consumer marketing. Westbrook and Oliver (1981) highlighted that central to the construct of satisfaction is the presence of affect. Customers are thought to experience varying degrees of feeling or emotion associated with their evaluations of outcomes. Favourably evaluated outcomes are said to be associated with happy, pleasant feelings, while unfavourably evaluated outcomes are associated with unhappiness, irritation or regret (Westbrook & Oliver, 1981). Westbrook (1987) further generalised customer emotions and suggested that if customers perceive that the product performance is good, they will experience positive emotions, whereas if they perceive that the performance is bad, they will experience negative emotions. As a result, satisfaction has been defined as a customer's emotional feelings about a particular consumption experience (Schneider & White, 2004). What is meant by the customers emotional feeling here is a mental state of readiness that arises from the cognitive appraisals of the consumption experience. This response is in turn considered to have a phenomenological tone accompanied by physiological processes, which is often expressed physically (Bagozzi, Gopinath, & Nyer, 1999). Bagozzi et al. (1999) suggested that the reason for these specific actions is to affirm or cope with the emotion,

depending on its nature and meaning for the person having it. While the investigation of the impact of emotions on post-purchase reactions is an important development in consumer marketing, much of the research is concerned with post-purchase behaviours such as customer loyalty, word-of- mouth and re-purchase intentions (Bagozzi et al., 1999). In such cases, indirect measures such as the Net Promoter Score (NPS) – which classifies customers as "Promoters" or "Detractors" (measure of customer loyalty) are used as a measure of organisation performance.

However, more and more organisations also continue to use psychometric ratings scales to obtain direct measures of customer satisfaction. Ratings obtained from these surveys are interpreted as organisation performance and used to aid organisations improve their products or services to increase customer satisfaction in the future. In addition, organisations also use these ratings for marketing purposes to inform future customer choices. In Chapter 2, a framework for obtaining a metric for customer satisfaction – that addresses the multi-criteria nature of the construct and takes into account the asymmetric relationship between satisfaction and quality – was introduced to enable the efficient handling of multi-criteria type satisfaction feedback. Following the acquisition of this data, it is necessary to present these results in a manner that enables the rapid assimilation and understanding of the underlying data. Traditional data presentation formats such as diagrams usually represent disparate portion of piecemeal information that require much in human processing to completely grasp the information conveyed. Thus, the present study aims to impact the legibility of feedback data by using non-verbal means to convey the data. In particular the non-verbal communication power of the face emphasised in Chapter 1 will be used as a means to achieve this.

The feedback data presentation format proposed here can be considered a fundamental extension of the type of data visualisation pioneered by Chernoff (1973), who tried to exploit the idea that people are 'hardwired' to understand faces. However in Chernoffs method, the data display was unnatural and changes in the underlying data resulted in changes in the display to which no meaning could be attributed 'at-a-glance'. The present study builds on the work of Musterle and Rossler (1986) who demonstrated the use of the enhanced versatility of the computer to generate realistic looking faces (Computer Faces). They suggested that provided a suitable mapping is made between the numerical data parameter and outlines of natural FEs, it is possible to convey numerical data using meaningful and realistic facial expressions. Unlike Chernoff faces, this method involves representing a meaningful succession of points in an *n*-dimensional space using realistic

faces. Thus, the method ensures that trajectories between data points automatically acquire natural affective content, which can be interpreted 'at-a-glance'.

The data parameter considered in the present study is the level of satisfaction, therefore it is important to identify which FEs characterise this interaction. Specifically, it is important to identify what FEs of emotion convey different levels of satisfaction so that meaningful mappings can be made between the numerical data and natural FEs. In addition it is necessary to ensure the perceptual validity of the mappings, which impact the accuracy of the data displayed. In order to accurately decode any emotional message from the data display, the receiver needs to first understand the alphabet that consists of the parameters that encode the message. To understand the alphabet the interpreter needs to know the author. Bimler and Paramei (2006) remarked this implies that the process of encoding and decoding emotional FEs is two sides of a coin and how FEs are perceived can only be understood in conjunction with how emotional information is encoded in a facial display. Therefore it is necessary to correctly identify what FEs are naturally used to convey different levels of satisfaction. This would allow the resultant data display to provide an accurate and 'at-a-glance' pictorial model of a collective outcome of satisfaction feedback, which can in turn allow for better comprehension of the data for decision-making.

The past three centuries have seen a rise in research on FEs of emotion in an attempt to fully understand the mechanisms and basis behind the unique ability of humans to generate and recognise the variety of emotional FEs. The following section provides a historical perspective on the research of FEs of emotion to highlight the current methods used to study and characterise FEs. The latter sections report on two psychophysical experiments that were conducted to map FEs of emotion to the traditional one-dimensional *Satisfaction-Dissatisfaction* scale and the two-dimensional *Satisfaction-Requirement Fulfilment* space introduced by Kano et al., (1984).

3.2 Facial Expressions of Emotion: Historical Perspective

The first reported research on facial expressions stems back to the work of Charles Bell in the early 19th century: "expression is to passion what language is to thought" (cit. in Loudon, 1982, p. 2). Bell who studied the anatomy of human expression provided an explanation based on natural theology where he considered FEs to be a divinely created system of human muscles used to express unique human feelings. This resulted in FEs being considered unique

to humans with a special relationship to the 'Creator'. This notion was challenged by Darwin (1872, p. 351): "the young and the old of widely different races, both with man and animals, express the same state of mind by the same movements". In his book, Darwin (1872) illustrated similarities in expressions between humans and animals eliminating the previous concept that FEs were unique to humans. Darwin also carried out initial cross-cultural studies that concluded that human facial expressions were universally recognised and the underlying process was completely biological. This concept of universality implied that emotional FEs serve as stable, predictable, and accurate signals and has settled as the foundation for years of research to come (Aviezer, Hassin, Bentin & Trope, 2008; Ekman, 1993).

3.2.1 Facial Expressions: Conveying Discrete Categories of Basic Emotions

Following Darwin's concept of universality, Tomkins (1962) (the developer of the Affect Theory) directed Ekman (1972) and Izard (1972) to simultaneously pursue cross-cultural research studies on facial expressions by collecting data from isolated literate and preliterate cultures. The results of both studies demonstrated a high degree of cross-cultural agreement in selecting emotion terms that fit facial expressions, supporting Darwin's concept of universality (Ekman, 1972). Following the acquisition of a substantial body of evidence, the categorical approach to studying facial expressions was proposed by Ekman and Friesen (1975). This approach assigned FEs to a limited number of basic emotions, ideally six (*Happiness, Sadness, Anger, Disgust, Fear and Surprise*) in view of these as the building blocks of more complex feeling states.

a) 

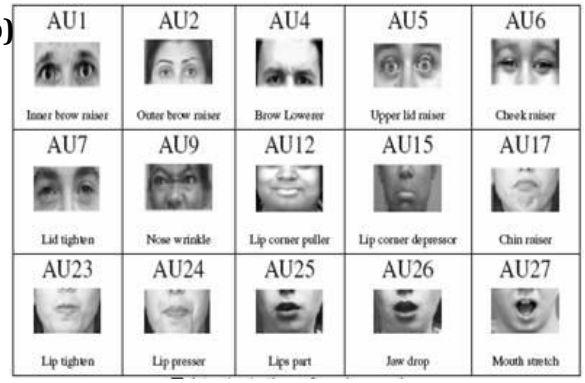
b) 

Figure 3.1. Examples of a) the six basic emotions and b) a selection of Action Units (Tong, 2007).

In order to explain the action of facial features in generating discrete expressions, distinctive changes in the configuration of the facial muscles were separated into action units (AUs) and

ascribed to the basic emotions (Ekman & Friesen, 1976) (Figure 3.1). Ekman and Friesen (1978) developed the Facial Action Coding System (FACS) as a means of quantifying facial movements in terms of these AUs. This approach assumes that all information necessary for recognition of basic FEs is based on their distinctive physical configuration, which is an aggregate of the AUs. These expressions are thus thought to be universal (Ekman, 1993), genetically determined and perceptually discrete signals that are objective in nature. The above concept of universality does not allow for the possibility of a subjective expression signal to change its meaning every time it appears (Carroll & Russell, 1996). This assumption eliminates the possibility of any social or cultural influences in determining the expression and perception of emotional FEs.

Ekman's resulting series of emotional faces (Ekman faces) are widely used to date in research into emotional FEs and the FACS remains the single most comprehensive and commonly accepted method for quantifying FEs (Aviezer et al., 2008). Yet no consensus has been reached about how the AUs work together. One AU is rarely found ascribed to a single emotion label. Conversely, a single emotional expression is found to encapsulate several combinations of AUs. The ranges of AU combinations are so diverse that it is difficult to characterise an emotional FE in terms of a single defining feature using the FACS (Alvarado, 1996; Wallbott & Ricci- Bitti, 1993).

3.2.2 Dimensional Approach to the Study of Facial Expressions

Although Ekman's six basic emotions and FACS are sometimes considered the golden standard, there is however a different branch of research on facial expressions. That challenged the above categorical approach. Following Woodworth's (1938) ingenious idea of a scale of facial expressions, Schlosberg (1941, p. 498) proposed "If it were possible to arrange facial expressions along a continuum, instead of in an indefinite number of categories, it would be possible to obtain some numerical measure of divergence in judgements". Woodworth and Schlosberg (1954) thus pioneered the research on viewing FEs of emotions as continuous signals.

Following experimentation using multidimensional scaling methods, Schlosberg (1954) provided a description of facial expressions in terms of two dimensions in a circular arrangement that he described as being analogous to the circular colour space. The dimensions first identified by Schlosberg were labelled *Attention-Rejection* and *Sleep-Tension* (Schlosberg, 1952; Woodworth & Schlosberg, 1954). Other dimensions that have

been proposed since are a *Control* or *Personal Agency* dimension, which separates anger and disgust from fear and surprise in addition to the *Pleasure-Displeasure* dimension (Frijda, 1969). Russell (1980) followed up work by Schlosberg to develop the *Circumplex Model of Affect* where all of the emotions (based on emotion terms) are characterised by a conjunction of values along two underlying factors that consist of bipolar dimensions (Figure 3.2a). These dimensions were coined *Valence* (pleasant vs. unpleasant) and *Arousal* (activated vs. deactivated). Psychological *Arousal* is generally thought to be increasing along a single axis from most calm (A- in Figure 3.2b) to most exciting (A+ in Figure 3.2b) (Lewis, Critchley, Rotshtein & Dolan, 2007). *Valence* on the other hand cannot be attributed to a single axis as it represents both positive and negative affect. Thus the common formulation of *Valance* is as a bipolar continuum that varies from most happy (P+ in Figure 3.2b) to most sad (P- in Figure 3.2b).

Russell's (1980) circumplex model considers emotional facial expressions to be related to one another by their degree of *Arousal* and *Valence*. This means that expressions can be located next to or distant from each other in a two dimensional circular arrangement. Expressions that share similar degrees of *Arousal* and *Valence* fall adjacent to each other in the circumplex (e.g. anger and disgust) (Figure 3.2a), while those differing in their degrees of *Arousal* and *Valence* will be positioned in non-adjacent locations on the circumplex (Russell, 1980; Russell & Bullock, 1985). It is these dimensional values, but not specific emotion categories, that are thought to be expressed in the face in comparison to the discrete representation proposed by Ekman (1972) (Aviezer et al., 2008).

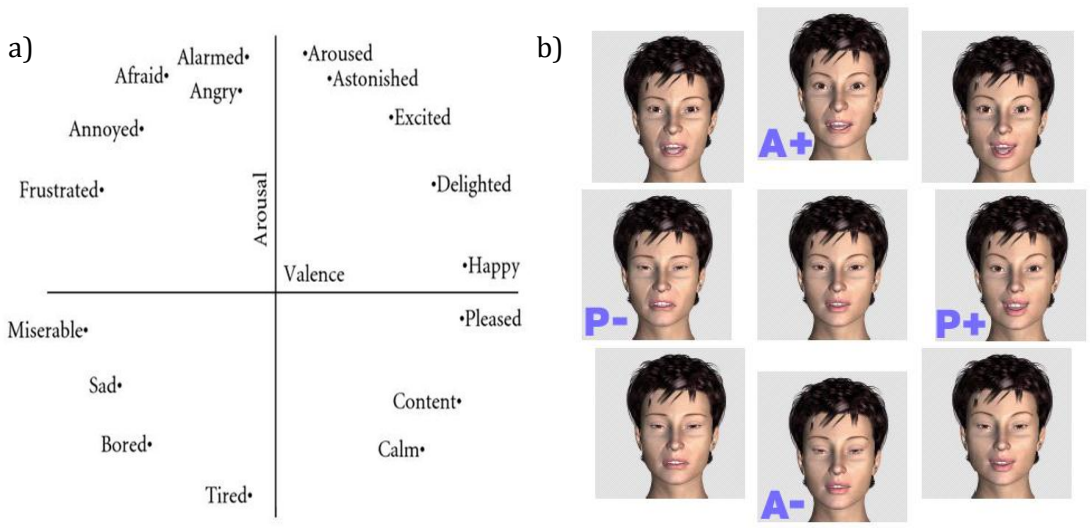


Figure 3.2. Depictions of a) The Circumplex model of Affect (Russell, 1980) and b) A Circumplex model of facial expressions (Grammer, Tessarek & Hofer, 2002).

Further evidence for supporting this model was shown by Russell and Bullock (1985) who carried out a multidimensional scaling experiment with a group of pre-schoolers and a group of adults. The participants were asked to group together pictures of FEs based on degree of similarity. A clear bipolar representation was observed with factors of *Valence* and *Arousal* emerging for both groups. In addition it was observed that the low linguistic proficiency of pre-schoolers did not affect the overall representational structure they generated for the faces (Russell & Bullock, 1985). These findings imply that a more subjective cognitive appraisal results in values of *Valence* and *Arousal* that are then expressed by changes in the facial features accordingly.

It has been found that *Valence* is conveyed predominantly by the mouth width and curvature (Bimler & Paramei, 2006; Breazeal, 2003) while *Arousal* has the greatest impact on the eyes (Morris, DeBonis & Dolan, 2002; Partala, Jokiniemi & Surakka, 2000). These findings are convincing as the general observation of a person's mouth curvature is sometimes sufficient to infer whether the person is feeling happy or sad while observation of a person's eyes can tell if a person is tired or excited. Yet effects of these dimensions of affect on more subtle facial features are not known for certain.

As discussed above, one of the fundamental issues in understanding FEs of emotion is the continuing debate as to whether facial expressions are perceived as varying continuously along underlying dimensions or as belonging to qualitatively discrete categories (Calder, Young, Perrett, Etcoff & Rowland, 1996). Based on a review of literature on perception of FEs of emotion, Bimler and Paremei (2006, p. 20) described FEs at a number of levels; "as an aggregate of individual features such as raised eyebrows and opened mouth; as a gestalt emerging from its features; as a configuration (i.e., topographical relations between facial landmarks)". They further commented that it is an open question as to which level of description is best targeted when studying the facial communication of affect (Bimler & Paramei, 2006). This debate still continues and consequently has had a significant effect on researchers in other disciplines that rely on accurate psychological theories and models of emotion.

3.3 Mapping Facial Expressions to Satisfaction–Dissatisfaction Scales

3.3.1 Purpose

The purpose of this study was to determine for the continuous Satisfaction–Dissatisfaction scale a set of emotional facial expressions that can meaningfully represent it in a pictorial form. Facial muscle actions are important and meaningful components in decoding emotion expressions (Bimler & Paramei, 2006). As described above, FEs of emotion are studied as discrete categories or as continuously varying along two dimensions. The categorical approach links facial features (AUs) to distinct emotion categories while the continuous approach assumes a relationship between facial features and the dimensions of *Valence* and *Arousal*. Although satisfaction is mainly defined as a general affective outcome of varying intensity, it is unclear whether satisfaction is distinct from other emotion categories. Attempts to classify satisfaction into categories have shown that satisfaction and dissatisfaction are neither basic emotions nor central emotional categories in leading theories of emotions (for a review see Bagozzi, Gopinath, & Nyer, 1999). However, it has been found that satisfaction at shares considerable variance with positive emotions such as happiness, joy, gladness, elation, delight, and enjoyment, among others (Shaver, Schwartz, Kirson & O'Connor, 1987).

Although several emotions that are related to the satisfaction and dissatisfaction have been identified, the lack of consensus on these descriptions makes it difficult to attribute specific emotion categories to satisfaction. Therefore, for the purpose of the present study, FEs of emotion that characterise the Satisfaction-Dissatisfaction scale are considered to vary continuously (cf. Schlosberg, 1941; Russell, 1980). Hence, an experimental procedure implying facial expressions as varying continuously was elaborated to address the following research question:

> **Q1**-What facial expressions represent different levels on the Satisfaction scale from '*Extremely satisfied*' to '*Extremely dissatisfied*'?

3.3.2 Method

Participants

Opportunity sampling was used to recruit 48 participants (24 male, 24 female, M_{age}=31.4 years, age range: 16-62 years). Participants were of different ethnicities with a majority being Caucasian and the rest Non Caucasian (Asian, Middle Eastern, African, and Caribbean) (see Table 3.1).

Table 3.1. *Participant demographic characteristics*

Ethnicity	**Number of participants**	**Gender**		**Age (Mean ± SD)**	
		Male	Female	**M**	**F**
Caucasian	31	16	15	34.7±16.1	31.1±11.4
Non Caucasians	48	24	24	30.8±10.1	32.1±12.9
Total	**48**	**24**	**24**	30.8±10.1	32.1±12.9

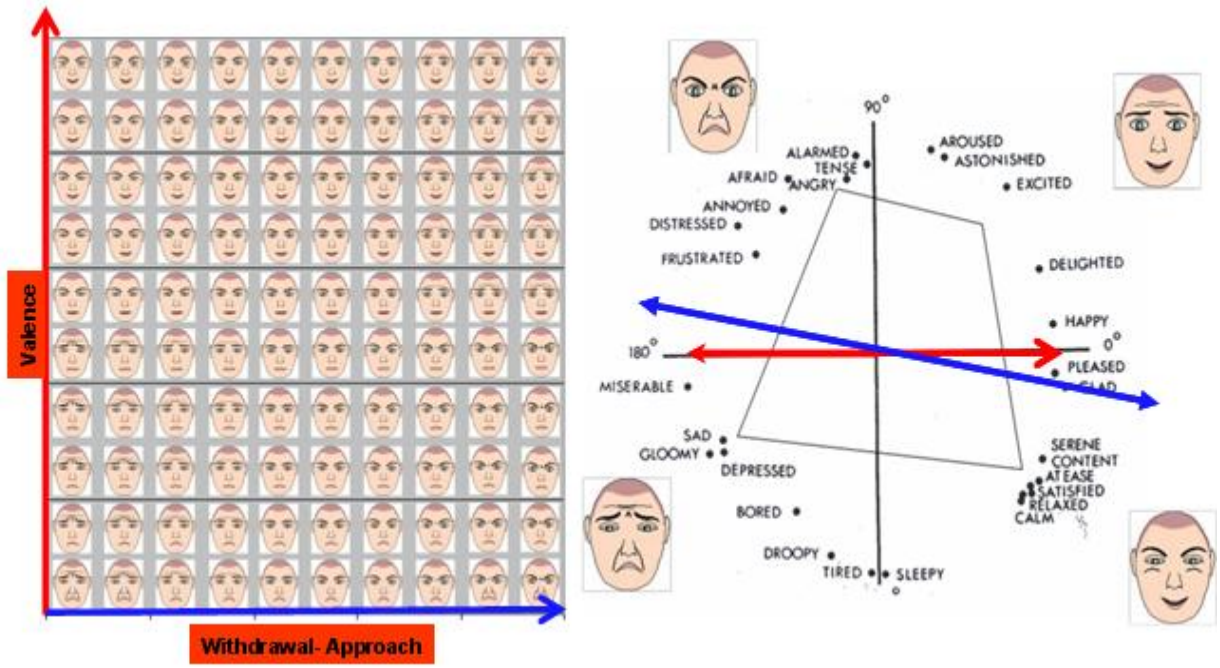


Figure 3.3. Position of stimuli set anchors on Russels two-dimensional scaling solution for 28 English emotion-related words (Adapted from Russell, 1983).

Stimuli

As stimuli, a set of 10x10 emoticons was used (Appendix 1), adopted from the study of Lim and Aylett (2009). The stimuli set provided a semi-realistic but comprehensible FE similar to to outlines. This set of emoticons (although not real faces) consisted of a single male cartoon face whose facial features changed continuously along two dimensions. In the original study, Lim and Aylett (2009) described the stimuli set in terms of the dimensions *Valence* and *Arousal* as illustrated by Russell's Circumplex Model (Russell, 1980). However, the stimuli set does not completely fit Russell's *Valence* (*Pleasure-Displeasure)* and *Arousal* (*Sleep-Tension*) dimensions (see Figure 3.3).

In order to create the emoticon set, Lim and Aylett (2007) varied three facial features: mouth, eyes and eyebrows while relating the changes to the *Valence* (vertical dimension) and *Arousal* (horizontal dimension). Each dimension is represented by changes in the above facial features. Previous research on emotional facial expressions showed that *Valence* is conveyed predominantly by the mouth width and curvature (Bimler & Paramei, 2006; Breazeal, 2003). In the emoticon set used, the increase of *Valence* is conveyed by the change in lip curvature from an upturn U to downturn U as seen in Figure 3.4.

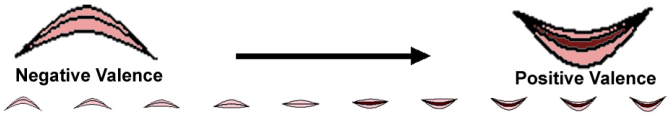


Figure 3.4. Variation of mouth curvature along the Valence dimension.

In comparison, *Arousal* has the greatest impact on the eyes (Morris, DeBonis & Dolan, 2002; Partala, Jokiniemi & Surakka, 2000). Thus in the stimuli, the size of the eye opening increases in a linearly proportional manner with change in *Arousal* from low *Arousal to* high *Arousal* as seen in Figure 3.5.

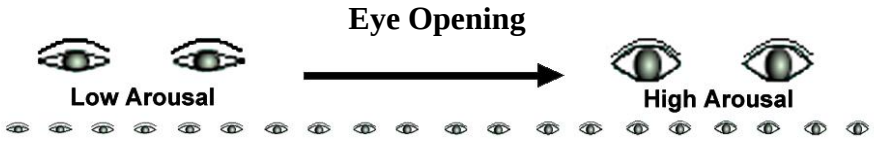


Figure 3.5. Variation of Eye Opening along the Arousal Dimension.

The curvature and excursion of eyebrows have also been found to be significant for facial expression recognition (Sadr et al., 2003). Thus in the emoticon set used eyebrow curvature varies with both *Valence* and *Arousal* as seen in Figure 3.6.

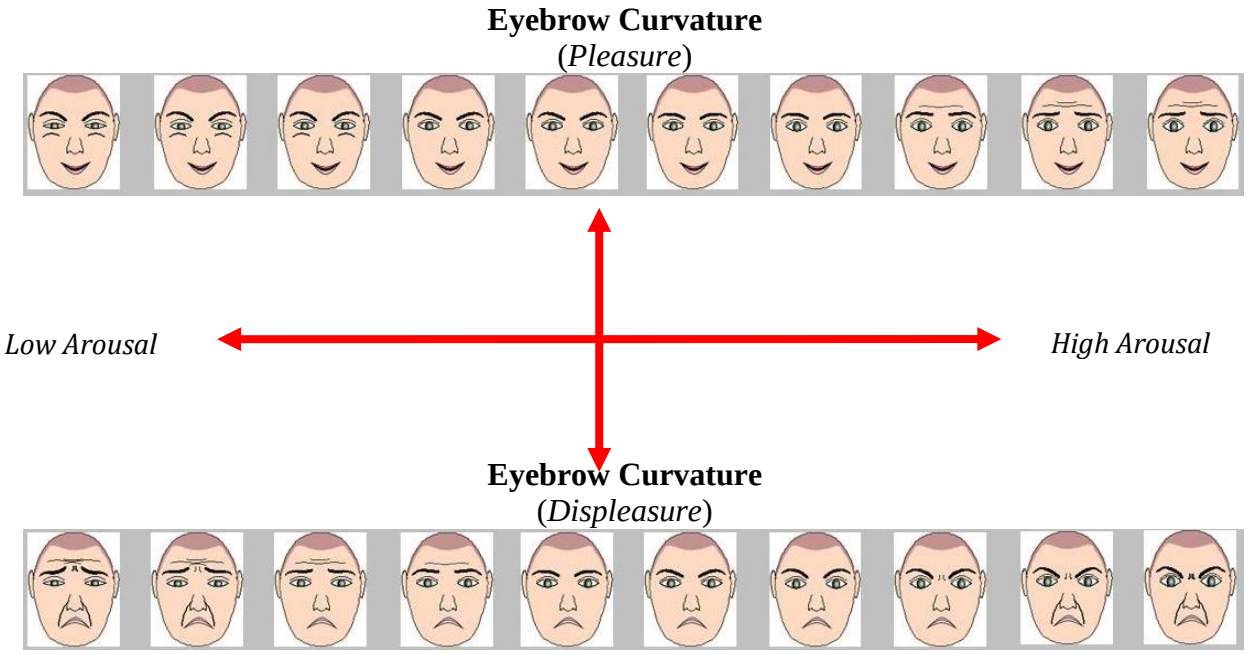


Figure 3.6. Variation of Eyebrow curvature along Valence and Arousal Dimensions.

When the *Valence* is positive (*Pleasure*), change from low *Arousal* to high *Arousal* is reflected in the change of eyebrow curvature from a V shape to a more straightened shape. Forehead wrinkles also become apparent with the increase of *Arousal*. On the other hand, when the *Valence* is negative (*Displeasure*) the opposite takes place whereby change from low *Arousal* to high *Arousal* is reflected in the change of eyebrow curvature in the opposite direction with a wider range of curvatures (Figure 3.6). Wrinkles appear on the forehead of sad faces in the low *Arousal* end of the dimension while a furrow appears in the high *Arousal* end. Additional facial features seen in the emoticon set include a cheek raiser visible below the eyes used to denote cases of extreme pleasure (maximum +ve *Valence*) and naso-labial furrow in cases of extreme displeasure (minimum –ve *Valence*).

The *Valence* dimension of the stimuli set clearly distinguishes positive emotions from negative emotions with angry and sad faces at the bottom of the stimuli set and happy faces at the top of the stimuli set. Therefore the affective dimension *Valence* was retained to describe this dimension in the present study. As described in Chapter 2, satisfaction is mostly defined as a general affective response of varying intensity (Giese & Cote, 2002). It is also the general agreement in consumer marketing literature, that when a product or service falls below the customer's expectations, the customer displays negative emotions and if a product

or service meets or exceed expectations the customer responds with positive emotions (Oliver, 1993b; Oliver & Westbrook, 1993). As described earlier, *Valence* is a subjective feeling of pleasantness or unpleasantness. Similarly satisfaction is often defined as the pleasure or displeasure experienced as a result of a consumption experience. Relationships have been found between positive emotions and satisfaction, and negative emotions and dissatisfaction. Research on consumption experience have also found that positive *Valence* is an increasing function of satisfaction while negative *Valence* is a decreasing function of satisfaction. Based on this, it can be anticipated that when a customer is satisfied this will be displayed by FEs with positive *Valence* and when the customer is dissatisfied this will be conveyed using FEs with negative *Valence*.

However, based on the dimensional approach to the study of facial expression, the expression of Satisfaction-Dissatisfaction cannot only be related to *Valence*. Studies in consumption emotions tend to use *Arousal* to explain intensity of pleasure or displeasure experienced. However a clear link between *Arousal* and satisfaction has not been found. In addition, as the present study is more interested on the expression of FEs in relation to satisfaction rather than the implicit feeling experienced during a certain consumption experience. Therefore, in order to distinguish the dimension separating the content and sad faces from excited and angry faces, FEs of emotions can be understood in respect to the implicit basic behavioural tendencies (Paramei & Schneider, 1994). With respect to the classification of behavioural tendencies, several theories propose the dimension of *Withdrwal-Approach* tendencies or *Attack-Affiliate* tendencies (for a review see Bagozzi et al, 1999). In line with the objective of the present study, it is useful to know which of these behaviours will be expressed in the face for different levels of *Satisfaction-Dissatisfaction*.

In a study of Chernoff-type schematic faces, where only mouth curvature and eyebrow slant were varied, Paramey, lzrmailov, and Babina (1992 cit. in Paramei & Schneider, 1994) characterised emotional expressions as "active vs. reactive". This classification based on behavioural tendencies assumes that active expressions reflect emotions directed at, rather than produced by, a feature of the inner or outer environment (Stringer, 1967, p.78 cit. in Paramei & Schneider, 1994). Based on this the behavioural tendency dimension *Reactivity* was used to describe the dimension separating the content and sad faces from excited and angry faces.

As described in Chapter 2, affect is found to mediate the relationship between the attribution process – the perceived cause of the emotion – and satisfaction in one-dimensional satisfaction models (Oliver, 1993b). Furthermore, Oliver (1996) suggested that anger is often

exhibited in complaint situations where the customer attributes the performance failure to the product or service provider (directed at). Therefore, FEs that display levels of anger can be described as 'active' revealing emotions directed at the provider. On the contrary, sadness is considered inward oriented, and in the consumer satisfaction domain, more likely attributed to circumstances beyond the control of a provider (Bagozzi et al, 1999). Therefore, FEs in the stimuli set that displays sadness can be labelled 'passive' indicating the inward nature of the emotion expressed in the face. In the case of positive *Valence*, expressions of content (portraying less activated facial features) can be thought of as inward oriented and thus labelled 'passive' while expressions portraying activated facial features can be linked to a perceived cause of satisfaction and thus labelled 'active'. Therefore, it is logical to maintain that any FE of emotion that is analysed in this study, in its relationship to the *Satisfaction-Dissatisfaction,* can be classified in terms of its *Valence* and *Reactivity*.

These dimensions were then assigned numerical values. Labelling the underlying dimensions of the stimuli set serves the purpose of creating two continuous interval scales for the dimensions *Valence* ($-0.5 \leq V \leq 0.5$) and *Reactivity* ($0.1 \leq R \leq 1.0$). The stimuli set is thus assumed to vary along two dimensions, *Valence* and *Reactivity*; whereby the degree of these is conveyed by changes in certain featural characteristics.

Design

To obtain subjective Satisfaction-Dissatisfaction scales attributed by FEs, two kinds of psychophysical methods (Category Scaling and Magnitude Estimation) were used. A scale is a rule by which numbers are assigned to objects or events (Ehrenstein & Ehrenstein, 1999), and scaling methods in psychophysics deal with ordering and distributing stimuli along a perceptual dimension (Wegener, 1983).

In a category scaling (CS) task the participant is provided with a limited number of ordered response categories and is instructed to place the stimulus of a series with the lowest subjective magnitude into the lowest category available and the stimulus with the highest subjective magnitude into the highest and the subsequent stimuli of the series in between according to the perceived sensational strength of the stimuli (Wegener, 1983). This method assumes that the subjective width between categories is equal thus a category scale can be assumed to be an interval scale.

In comparison, in a magnitude estimation (ME) method, no response categories are provided. Instead, a stimulus is presented and the observer is asked to rate it numerically (Gescheider, 1988) so that the ratios of the numbers correspond to the "ratios" of the

subjective magnitudes of the stimuli series (Wegener, 1983). As magnitude estimations map subjective "ratios" into numerical ratios, ME scales can be assumed to be ratio scales. Some practitioners provide a reference or anchor, and some don't, allowing the observer to use their own scale (Pelli & Farell, 1995).

Usually category scales with 4–11 response alternatives are used to measure the sensational strength or intensity of a certain stimuli, with five being the most popular (Pelli & Farell, 1995). Often these scales are associated with numbers, words or graphical symbols known as ‘labels’, ‘qualifiers’ or ‘anchors’ (Cools, Hofmans, & Theuns, 2005). As described in Chapter 2, measurements of customer satisfaction are most commonly obtained using psychometric scales with 5, 7, 9, or 10 response alternatives. In the case of measuring satisfaction in as an attitude the highest number of the scale corresponds to the '*Extremely satisfied*' anchor and the lowest to the *'Extremely dissatisfied*' one. Successfully mapping FE of emotion to these satisfaction scales could provide the ability to obtain a natural FE depiction for numerical data obtained using any of the above scales.

Procedure

Along with the stimuli set described earlier, a vertical satisfaction-dissatisfaction scale was presented (top ‘*Extremely satisfied*’ anchor and bottom ‘*Extremely dissatisfied*’) to participants on a computer monitor in four different response formats (Appendix 2). In three conditions the response format implied the method of category scaling with 5, 7 or 9 equally spaced divisions. Here, participants were requested to drag and drop emoticons from the FE stimuli set onto the response formats provided. Their task was to choose from the FE set emoticons that, in their opinion reflected the corresponding level of satisfaction on the 5-, 7-, or 9- category scale.

In the fourth condition, a magnitude estimation (ME) method was used without any explicit divisions or numbers. Here, participants were requested to choose ten emoticons placing them at deliberate positions between the top ‘*Extremely satisfied*’ anchor and the bottom ‘*Extremely dissatisfied*’ anchor. In the latter it was explicitly indicated that the chosen emoticons can overlap or have gaps between them in the ME scale. In the experiment, the order of presentation of the four tasks was counterbalanced among the participants (4! =24).

3.3.3 Results

Frequency Analysis of emoticon choices for satisfaction scale anchors

A frequency analysis was carried out to identify the emoticons chosen to represent the two anchors, '*Extremely satisfied*' (**Green**) and '*Extremely dissatisfied*' (**Red**), as well as the neutral (**Yellow**) position on the four Satisfaction-Dissatisfaction scales (Appendix 3). The emoticons that had a selection frequency >10% were selected and investigated further.

For the '*Extremely satisfied*' anchor, a single consensual emoticon that represented the anchor was not identified. However, all the emoticons that had a selection frequency >10% shared the same *Valence* (+ve). Emoticon 'i1a' had the highest selection frequency across all four response formats (Figure 3.7). Nevertheless, expect for the ME scale, none of the other 3 scales had selection frequencies greater than 25% for this emoticon. The 5-point scale had the lowest selection frequency for this emoticon (19%). Three emoticons had selection frequency >10% for the 7-point scale (emoticons 'i1a', 'i3a' and 'i7a'). Two emoticons had selection frequency >10% for the 9- and ME scales. The selection frequencies for emoticons 'i1a' and 'i7a' were quite similar for the 7- and 9- point scales.

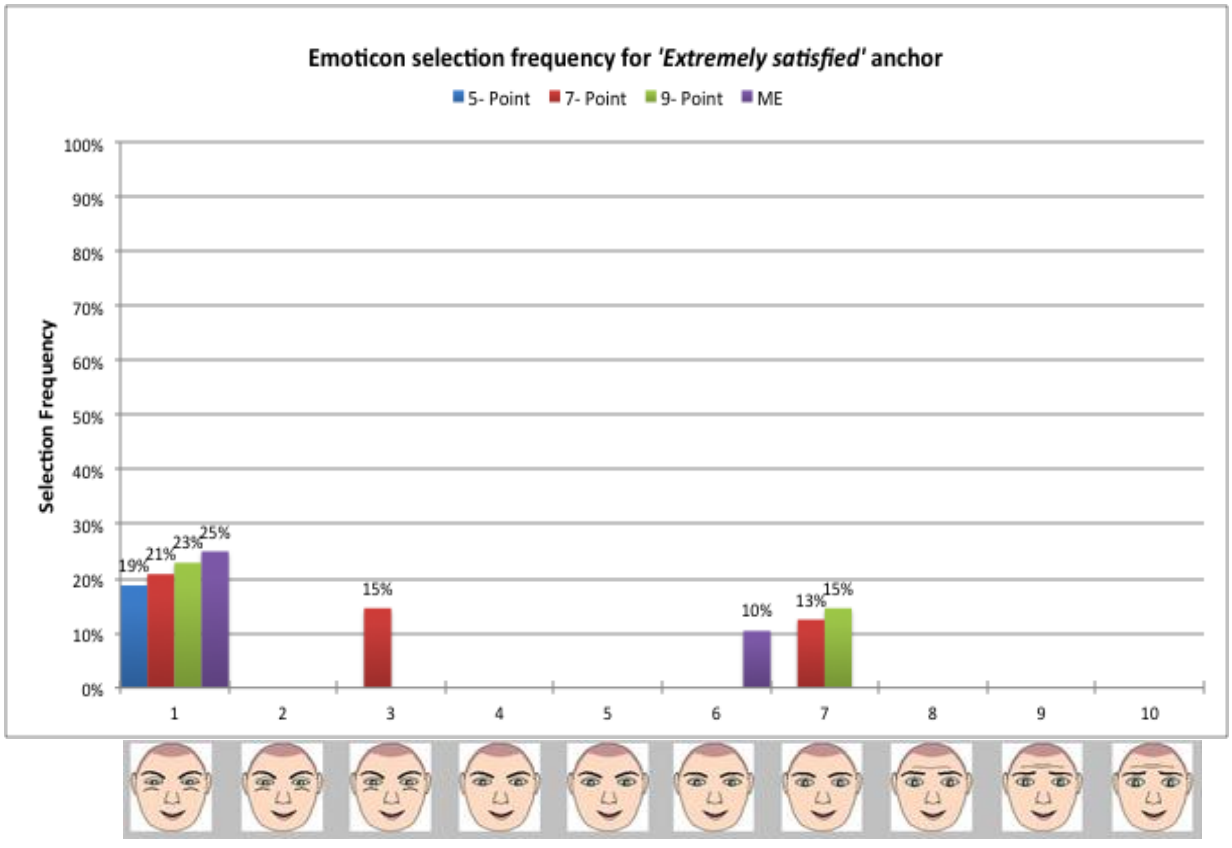


Figure 3.7. Emoticons selected to represent the '*Extremely satisfied*' anchor for the four satisfaction scales (Selection frequency >10).

A range of emoticons along the dimensions of *Valence* and *Reactivity* were selected to represent the mid-point in each of the 3 category scales (see Appendix 3). Emoticon 'i5f' was found to have the highest selection frequency in all three scales, however the selection frequency of this emoticon was below 25% for all three scales (Figure 3.8).

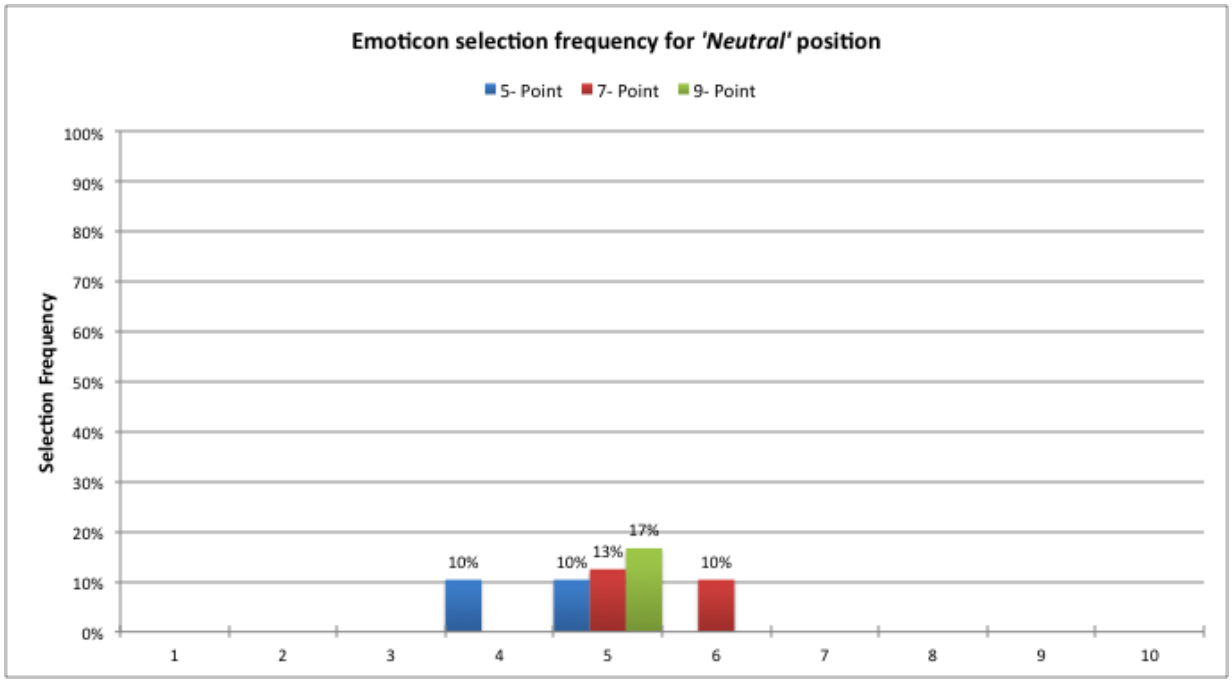


Figure 3.8. Emoticons selected to represent the 'Neutral' position for the three satisfaction scales (Selection frequency >10).

For the ME scale the image selected to represent the midpoint of the scale was considered as the neutral choice (scale median ± SD). The results of the ME scale distribution indicated a predominant choice of a – ve *Valence* emoticons for the neutral position. Thus, subjective distances between the neutral and the '*Extremely satisfied*' anchor were less than that of the neutral and '*Extremely dissatisfied*' anchor indicating an asymmetry in the one-dimensional satisfaction scale.

Similar to the '*Extremely satisfied*' anchor, a consensual emoticon was not identified for the '*Extremely dissatisfied*' anchor across all response formats. Furthermore, all the emoticons that had a selection frequency >10% also shared the same *Valence* (-ve). However the emoticons that had high selection frequency were clustered at extremes of the *Reactivity* dimension (Figure 3.9). Two emoticons ('i1j' and 'i10j'), had the highest selection frequencies above 15% for all four scales. For the 5- point scale, both emoticons 'i1j' and 'i10j' had response frequencies above 25% (25% and 27% respectively). For the 9- point scale, emoticon 'i9j' also had a selection frequency over 15%. It is worth noting here that

emoticon ‘i1a’ represents a sad face while emoticons ‘i9j’ and ‘i10j’ represent angry faces. Emoticon ‘i10j’ (corresponding to the angry face) had the highest selection frequency across all four response formats. It is also observed that as the number of scale points increased, the response frequency of emoticon ‘i1a’ decreased while that of emoticon ‘i10j’ increased. A similar bifurcation of the choices along the *Reactivity* dimension also appears in the ‘*Extremely satisfied*’ anchor for the 7-, 9- category scales and the ME scale but is less distinct compared to the bifurcation at the ‘*Extremely dissatisfied*’ anchor. On the contrary, for the ‘*Extremely satisfied*’ anchor, the selection frequency for emoticons that fell on the high *Reactivity* end of the scale decreased while those on the low *Reactivity* end increased with the number of scale points (Figure 3.7).

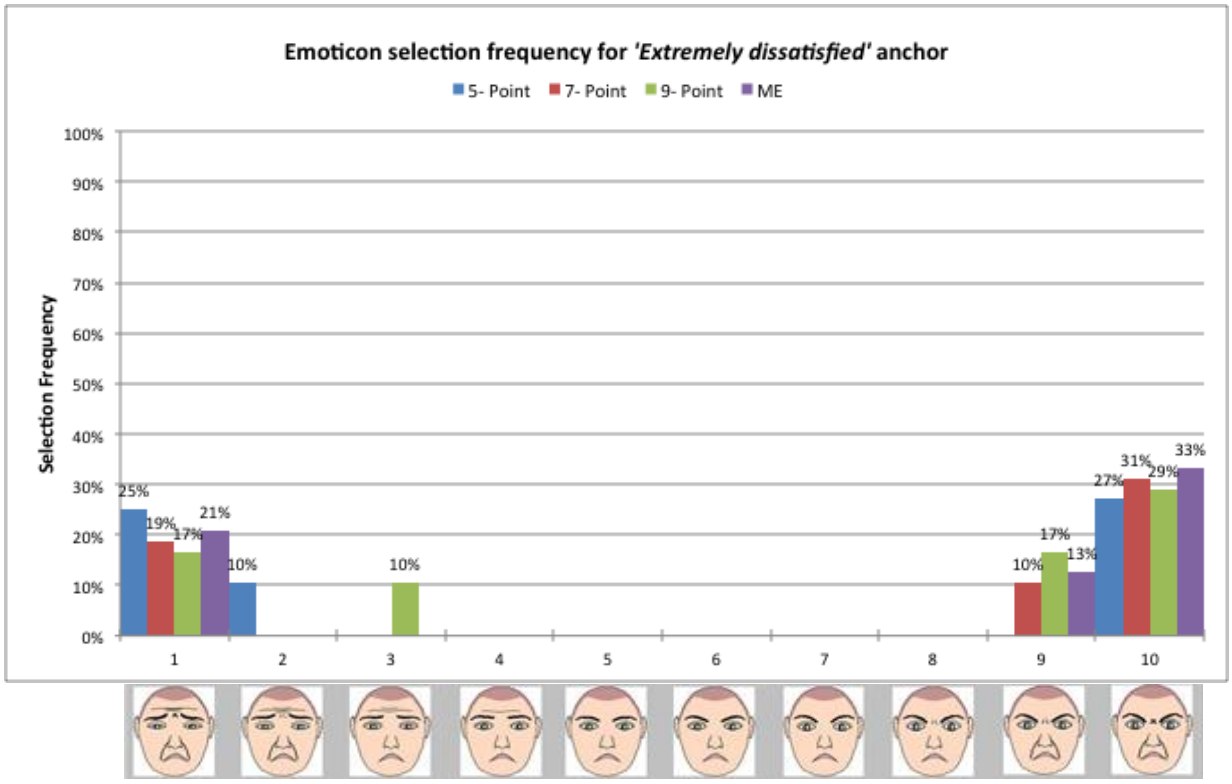


Figure 3.9. Emoticons selected to represent the ‘Extremely dissatisfied’ anchor for the four satisfaction scales (Selection frequency >10).

Figure 3.10 displays the summary of the selections for each of the four scales. The darker shades indicate the emoticons that had the highest selection frequencies. The curves illustrate various combinations of the choices that may differ along the *Valence* - *Reactivity* dimension with satisfaction. Due to the range of emoticons selected to represent the anchor points and the observed bifurcation described above, the *Reactivity* dimension was split into 2

behavioural categories which split the angry expressions from the sad expressions and further analysed (**Passive,** *Reactivity*<=0.5; **Active,** *Reactivity*>0.5) (Figure 3.11).

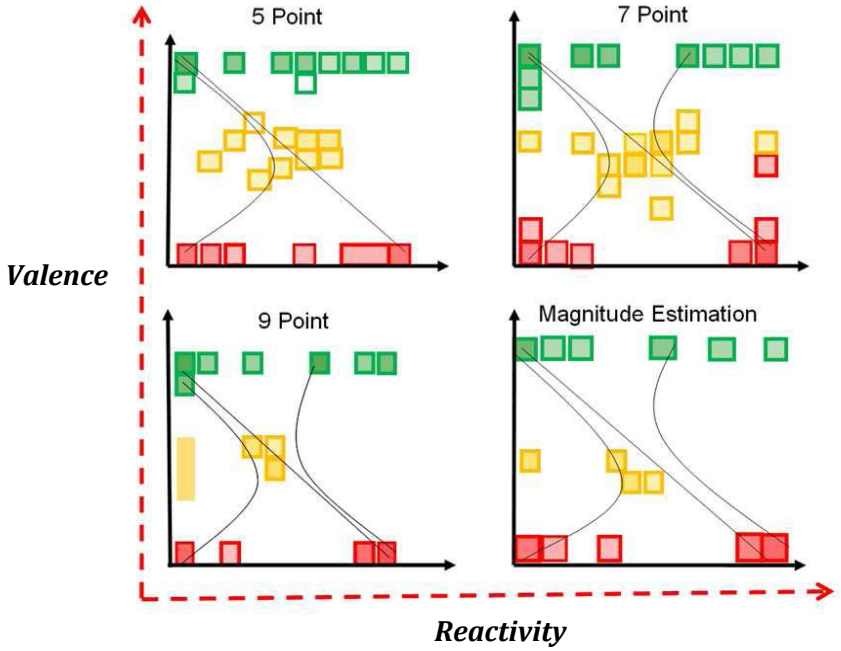


Figure 3.10. Distribution of selected emoticons along the dimensions of *Valence-Reactivity* for each of the four response formats.

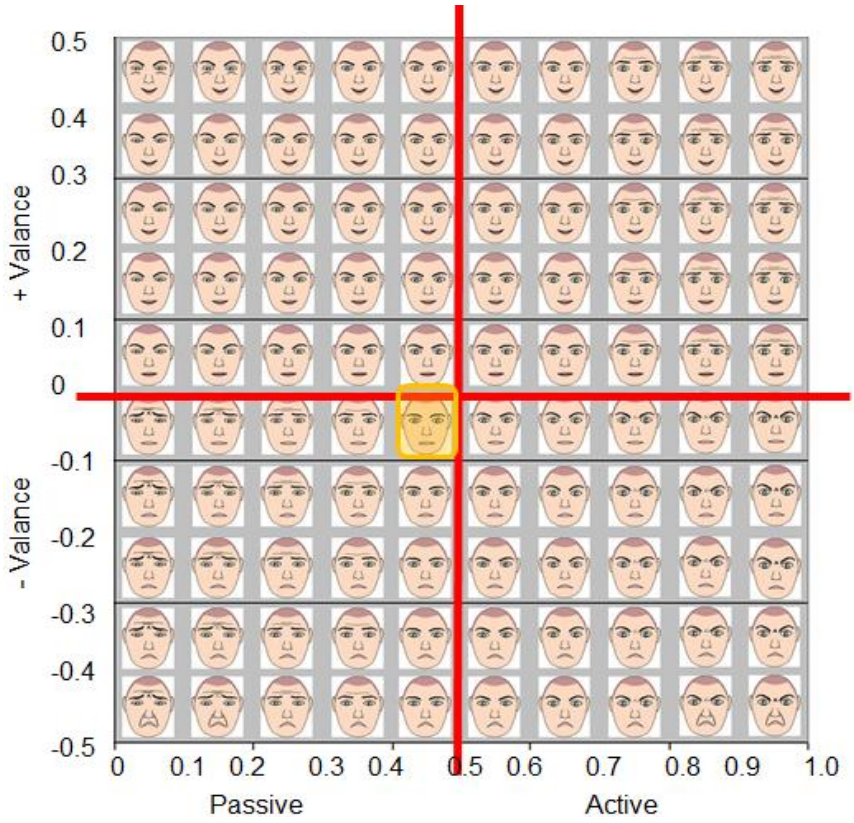


Figure 3.11. Emoticon *Valence* and *Reactivity* dimensions

Frequency Analysis of emoticons based on *Reactivity* for each response category

The selection frequency for high *Reactivity* (Active) and low *Reactivity* (Passive) emoticons were calculated for each category in the four response formats. A Chi square test (χ^2) was used to test whether there was a significant difference between the selection of active and passive expressions for each position on the satisfaction scale. For the Chi square test, the null hypothesis states that there is no significant difference between the expected and observed result. For the purpose of this study the selection frequency of passive expressions was compared to that of active expressions where a *p* value <0.05 indicates that the null hypothesis is rejected. These results are displayed in Tables 3.2, 3.3, 3.4 and 3.5.

Table 3.2. *Comparison of the Selection Frequency of High Reactivity (active) and Low Reactivity (Passive) Emoticons for the 5- point category scale*

		Selection Frequency (%) (*n*=48)				
		Satisfaction				
		1	2	3	4	5
Reactivity (R)	*R* <=0.5 (Passive)	50.0	75.0	56.3	58.3	62.5
	R >0.5(Active)	50.0	25.0	43.8	41.7	37.5
	χ^2	.000	12.000	.750	1.333	3.000
	Significance *(p)*	1.000	.001	.386	.248	.083

Table 3.3. *Comparison of the Selection Frequency of High Reactivity (angry) and Low Reactivity (sad) Emoticons for the 7- point category scale*

		Selection Frequency (%) (*n*=48)						
		Satisfaction						
		1	2	3	4	5	6	7
Reactivity (R)	*R* <=0.5 (Passive)	41.7	64.6	62.5	52.1	58.3	60.4	58.3
	R >0.5(Active)	58.3	35.4	37.5	47.9	41.7	39.6	41.7
	χ^2	1.333	4.083	3.000	.083	1.333	2.083	1.333
	Significance *(p)*	.248	.043	.083	.773	.248	.149	.248

Table 3.4 *Comparison of the Selection Frequency of High Reactivity (angry) and Low Reactivity (sad) Emoticons for the 9- point category scale*

		Selection Frequency (%) (*n*=48)								
		Satisfaction								
		1	2	3	4	5	6	7	8	9
Reactivity (R)	*R* <=0.5 (Passive)	39.6	66.7	54.2	70.8	68.8	58.3	68.8	50.0	58.3
	R >0.5(Active)	60.4	33.3	45.8	29.2	31.3	41.7	31.3	50.0	41.7
	χ^2	2.083	5.333	.333	8.333	6.750	1.333	6.750	.000	1.333
	Significance *(p)*	.149	.021	.564	.004	.009	.248	.009	1.000	.248

Table 3.5 *Comparison of the Selection Frequency of High Reactivity (angry) and Low Reactivity (sad) Emoticons for the ME scale*

		Selection Frequency (%) (*n*=48)									
		Satisfaction									
		1	2	3	4	5	6	7	8	9	10
Reactivity (R)	*R* <=0.5 (Passive)	41.7	56.3	52.1	58.3	62.5	68.8	60.4	50.0	58.3	58.3
	R >0.5(Active)	58.3	43.8	47.9	41.7	37.5	31.3	39.6	50.0	41.7	41.7
	χ^2	1.333	.750	.083	1.333	3.000	6.750	2.083	.000	1.333	1.333
	Significance *(p)*	.248	.386	.773	.248	.083	.009	.149	1.000	.248	.248

The results above indicate that for the '*Extremely dissatisfied*' anchor and the '*Extremely satisfied*' anchor (Satisfaction =1) of each response format, there was no significant difference between the participants who selected active and passive emoticons indicating a bifurcation of choices along the *Reactivity* dimension. The same is the case for the '*Extremely satisfied*' anchor (Satisfaction=5, 7, 9 and 10). For the position in the scale where Satisfaction =2, a significant number of participants selected passive emoticons compared to active emoticons for the 5-, 7- and 9- scale. Although the number of participants that selected passive emoticons was higher for this position on the ME scale, the difference was not statistically significant.

It can be observed from the data set that the selection frequency for passive emoticons was higher than that for active emoticons for the 7- point, 9-point and ME scale except for the '*Extremely dissatisfied*' position. Although the selection frequency of active faces was higher for this position, the difference was not statistically significance. An interesting observation is the increase in selection frequency of active emoticons when the level of satisfaction reduces from 2 to 1 in the scale ('*Dissatisfied'* to '*Extremely dissatisfied'*).

For the 9- point scale four positions provided statistically significant differences in the selection frequency of passive and active emoticons. For these points (on either side of the neutral position), more participants selected passive emoticons than active emoticons. This indicates that the 9- point scale provides participants more discrimination between scale categories compared to the 5- and 7- point scales. While the ME scale did include an additional emoticon assignment, the inability of the participants to discriminate *Reactivity* for this scale could be an indication of cognitive overload as subjects might be finding it difficult to distinguish reliably between adjacent categories. In addition the lack of categories boundaries on ME scale might have influenced this.

Frequency Analysis of emoticons based on *Reactivity* and Gender for each response category.

The same analysis conducted above was carried out on male and female data sets separately to investigate the impact of gender on the selection frequency of active and passive emoticons. The results are displayed in Tables 3.6, 3.7, 3.8 and 3.9.

Table 3.6. *Comparison of the Selection Frequency of High Reactivity (angry) and Low Reactivity (sad) Emoticons based on Gender for the 5- point category scale*

Selection Frequency (%)

(Male *n*=24) (Female n=24)

		Satisfaction									
		1		2		3		4		5	
		Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Reactivity (R)	*R* <=0.5 (Passive)	62.5	37.5	79.2	70.8	66.7	45.8	70.8	45.8	58.3	66.7
	R >0.5(Active)	37.5	62.5	20.8	29.2	33.3	54.2	29.2	54.2	41.7	33.3
	χ^2	1.500	1.500	8.167	4.167	2.667	.167	4.167	.167	.667	2.667
	Significance *(p)*	.221	.221	.004	.041	.102	.683	.041	.683	.414	.102

Table 3.7. *Comparison of the Selection Frequency of High Reactivity (angry) and Low Reactivity (sad) Emoticons based on Gender for the 7- point category scale*

Selection Frequency (%) (*n*=48)

(Male *n*=24) (Female n=24)

		Satisfaction													
		1		2		3		4		5		6		7	
		M	F	M	F	M	F	M	F	M	F	M	F	M	F
Reactivity (R)	*R* <=0.5 (Passive)	50.0	33.3	75.0	54.2	66.7	58.3	50.0	54.2	62.5	54.2	70.8	50.0	58.3	58.3
	R >0.5(Active)	50.0	66.7	25.0	45.8	33.3	41.7	50.0	45.8	37.5	45.8	29.2	50.0	41.7	41.7
	χ^2	.000	2.667	6.000	.167	2.667	.667	.000	.167	1.500	.167	4.167	.000	.667	.667
	Significance *(p)*	1.000	.102	.014	.683	.102	.414	1.000	.683	.221	.683	.041	1.000	.414	.414

For the 5- point scale it was observed that female participants predominantly selected active emoticons while a majority of male participants selected passive emoticons for the '*Extremely dissatisfied*' scale position. However this inferred correlation was not statistically significant. For the '*dissatisfied*' position (satisfaction =2) in the 5- point scale, both male and female participants had a significantly higher selection frequency of passive emoticons. Male participants displayed this selection for the '*dissatisfied*' position in the 7- and 9- point scale

as well. As the number of scale points increased from 5- to 7- , female participants selected more active emoticons. The same was observed for the '*Extremely dissatisfied*' scale position although this difference in selection frequency was not statistically significant. The female selection frequencies for the '*dissatisfied*' position remained constant for the 9- and ME scale. Male participants displayed a fluctuation in selection frequencies for passive and active emoticons between the points 2 to 4 for the 5- point scale. For the 7- point scale this fluctuation was observed between points 2 to 6 and for the 9- point between points 2 to 4 and 5 to 7. For the ME scale this fluctuation was observed between the points 4 to 6 and 6 to 9. These fluctuations seem to occur on either side of the mid-point. Although a similar fluctuation of selection frequencies was observed for the female participants, this was not statistically significant.

These results also indicate that as the number of scale points increase more discrimination between scale points is made. As a result participants might be able to map expressions better. Male participants showed more discrimination compared to female participants across all response formats. However the fluctuations could also indicate differences in behavioural threshold for the male and female participants. What is meant by threshold here is a level of Satisfaction or Dissatisfaction one may reach before their behaviour is changed.

Table 3.8. *Comparison of the Selection Frequency of High Reactivity (angry) and Low Reactivity (sad) Emoticons based on Gender for the 9- point category scale*

		Selection Frequency (%) (*n*=48) (Male *n*=24) (Female n=24)																	
		Satisfaction																	
		1		2		3		4		5		6		7		8		9	
		M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
Reactivity (R)	*R* <=0.5 (Passive)	45.8	33.3	79.2	54.2	66.7	41.7	75.0	66.7	79.2	58.3	50.0	66.7	79.2	58.3	54.2	45.8	66.7	50.0
	R >0.5(Active)	54.2	66.7	20.8	45.8	33.3	58.3	25.0	33.3	20.8	41.7	50.0	33.3	20.8	41.7	45.8	54.2	33.3	50.0
	χ^2	.167	2.667	8.167	.167	2.667	.667	6.000	2.667	8.167	.667	.000	2.667	8.167	.667	.167	.167	2.667	.000
	Significance *(p)*	.683	.102	.004	.683	.102	.414	.014	.102	.004	.414	1.000	.102	.004	.414	.683	.683	.102	1.000

Table 3.9. *Comparison of the Selection Frequency of High Reactivity (angry) and Low Reactivity (sad) Emoticons based on Gender for the ME scale*

		Selection Frequency (%) (*n*=48) (Male *n*=24) (Female n=24)																			
		Satisfaction																			
		1		2		3		4		5		6		7		8		9		10	
		M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
Reactivity (R)	*R* <=0.5 (Passive)	45.8	37.5	58.3	54.2	54.2	50.0	75.0	41.7	66.7	58.3	70.8	66.7	62.5	58.3	54.2	45.8	70.8	45.8	54.2	62.5
	R >0.5(Active)	54.2	62.5	41.7	45.8	45.8	50.0	25.0	58.3	33.3	41.7	29.2	33.3	37.5	41.7	45.8	54.2	29.2	54.2	45.8	37.5
	χ^2	.167	1.500	.667	.167	.167	.000	6.000	.667	2.667	.667	4.167	2.667	1.500	.667	.167	.167	4.167	.167	.167	1.500
	Significance *(p)*	.683	.221	.414	.683	.683	1.000	.014	.414	.102	.414	.041	.102	.221	.414	.683	.683	.041	.683	.683	.221

Central Tendencies of Valence and Reactivity for different levels of Satisfaction

Measures of central tendency were computed to deduce the values for *Valence* and *Reactivity* for each division on the category scales and each successive position in the ME scale. Figures 3.12 and 3.13 displays the variation of *Valence* and *Reactivity* of the emoticon choices with the satisfaction for each of the four response formats. In each response formats it is observed that *Valence* increases with Satisfaction in a linearly proportional manner while *Reactivity* fluctuates for low levels of Satisfaction. As Satisfaction increases the *Reactivity* becomes constant with smaller fluctuations in *Reactivity*. Male participants showed higher mean *Valence* compared to female participants for the 7- and 9- point scales. On the contrary, Female participants showed higher mean *Reactivity* compared to male participants across all response formats. The 9- point scale also shows more discrimination in the positive end of the scale with more fluctuations in *Reactivity* with increase in Satisfaction from the neutral. Although the levels of Reactivity are not exactly the same, only the 9- point scale shows similar discrimination for male and female participants (observed by the peaks and troughs of Figure 3.12).

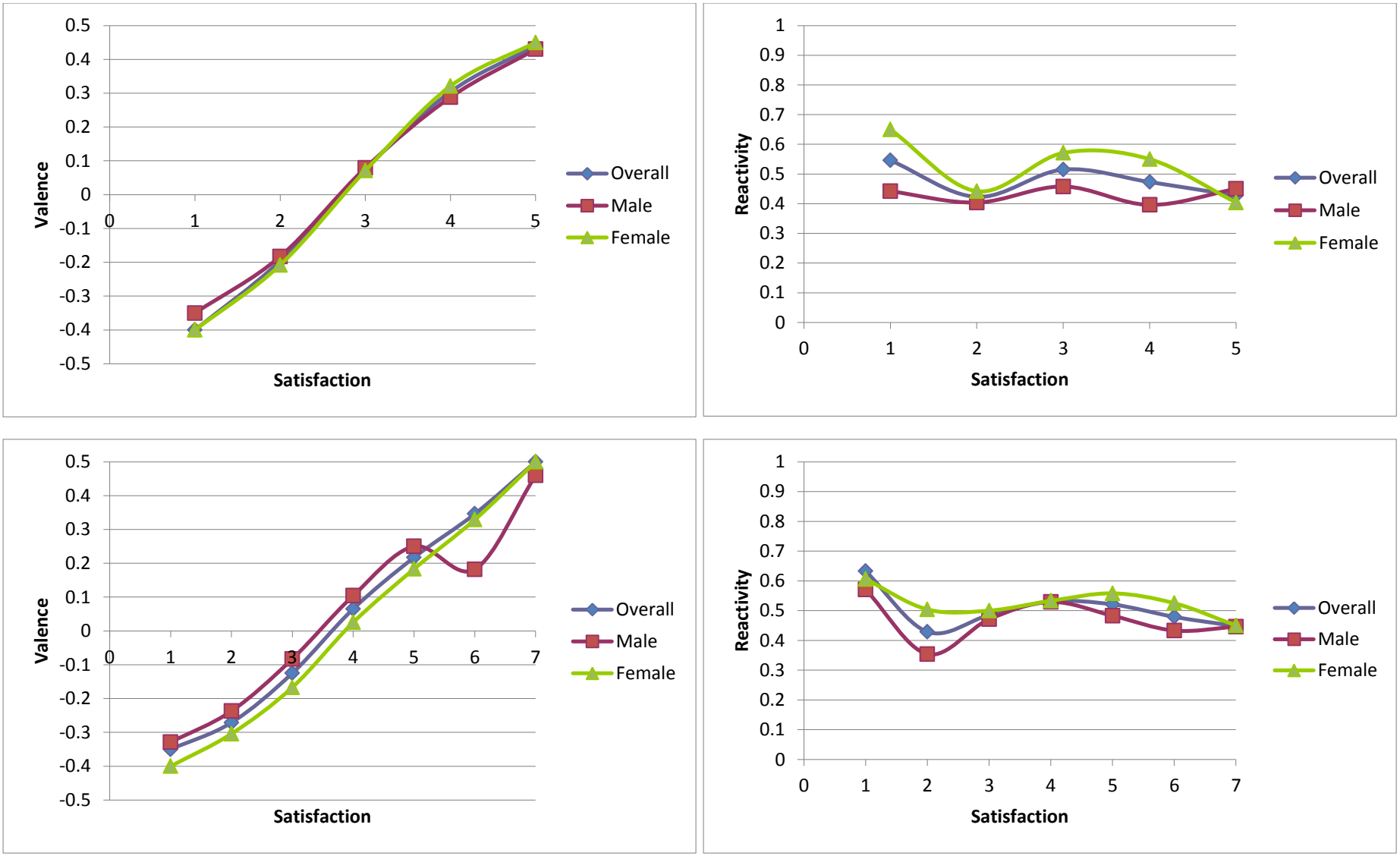


Figure 3.12. Relationship of *Valence* and *Reactivity* with Satisfaction for the 5- point and the 7- point category scales

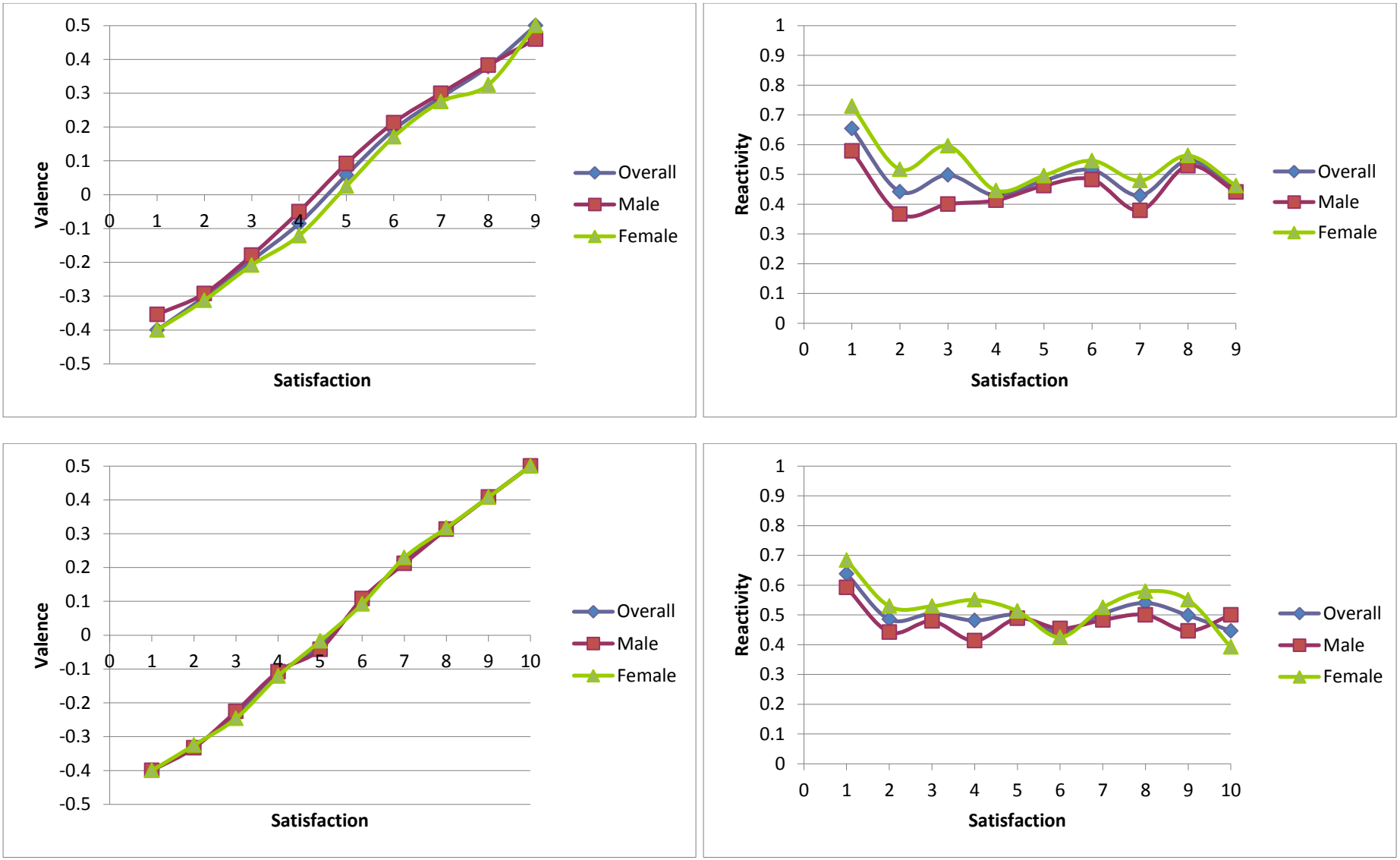


Figure 3.13. Relationship of *Valence* and *Reactivity* with Satisfaction for the 9- point category scale and the Magnitude Estimation scale

3.4 Mapping Facial Expressions to two-dimensional Customer Satisfaction Space

While the traditional models consider satisfaction to be one-dimensional, in Chapter 2 the two-dimensional Kano model which defines satisfaction as a function of performance was introduced. This model considers the subjective and objective nature of quality and states that subjective quality pertains to customer satisfaction while objective quality pertains to the fulfilment of requirements. Kano et al. (1984) classified customer requirements based on their perceived impact on customer satisfaction. In particular, three main categories of requirements were identified: Must-be (expected), Attractive (exciters) and One-dimensional (performance). According to the Kano model, each of these categories has a different impact on satisfaction and dissatisfaction. Consequently, must-be requirements are labelled monovalent dissatisfiers, attractive requirements as monovalent satisfiers and one-dimensional requirements as bivalent satisfiers. Therefore it can be thought that when customers provide ratings on a one-dimensional satisfaction scale, their ratings are subjective judgements of quality. These judgements are not only related to the level of need fulfilment, but are also related to the customer's perceived value of the need. Therefore finding FEs that characterise this two-dimensional satisfaction space (*Customer satisfaction-Requirement fulfilment*) could provide a means of representing the relationship between all three types of requirement categories (O, A, M) successfully using a FE depiction.

Oliver (2010) suggested that customers expressing unfulfilled needs lack essentials in their lives and thus pursue restoration. Therefore when one-dimensional and must-be attributes are not met, this might be expressed in the face in a manner that attempts to pursue restoration of the original requirement fulfilment. FEs representing the un-fulfilment of these needs can be hypothesised to have -ve *Valence* and high *Reactivity*. Similar use of active emotions as negative reinforcement in situations where needs are not met (complaint behaviour) has been reported. This theory can also be applied to situations where attractive and one-dimensional requirements are fulfilled. Customers might display +ve *Valence* and high *Reactivity* expressions in order to provide positive reinforcement. However, this theory only provides an explanation for emotions directed at. As explained in section 3.3.3, the *Reactivity* dimension is used to describe behavioural tendencies where active expressions were assumed to reflect emotions directed at while passive expressions were assumed to reflect expressions produced by. This raises the question about what determines this active

reinforcement behaviour and what determines the passive behaviour. In particular, how does an individual determine the direction of the emotion expressed?

The absence of a consensus on the type of expression produced by the face for the same level of satisfaction (observed in Experiment 1) indicates a possibility that interpersonal factors could be a factor influencing *Reactivity*. Individual differences are commonly attributed to an individual's personality. Personality is defined as the unique pattern of enduring thoughts, feelings, and actions that characterise an individual and is regarded as the sum total of what an individual is biologically, psychologically, and behaviourally (Hock, 2001). Several different theories of personality exist in psychological literature that attempts to characterise individual behaviours. Among many, these include Trait theory, Psychodynamic Theory, Humansitic Theory, and Integrative Approach (Higgins, 2000). Of these the most widely used are the Big Five personality traits of neuroticism, extraversion, agreeableness, conscientiousness, and openness to experience (Caligiuri, 2000). However in consumer marketing literature, Oliver (1993) suggested that the '*Locus of Control*', which is concerned with positive and negative reinforcement, influences the customer's emotions, which in turn affects satisfaction. However this has not been investigated empirically.

The concept of '*Locus of Control*' (LoC) was put forward by Julian Rotter **(**1966**)** who identified that individuals differed in their ideas about the connection between their personal characteristics and actions and the results they experience.

> "....When a reinforcement is perceived by the subject as following some action of his own but not being entirely contingent upon his action, then, in our culture, it is typically perceived as the result of luck, chance, fate, as under the control of powerful others, or as unpredictable because of the great complexity of the forces surrounding him. When the event is interpreted in this way by an individual, we have labelled this a belief in external control. If the person perceives that the event is contingent upon his own behaviour or his own relatively permanent characteristics, we have termed this a belief in internal control*"* (Rotter, 1966, p. 1)

This concept of 'internal' versus 'external' control of reinforcement was developed out of Social Learning Theory and is referred to by some investigators as the major or central concept in social learning theory (Rotter, 1975). As a concept LoC is a frequently explored element in occupational behaviour, satisfaction and performance psychology alongside numerous 'Expectancy theories' (e.g. Andrisani & Nestel, 1976; Judge & Bono, 2001; Lawler, 1971; Szilagiji & Sims, 1975; Vecchio, 1981). Longitudinal studies on performance,

satisfaction and performance to outcome expectation has been significantly aligned to LoC (e.g. Becker & Krzytofiak, 1982; Frantz, 1980; Vecchio, 1981). Furthermore, Broedling (1975) found a significant relationship between locus of control and established expectancy model constructs of valence. Frantz (1980) used an abbreviated Rotter Locus of Control Scale and found it was significantly linked to job satisfaction, performance and other work related behaviour. Furthermore Hammer and Vardi (1981) suggest that some reciprocal causation might be evident in a feedback loop (i.e. favourable experienced increase tendencies towards internal control, which in turn increase employee initiative in self-development with favourable outcomes and vice versa).

The idea that locus of control is a moderator variable by many has always been prevalent (Blau, 1987; Storms & Spector 1987). For example, Blau (1987) found that locus of control moderated the relationship between job dissatisfaction (thinking of quitting, looking for alternative positions) and job turnover. Storms and Spector (1987) similarly found that those with a strong internal locus of control were less likely to respond to frustration in counterproductive aggressive behaviour.

Among the many reviews of research literature on the role of locus of control and its part in other behavioural dynamics, Spector's (1982) review provides particular insight into the domains that LoC significantly influences. He suggests that Motivation, performance, satisfaction, leadership, perception and turnover in an occupational domain, are the primary behavioural dynamics to be influenced. In adition, among the Big Five traits, neuroticism is found to be closely related to LoC (Bono & Judge, 2003).

3.4.1 Purpose

The purpose of this study was to map FEs of emotion to the two-dimensional customer satisfaction/requirement fulfilment space defined by Kano et al. (1984). The research questions posed by this study are:

Q1- Does the presence of a second dimension influence what FEs of emotion are used to display satisfaction?

Q2- Do interpersonal factors influence the expression satisfaction using FEs of emotion?

3.4.2 Method

Participants

Opportunity sampling was used to recruit 100 participants (50 male and 50 female). The participants' age ranged from 18 to 65 (mean age of 28.6 ± 9.3 y.o.). Participants were of different ethnicities with 50% Caucasians and 50% Non-Caucasians (see Table 3.10).

Table 3.10. *Participant demographic characteristics*

Ethnicity	**Number of participants**	**Gender**		**Age (Mean ± SD) y.o.**	
		Male	Female	**M**	**F**
White European	49	25	24		
White Non-European	1	0	1		
Caucasians	50	25	25	31.3±12.8	26.36±9.3
Asian	46	23	23		
African	4	2	2		
Non Caucasians	50	25	25	26.7±4.6	26.2±7.6
Total	**100**	50	50	31.3±12.8	26.4±9.3

Locus of Control (LoC) Assessment

Rotters (1966) *LoC* assessment questionnaire (Appendix 6) was presented on the monitor. In the assessment, participants were provided with 29 [23 + 6 "fillers"] pairs of statements and required to select the statement from each pair with which they agreed the most. These statements were used to calculate the participants' locus of control (0-23), which indicates the extent to which an individual believes that his or her destiny is controlled by themselves or by external factors (Furnham & Steele, 1993).

Figure 3.14. Locus of Control scale. [Adapted from Mind Tools Ltd (2007)].

A person with a low LoC, classified as 'Internal' (lower end of the scale shown in Figure 3.14) believes that they are in control of their destiny and consequently their reinforcement can be said to be *directed at* to achieve desired outcomes. On the other hand a person with a high LoC, classified as 'External' believes that they have no or very little control over their destiny thus the individual expects external factors to control outcomes. Therefore when an

unfulfilled need is experienced by external individuals, it can be hypothesised that the emotions is produced but will be more inward oriented. However this behaviour might be different in situations where requirements are fulfilled. For example internal individuals who think that a requirement fulfilment is a result of their hard work might direct +ve Valence emotions inwards. This could be the basis behind being content. External, individuals on the other hand might become delighted when their requirements are met as they did not believe this was under their control in the first place. This might result in active expressions in situations where extreme +ve *Valence* is experienced by external indiciduals.

Stimuli

The same 10x10 emoticon set used in experiment 1 was used as the stimuli set for this experiment.

Design

In contrast to the one-dimensional satisfaction scales provided to the participants in the previous experiment, in this study satisfaction is considered as a two-dimensional construct. The experimental procedure in this study was designed to provide participants with a judgement task where each participant's FE choice also took into account a second dimension based on the Kano Model of Customer Satisfaction.

Procedure

Along with the emoticon set, two orthogonal dimensions (customer satisfaction vs. dissatisfaction and functionality vs. dysfunctionality of a product or service) were presented to participants on a computer monitor (corresponding to the dimensions of the Kano Model of Customer Satisfaction) (Appendix 4). The functionality and dysfunctionality dimension correspond to the level of Requirement fulfilment (*RF*) discussed in Chapter 2. The 2D space was divided into a 5 x 5 matrix providing the participants with a satisfaction space to map FEs to. As the subjective width between categories is assumed to be equal, this scale can be considered an interval scale.

Participants were requested to drag and drop 25 emoticons from the emoticon set onto the 5 x 5 two-dimensional layout provided. The participants task was to choose from the set those emoticons that in their opinion reflected the degree of satisfaction with respect to D1 (*Customer satisfied* vs. *Customer dissatisfied*) and D2 (*Requirement fulfilled* vs. *Requirement not fulfilled*). To help them with the mapping, participants were provided with an instruction

sheet which contained statements that corresponded to each of the four quadrants of 2D space based on the Kano Model (Appendix 5).

3.4.3 Results

A frequency analysis was carried out to identify the emoticons chosen to represent each of the 25 positions in the two-dimensional *Satisfaction-Requirement fulfilment* grid shown in Figure 3.15. Emoticons that had a selection frequency of >10% were investigated.

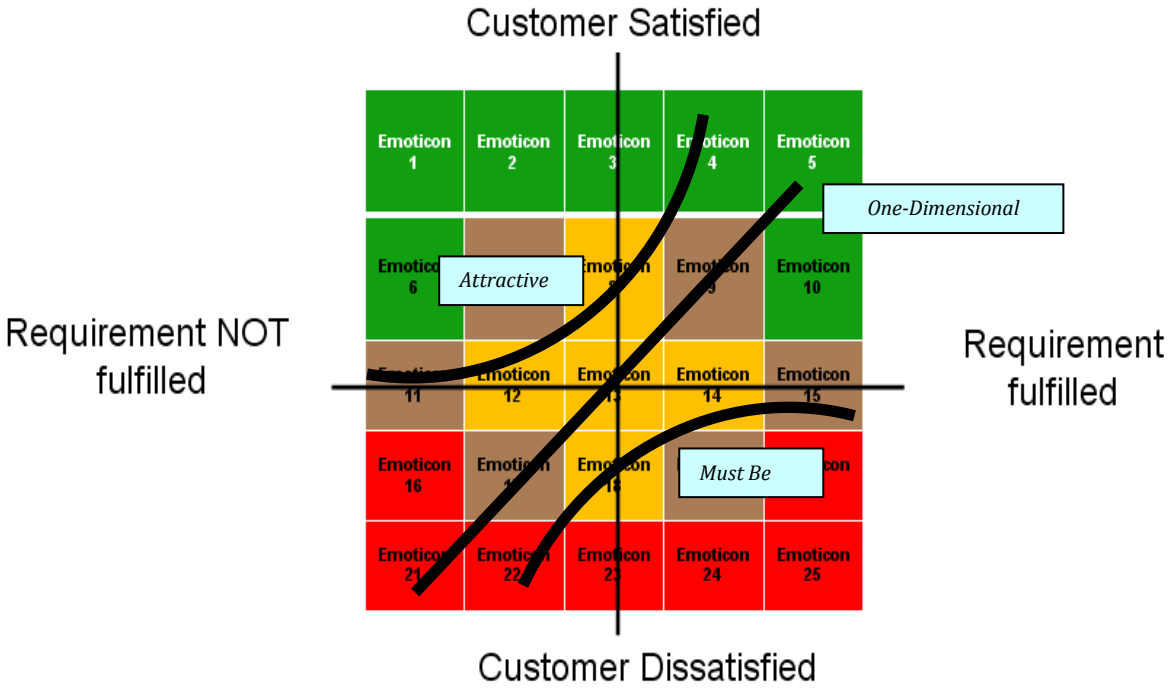


Figure 3.15. Emoticon positions on the two-dimensional Satisfaction-Requirement fulfilment grid

Only grid positions labelled Emoticon 5 and Emoticon 21 in Figure 3.15 were assigned emoticons with over >10% agreement. These grid positions correspond to the one-dimensional *Customer Satisfied/Requirement fulfilled* and *Customer Dissatisfied/ Requirement Not Fulfilled* positions respectively. Figure 3.16 and Figure 3.17 display the emoticons selected (selection frequency>10) to represent these two grid positions. It is seen that similar the one-dimensional experiment, emoticon 'i1a', which represents passive emoticons, received the highest selection frequency when the level of satisfaction was high. In addition, emoticon 'i10j' received the highest selection frequency when the level of satisfaction was low. The bifurcation of emoticon responses observed in experiment 1 was

also observed when customer satisfaction was low with 17% of the respondents selecting the low *Reactivity* emoticon ‘i1j’’ for this position.

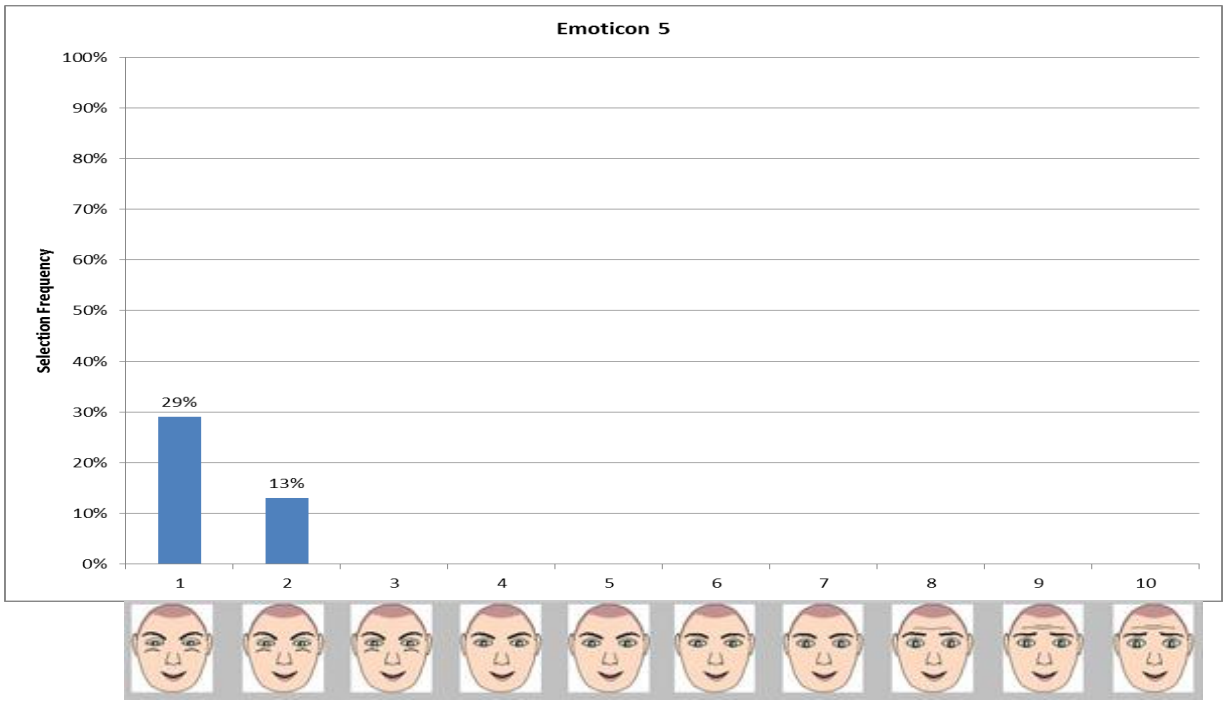


Figure 3.16. Selection frequency of emoticons selected (selection frequency>10%) to represent the ‘Extremely dissatisfied’ anchor for the *Extremely satisfied/Requirement fulfilled* grid position (Emoticon 5)

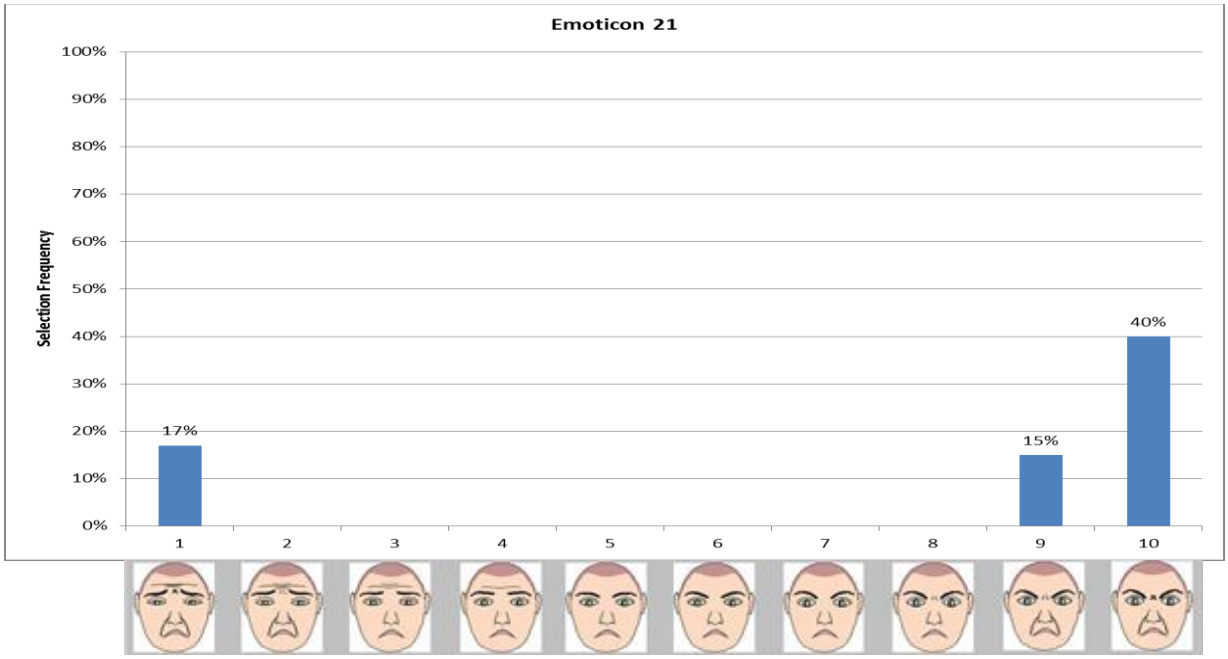


Figure 3.17. Selection frequency of emoticons selected (selection frequency>10%) to represent the ‘Extremely dissatisfied’ anchor for the *Extremely satisfied/Requirement fulfilled* grid position (Emoticon 5)

The emoticon selection frequencies were analysed further by splitting the *Reactivity* dimension based on behavioural tendencies (**Passive,** *Reactivity*<=0.5; **Active,** *Reactivity*>0.5) (Figure 3.11). For the purpose of this analysis, the continuous LoC scores were categories into External and Internal LoC (External= LoC>12, Internal=LoC<=12).

Table 3.11. *Comparison of the Selection Frequency for Emoticon 5*

		Selection Frequency (%)						
		Extremely dissatisfied/ Requirement not fulfilled						
		Overall (n=100)	Gender		Ethnicity		LoC	
			Male (n=50)	Female (n=50)	Caucasian (n=50)	Other (n=50)	External (n=52)	Internal (n=48)
Reactivity (R)	*R* <=0.5 (Passive)	34.0	26.0	42.0	22.0	46.0	28.8	39.6
	R >0.5(Active)	66.0	74.0	58.0	78.0	54.0	71.2	60.4
	χ^2	10.240	11.520	1.280	15.680	.320	9.308	2.083
	Significance *(p)*	.001	.001	.258	.000	.572	.002	.149

Table 3.11 presents the selection frequencies for this position for the whole sample and participants characteristics (Gender, Ethnicity and LoC). In comparison to the results obtained for the '*Extremely dissatisfied*' anchor in one-dimensional satisfaction scales, a significantly higher number of male participants selected active emoticons to represent this position. The selection frequency of high active emoticons was also significant for Caucasian and External participants. This finding about external participants selecting predominantly active expressions to represent this position contradicts the previous explanations provided as to how LoC might influence Reactivity in extremely dissatisfied positions.

Analysis of FEs of emotion that characterise one-dimensional and two dimensional Satisfaction

The central tendencies were calculated for each position on the two-dimensional satisfaction space. The *Requirement fulfilment* dimension was assumed to vary between 0-1 and the *Satisfaction* dimension from -1 to 1. The *Valence* and *Reactivity* for the one-dimensional satisfaction dimension and the dimension where *Satisfaction* increases while *Requirement fulfilment* is at its neutral (blue dashed lines in Figure 3.18) were obtained and compared with to the results obtained in experiment 1. As the interval in each of the dimensions consisted of 5 emoticons, the results were compared to the results of the 5- point category scale from experiment 1. Figure 3.19 illustrates the relationship of these three dimensions to the *Valence* and *Reactivity* respectively. The *Valence* and *Reactivity* of the 5- point scale and the *Satisfaction/Requirement fulfilment* (S= f (RF)) dimension follow very similar patterns compared to the *Satisfaction* dimension where *Requirement fulfilment* is not considered.

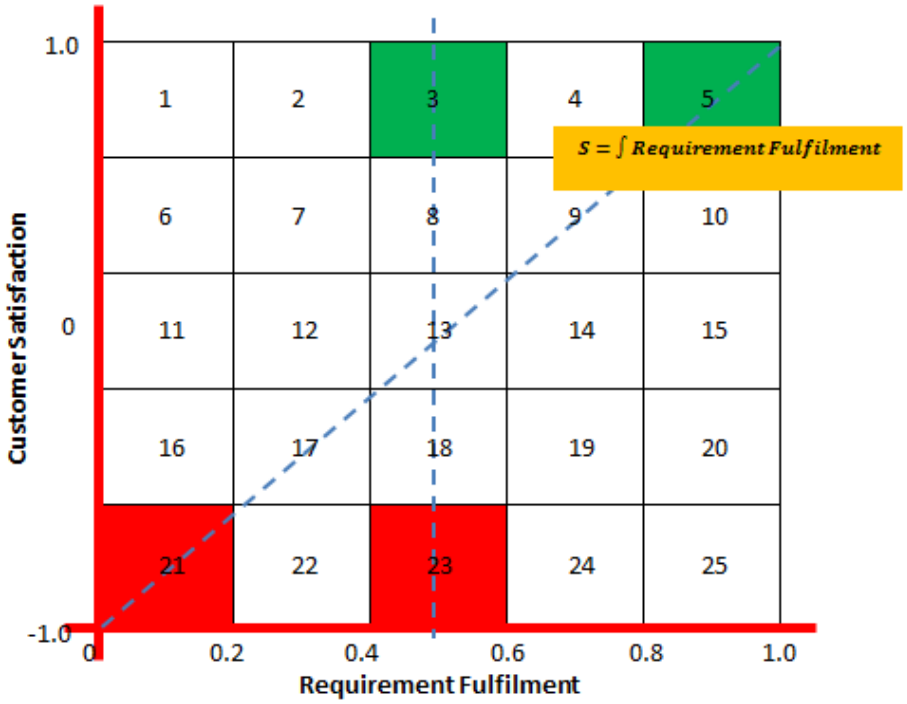
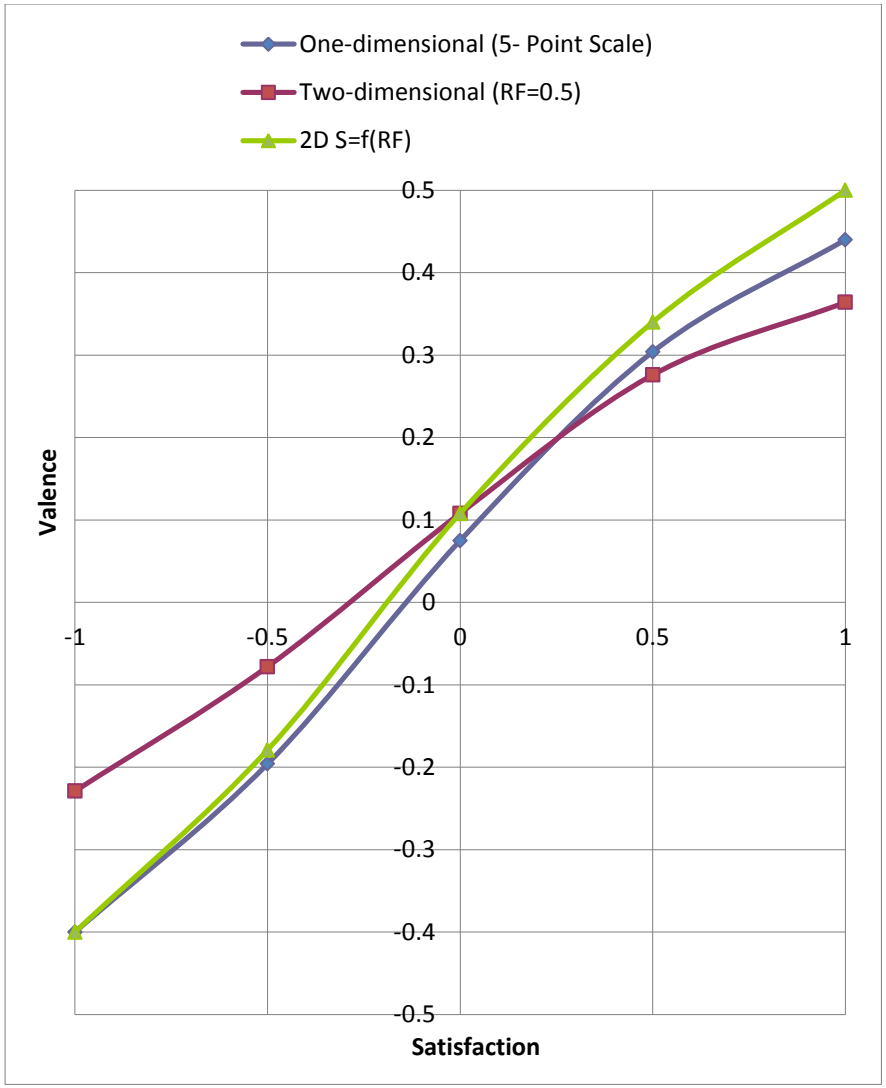


Figure 3.18. Quantification of the two dimensional space in to an interval scale

However these relationships portray differences in *Valence* and *Reactivity* at extreme levels of satisfaction with mappings on the two dimensional space indicating higher Valence when requirements are fulfilled and higher Reactivity when requirements are not fulfilled.



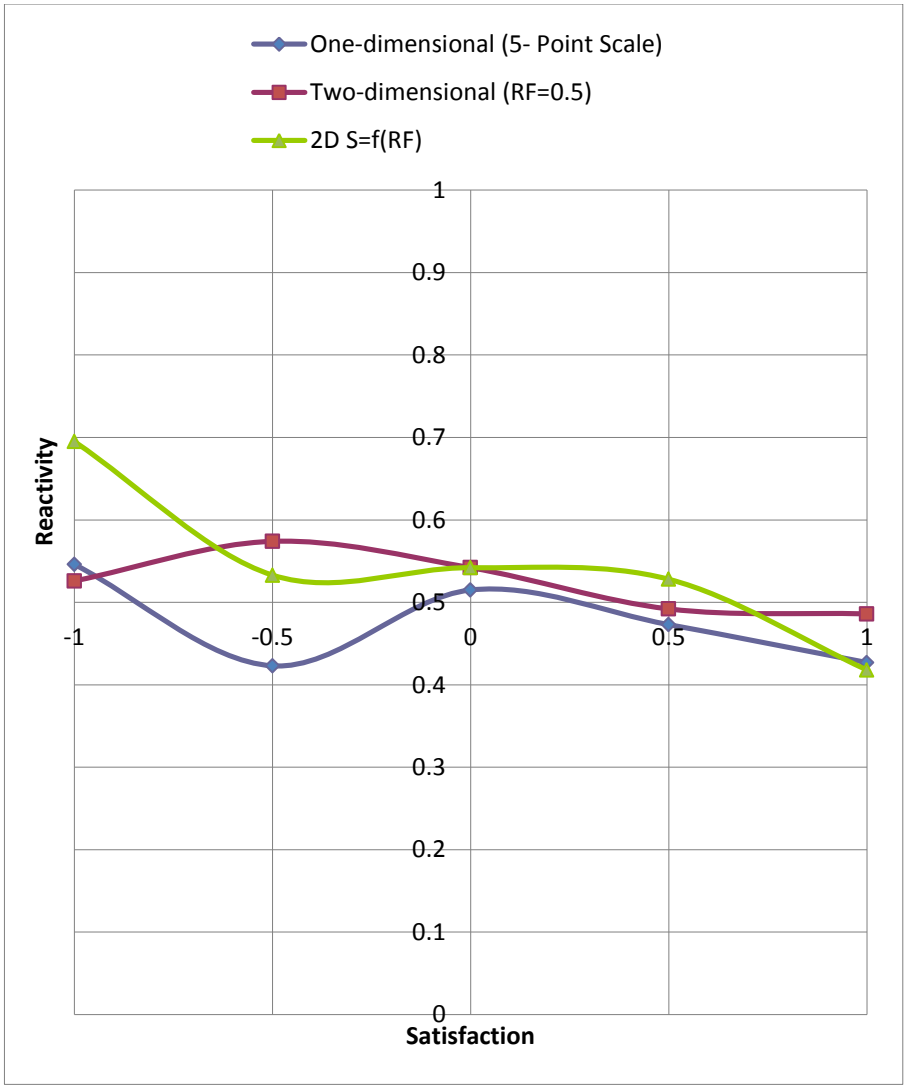


Figure 3.19. Relationship between Satisfaction dimensions and a) *Valence* b) *Reactivity*

Analysis based on requirement type (O, M. A)

Measures of central tendency for *Valence* and *Reactivity* were computed for each position on the 2D grid in Figure 3.15 and were used to plot the change in *Valence* and *Reactivity* for the three Kano product/service attribute types (One-dimensional, Attractive and Must Be) indicated by the black lines. To infer correct *Valence* and *Reactivity* values for the curves of the Attractive and Must Be attributes calculations of satisfaction were made based on the exponential relationship between Attractive ($S= e^{RF}$) and must-be requirements ($S= -e^{-RF}$) with satisfaction. Figure 3.20 exhibits the change in *Valence* and *Reactivity* with increase in Satisfaction and Requirement Fulfilment for the three Kano dimensions (One-dimensional, Attractive and Must Be).

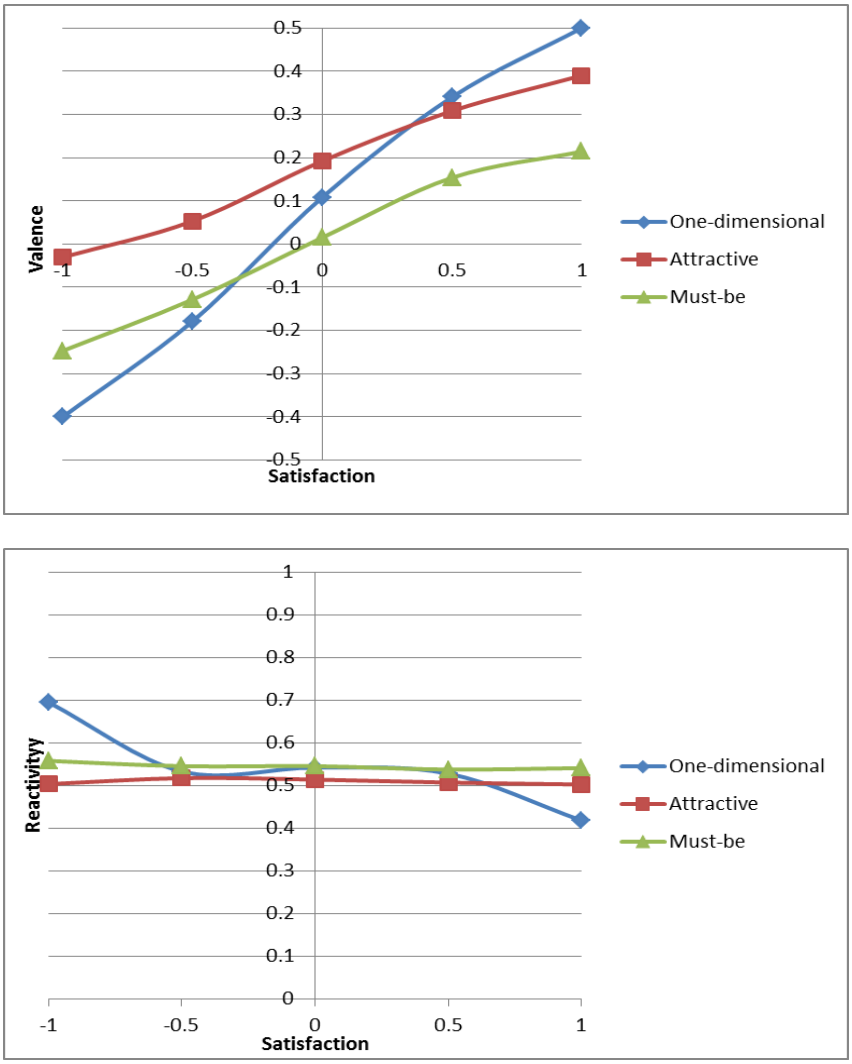


Figure 3.20. Relationship of *Valence* and *Reactivity* with Customer Satisfaction/Requirement Fulfilment for the Kano Dimensions (One-Dimensional, Attractive and Must BE) (n=100)

It was observed that similar to the results of the previous study the *Valence* of the selected emoticons increases with the level of Satisfaction and requirement fulfilment for the Kano one-dimensional positions. The *Valence* of the selected emoticons also increase in a parallel manner for the Attractive and Must Be positions with Attractive positions displaying higher levels of *Valence* compared to the Must be positions.

The *Reactivity* of the emoticons selected for the Kano one-dimensional positions followed a similar pattern to that observed in the previous study. On the other hand the *Reactivity* of the emoticons selected for the Attractive and Must Be positions did not show any variation. The *Reactivity* of emoticons selected for the Must be positions were slightly higher than those selected for the Attractive positions.

Similar to study 1, the emoticons selected for the Extremely Dissatisfied/Requirement not fulfilled end for each of the three dimensions were separated into two groups based on their levels of *Reactivity* (R <=0.5 and R >0.5) which separates the sad faces from the angry faces in the stimuli set. Similar to the study 1 an ambiguity of *Reactivity* was observed in the emoticon selection for all three Kano dimensions with more participants selecting low *Reactivity* sad faces. The difference between the selection frequency for active and passive expression were not statistically significant Table 3.12.

Table 3.12 *Comparison of the selection frequency of high Reactivity (angry) and low Reactivity (sad) emoticons for the Customer Dissatisfied/ Requirement not fulfilled positions*

		Selection Frequency (%) (*n*=100)		
		One-Dimensional	***Must Be***	***Attractive***
Reactivity (R)	R <=0.5 (Passive)	55	58	57
	R >0.5(Active)	45	42	43
	χ^2	1.000	2.560	1.960
	Significance *(p)*	.317	.110	.162

Effect of Gender and Requirements on Reactivity

The impact of gender on the *Reactivity* of emoticons selected to represent the *Customer Dissatisfied/ Requirement not fulfilled* positions was investigated. A pattern similar to that observed in study 1 was observed for the emoticons selected for one-dimensional Kano positions with Male participants selecting predominantly sad faces and female participants selecting predominantly angry faces (Table 3.13). For the Must Be and Attractive positions

the ambiguity of selection frequency was observed. However these finding were not statistically significant.

Table 3.13. *Male and Female selection frequencies of high Reactivity (angry) and low Reactivity (sad) emoticons for the Customer Dissatisfied/ Requirement not fulfilled positions.*

		Selection Frequency (%) (*n*=100)					
		One-Dimensional		***Must Be***		***Attractive***	
		Male (*n*=50)	Female (*n*=50)	Male (*n*=50)	Female (*n*=50)	Male (*n*=50)	Female (*n*=50)
Reactivity (R)	*R* <=0.5 (Passive)	62	48	58	58	56	58
	R >0.5(Active)	38	52	42	42	44	42
	χ^2	2.880	2.880	1.280	1.280	.720	1.280
	Significance *(p)*	.090	.777	.258	.258	.396	.258

Figure 3.21 displays the relationship curves for satisfaction and *Valence* and satisfaction and *Reactivity* for male and female participants. Male and female participants both exhibited the same pattern of emoticon selections with increase in satisfaction and requirement fulfilment to those observed for the whole sample. The difference in *Valence* for the emoticon selections between Attractive and Must be positions was smaller in female participants to that of male participants. This further indicates and ability of the male participants to detect changes to satisfaction level and change behaviour.

The *Reactivity* of the emoticons selected for the Kano one-dimensional positions showed a significant gender difference with female participants' selections showing little variation in *Reactivity* compared to male participants. A decrease in the *Reactivity* of the emoticon choices for the Must-be dimension was observed in female choices at the position customer satisfied/requirement fulfilled while an increase in *Reactivity* was observed for the same position in male participant choices (Figure 3.21). Conversely an increase in the *Reactivity* of emoticons selected for the Attractive dimension was observed in female participants' emoticon choices for the customer satisfied/requirement fulfilled position the while a decrease in *Reactivity* was observed in male choices for the same position. However, these differences were not statistically significant.

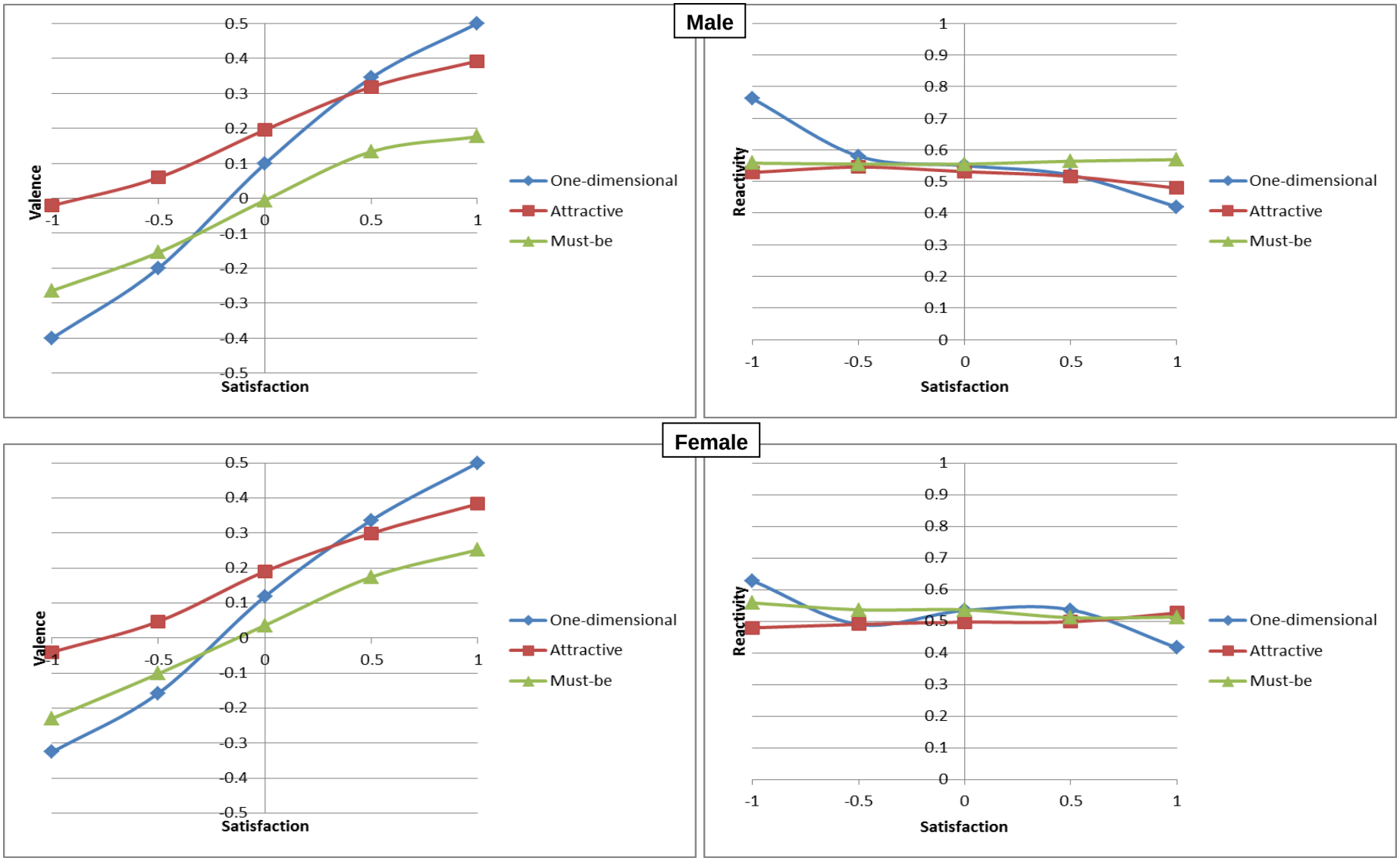


Figure 3.21. Relationship of *Valence* and *Reactivity* with Satisfaction for the Kano Dimensions (One-Dimensional, Attractive and Must BE)

Effect of Ethnicity and Requirements of Reactivity

The effect of ethnicity on the *Reactivity* of emoticons selected to represent the *Customer Dissatisfied/ Requirement not fulfilled* positions was also looked at. A clear bifurcation of the level of *Reactivity* of the emoticons chosen to represent this position was observed across all three Kano dimensions (Table 3.14). A majority of participants selected passive faces to represent this position across all three Kano dimensions. However these differences were not statistically significant except for the Reactivity of emoticons selected by Non-Caucasian participants. It was observed that a significantly high proportion of Non-Caucasian participants selected passive expressions to represent this position.

Table 3.14. Caucasian and Non-Caucasian selection frequencies of high *Reactivity* (*angry*) and low *Reactivity* (*sad*) emoticons for the Customer Dissatisfied/ Requirement not fulfilled positions.

		Selection Frequency (%) (*n*=100)					
		One-Dimensional		***Must Be***		***Attractive***	
		Caucasians	Non-Caucasians	Caucasians	Non-Caucasians	Caucasians	Non-Caucasians
Reactivity (R)		(*n*=50)	(*n*=50)	(*n*=50)	(*n*=50)	(*n*=50)	(*n*=50)
	R <=0.5 (Passive)	58	52	52	64	60	54
	R >0.5(Active)	42	48	48	36	40	46
	χ^2	1.280	.080	.080	3.920	2.000	.320
	Significance *(p)*	.258	.777	.777	.048	.157	.572

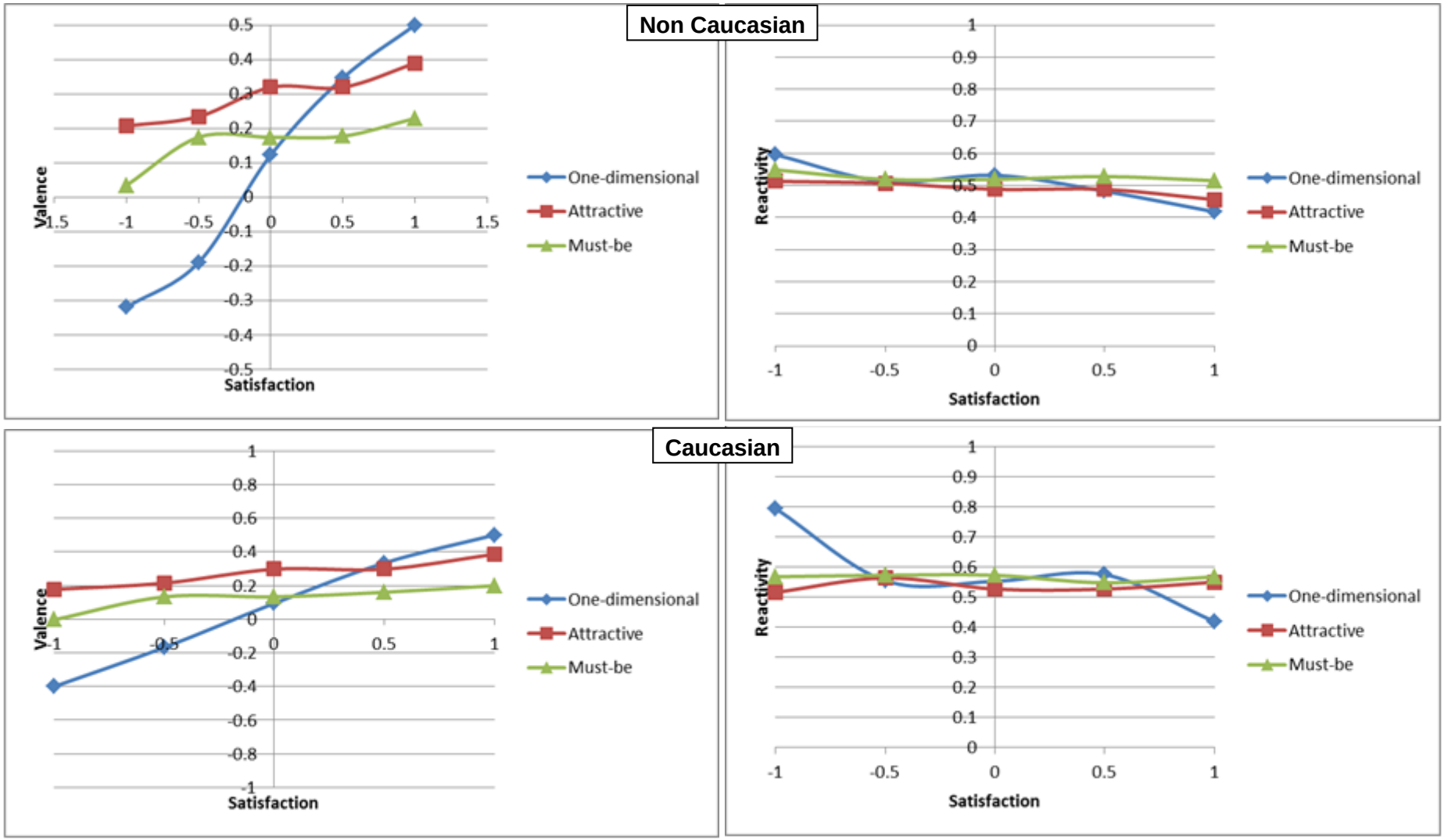


Figure 3.22. Relationship of Valence and Reactivity with Satisfaction for the Kano Dimensions (One-Dimensional, Attractive and Must BE)

Effect of Locus of Control

The Locus of Control was calculated for all participants. The mean LoC for the whole sample was 11.4±3.7. The male participants had a mean LoC of 10.5±3.5, while the female participants had significantly higher mean LoC of 12.2±3.7, $F(1, 98) = 5.13$, $p = .02$. Caucasian participants had a mean LoC of 11.52±3.7 similar to the Non-Caucasian mean LoC of 11.38 ±3.5. Caucasian males had a mean LoC of 11±3.4 which was slightly less than that of Caucasian females 12.04±3.9. On the contrary Non-Caucasian males had a lower LoC of 10.3±3.1 which was significantly lower than that of Non-Caucasian females which was12.44±3.5, $F(1, 48) = 5.05$, $p = .03$.

For the purpose of this analysis, the continuous LoC scores were divided into two categories (External= LoC>12, Internal=LoC<=12). The results of an analysis following this division showed that Internal individual's selected passive emoticons to represent the extremely dissatisfied position for Must be requirements (Table 3.15).

Table 3.15. Internal and External selection frequencies of high *Reactivity* (*angry*) and low *Reactivity* (*sad*) emoticons for the Customer Dissatisfied/ Requirement not fulfilled positions.

		Selection Frequency (%) (*n*=100)					
		One-Dimensional		***Must Be***		***Attractive***	
Reactivity (R)		Internal (*n*=48)	External (*n*=52)	Internal (*n*=48)	External (*n*=52)	Internal (*n*=48)	External (*n*=52)
	R <=0.5 (Passive)	52.1	57.7	66.7	50.0	60.4	53.8
	R >0.5(Active)	47.9	42.3	33.3	50.0	39.6	46.2
	χ^2	.083	1.231	5.333	.000	2.083	.308
	Significance *(p)*	.773	.267	.021	1.000	.149	.579

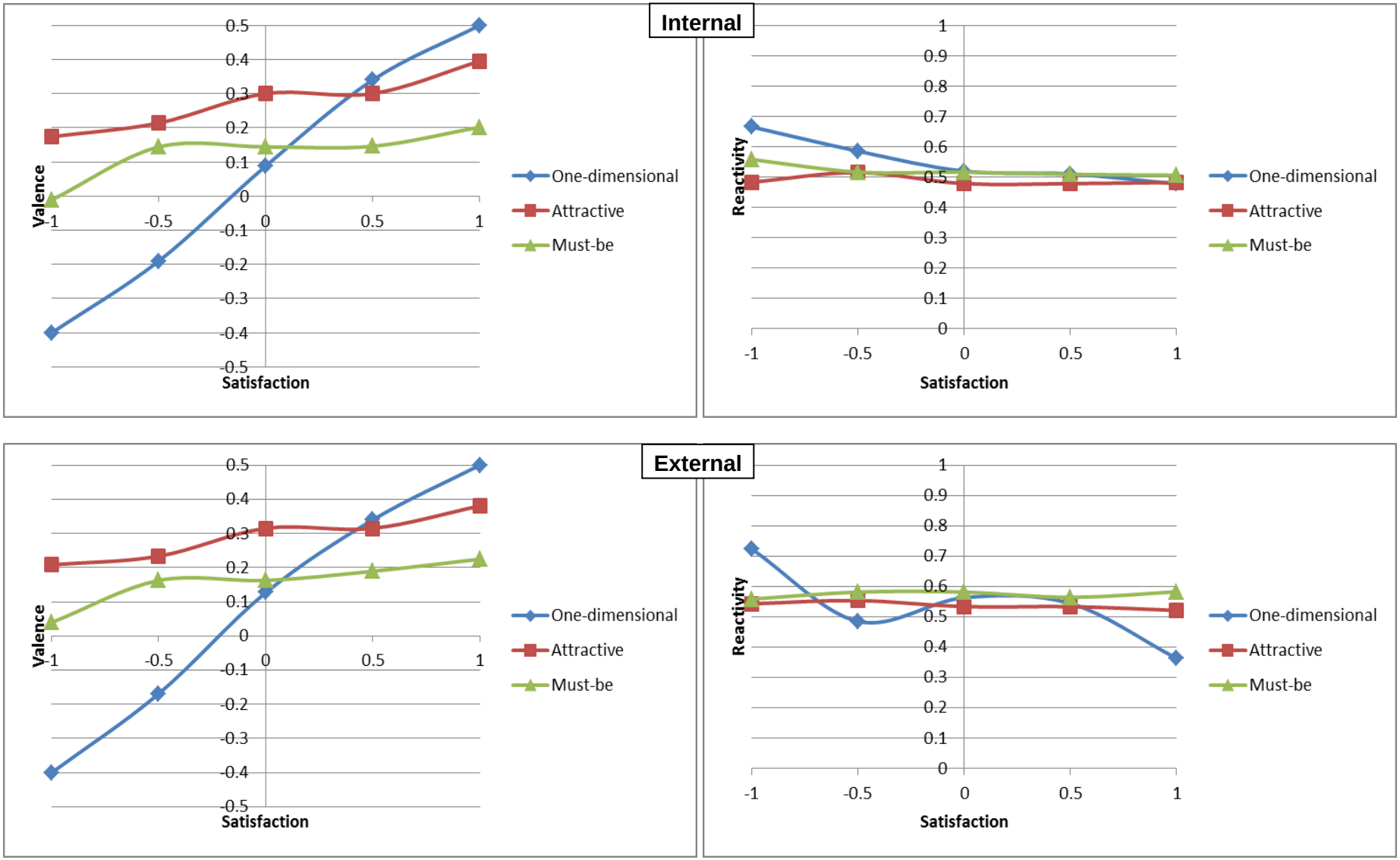


Figure 3.23. Relationship of Valence and Reactivity with Satisfaction for the Kano Dimensions (One-Dimensional, Attractive and Must BE)

3.5 Discussion

In this Chapter, FEs of emotion were mapped to one-dimensional and two-dimensional satisfaction scales. The results of both experiments supported the existing view that satisfaction results in positive emotions while dissatisfaction results in negative emotions. This was portrayed by the increase in *Valence* with increase in satisfaction and decrease in Valence with decrease in satisfaction. However, the *Reactivity* dimension fluctuates along the one-dimensional satisfaction dimension indicating the presence of a third dimension that may be affecting the selection of FEs to represent different levels of satisfaction. The influence of gender on *Reactivity* was observed by comparing the assignment of active (angry) and passive (sad) emoticons to the dissatisfaction points, and the assignment of active (excited) and passive (content) emoticons to the satisfaction points. However no conclusive results were obtained that can be used to accurately map *Reactivity* to the one-dimensional satisfaction scale. However, the discriminating power of the 9- point scale was observed. Furthermore, male participants seem to be able to make better discriminations of *Reactivity* along the satisfaction continuum and express this in frequent changes in behaviour. Or the results could mean that males are affected by *Requirement-fulfilment-non-fulfilment* more than females.

In terms of the fluctuation observed in the behavioural dimension of *Reactivity,* the following explanation given by Darwin (1852) makes some sense with the data observed in the two experiments in this chapter: "Persons suffering from excessive grief often seek relief by violent and almost frantic movements, as described in a former chapter; but when their suffering is somewhat mitigated, yet prolonged, they no longer wish for action, but remain motionless and passive, or may occasionally rock themselves to and fro. The circulation becomes languid; the face pale; the muscles flaccid; the eyelids droop; the head hangs on the contracted chest; the lips, checks, and lower jaw all sink downwards from their own weight. Hence all the features are lengthened; and the face of a person who hears bad news is said to fall" (Darwin, 1852, p. 176). However although Darwin proposes a description of the behaviour in such conditions the cause of this is not fully known.

An attempt made in the study to explore the effect of LoC on such behaviour was inconclusive. However findings did indicate that for non-fulfilment of must-be requirements, a significant number of internal individuals expressed dissatisfaction using a passive expression. This is in line with Storms and Spector (1987) results that people with strong internal locus of control were less likely to respond to frustration in counterproductive

aggressive behaviour. For non-fulfilment of one-dimensional requirements for the whole sample, external individuals were found to express this level of dissatisfaction using active faces.

In terms of ethnicity, Non-Caucasian participants used passive emoticons to express he non-fulfilment of must-be requirements. This also could be explained in terms of LoC as Non-Caucasian has a mean LoC of 11.38 ±3.5 which was slightly less than that for Caucasian. Non-Caucasian males had the lowest LoC of 10.3±3.1, thus the presence of Internal males in this non-Caucasian sample could be the reason for the passive expressions at the extremely dissatisfied end for must-be requirements.

When the results of both studies were compared it was evident that the relationship between *Valence* and satisfaction and *Reactivity* and satisfaction observed in the one-dimensional experiments was similar to the two dimensional representation of the same positions. This provides evidence that when making judgements along the satisfaction continuum, people are actually base their results on two dimensions. Further evidence for this will be tested in Chapter 5 when the accuracy of the system output will be evaluated. Although the results of the Reactivity dimension are not conclusive. The results obtained from this section can be used to inform the system development. The efficiency of the experimental results can then be found by testing how accurate the system output is in expression *Reactivity* and *Valence* with respect to Satisfaction.

Chapter 4

The National Student Survey (NSS) as a case study of measuring satisfaction

"The defining feature of a great education is what happens in the classroom. Everything starts from that and must be built around It.", Bill Gates

4.1 Measuring and managing quality in Higher Education (HE)

Education is a complex concept embedded in a political, cultural and economic context and has been viewed as both a process and a product. Methods for evaluating educational programs, for the most part have perceived education as a *product* in terms of knowledge acquired, skills improved, attitudes/values modified, and personal traits developed. On the other hand, the *process* of education has been evaluated in terms of its contribution to the product, and judged based on the amount of learning, high test scores, employment prospects or other outcomes anticipated from education (Pace, 1984). As a result, many definitions of quality in education exist focusing on education as a process, a product or both.

Education quality has been regarded as a rather vague, controversial and highly ambiguous concept (Cheng & Tam, 1997; Pounder, 1999). Harvey and Green (1993) commented that quality in higher education (HE) is a complex and multifaceted concept and a single correct definition of quality is lacking. One main reason for this is that different stakeholders have disparate or even contradictory perspectives on what quality is (for a review see Becket & Brookes, 2008). Consequently managing quality in HE has become a challenging task. The lack of consensus among the stakeholders' perspectives has also posed challenges when deciding appropriate measures for assessing quality of HE (Eagle & Brennan, 2007). As a result there is no set standard as to the best way to define and measure quality of HE.

Many countries have national organisations that are tasked with the responsibility of managing quality within Higher Education Institutions (HEIs). These bodies are

considered ‘external stakeholders’ whose role is chiefly concerned with the measurement and evaluation of institutional quality assurance procedures (Becket & Brookes, 2008). The Quality Assurance Agency for Higher Education (QAA) is the body in charge of providing an integrated quality assurance service for HE across the United Kingdom (Eagle & Brennan, 2007). The QAA defined academic quality as “a way of describing how well the learning opportunities available to students help them to achieve their award. It is about making sure that appropriate and effective teaching, support, assessment and learning opportunities are provided for them” (QAA, 2004, p. 1). According to this definition, education is perceived as a product where the education process is evaluated in terms of its contribution to the product. Pace (1984) argued that considering education as a product presumes that the educational institution is at fault if students do not benefit from their education experience. Naturally HEIs are accountable for the resources, facilities, programs and procedures and the stimuli and standards they provide for the student learning and development. However, students are also accountable for the outcome of their learning experience (Pace, 1984). Thus, Pace (1984) suggested that when educational programs are evaluated the quality of the students’ educational experience or process should also be taken into account rather than just the product.

4.2 Student Feedback

Harvey, Moon, Geall, and Bower (1997) stated that improvement is the aim of quality assurance in HE; therefore the focus on ‘improvement’ is crucial. Furthermore, Harvey (2001, p14) remarked, “students are important stakeholders in the quality monitoring and assessment process and it is important to obtain their views”. Students hold a rich source of information about the quality of the educational services provided and how they can be improved. Thus, student feedback is considered to play an important role in the maintenance of quality and standards in HE (Leckey & Neil, 2001; Williams & Brennan, 2003). Student feedback here refers to the expressed opinions of students about aspects of their learning experience including perceptions about learning and teaching, learning support facilities, the learning environment, support facilities and external aspects of being a student (Harvey, 2001).

Wright and O’Neill (2002) highlighted the extent to which the assessment of student perspectives has become a crucial requirement for HEIs to remain competitive. As a result HEIs all over the world conduct or take part in student surveys to obtain feedback

on learning experiences, learning environments and facilities. The results of these surveys are anticipated to identify areas of concern, help observe long-term trends, and monitor the impact of educational programs for the overall maintenance and enhancement of the quality of the institution (Gribovskaya & Sng, 2007).

HEIs typically collect student feedback using self-report questionnaires. These are usually administered at institution level (quality of overall student experiences), faculty level, course level (quality of learning and teaching) and/or module level (feedback on the operations of a specific module and teacher appraisal by students) (Gribovskaya & Sng, 2007). Still, there are concerns about the validity and reliability of self-report student data. Nevertheless, researchers have deduced that data from self-report questionnaires can be considered reliable if respondents have the knowledge to provide the information asked for; the questions are worded clearly with no ambiguity; questions refer to recent activities; students think the questions deserve serious and thoughtful responses; respondents perceive no threat, embarrassment, or violation of their privacy in answering the questions and the design of the survey is such that it does not encourage socially desirable responses (Gribovskaya & Sng, 2007; Pike, 1995).

Patterson and Johnson (1993) remarked that due to the experiential nature of the student learning process, the quality of HE cannot be measured objectively. Yet the sheer size of HEIs and the time and effort necessary for carrying out and analysing student feedback have made short student surveys the most preferred and robust method for gaining insight into the quality of the student learning experience. These surveys are almost always based on questionnaires, which mainly consist of questions with pre-coded answers along with one or two open ended questions (Harvey, 2001). The survey questions are generally derived through focused groups with stakeholders (students and academic staff) or adapted from existing questionnaires. Cuthbert (1996) pointed out that although these student surveys all attempt to measure the student experience, there is considerable diversity between HEIs in the range of constructs used as well as the number of questions administered and the time taken to complete the questionnaire. This makes it impossible to compare ratings across HEIs and make accurate judgements and comparisons of quality.

Several national institution-level instruments have been designed to measure educational quality in a national scale and produce ratings that can be compared across HEIs. Institution-level surveys tend to encompass most features of education (as a product, process or both) and seek to collect data that can provide HEIs information to encourage action for improvement. In addition these surveys also seek to provide a descriptive

overview of student opinion, which can be reported as part of appropriate accountability procedures. Based on these observations Harvey (2003) distinguished the two main functions of student feedback as 'internal information to guide improvement' and 'external information for potential students and other stakeholders, including accountability and compliance requirements'.

Current widely used national Institution-level survey instruments include the Australian Course Experience Questionnaire (CEQ) survey, the USA National Survey of Student Engagement (NSSE) and the British National Student Survey (NSS). While all these surveys are said to gather data on the quality of educational experiences, Harvey (2003, p. 4) remarked, "It is not always clear how views collected from students fit into institutional quality improvement policies and processes". Additionally establishing the conditions under which student feedback can give rise to improvement is not an easy task (Harvey, 2003). Therefore it has been proposed that evaluation of student perspectives on quality should be carried out with the objective of the HEIs public *accountability* and quality *improvement* in mind.

4.2.1 The National Student Survey (NSS)

The National Student Survey (NSS) is a survey of final year undergraduate students in England, Wales and Northern Ireland conducted annually since 2005 as part of the Higher Education Funding Council for England's (HEFCE) quality assurance framework (Richardson, Slater, & Wilson, 2007). The survey asks students in their final year of a course to provide feedback on their courses in a nationally recognised format. The survey aims to gather feedback from students on the quality of their courses for the twofold purpose of providing data to inform the choices of future students (accountability) and to provide data about institutions to support Quality Assurance Agency (QAA) audits of HEIs (improvement) (Lamb, 2010; Hewson, 2011).

The NSS measures six factors quantitatively (Teaching, Assessment and Feedback, Academic Support, Organisation and Management, Learning Resources and Personal Development) (Richardson, Slater, & Wilson, 2007). In addition a separate Overall Satisfaction item is also measured. Each factor in turn consists of multiple items making up a survey of 22 items (Appendix 7) (Marsh & Cheng, 2008). The declarative statements express a clearly positive opinion about each of the NSS items to solicit more definitive responses from respondents. Each survey item is presented as a declarative sentence followed by response options in the form of a 5- point Likert scale indicating varying

degrees of agreement (*Definitely agree*, *Mostly agree*, *Neither agree nor disagree*, *Mostly disagree* and *Definitely disagree*) and an additional *Not applicable* category (Figure 4.1).

	Definitely agree	Mostly agree	Neither agree nor disagree	Mostly disagree	Definitely disagree	Not Applicable
The teaching on my course						
1. Staff are good at explaining things	☐	☐	☐	☐	☐	☐
2. Staff have made the subject interesting	☐	☐	☐	☐	☐	☐
3. Staff are enthusiastic about what they are teaching	☐	☐	☐	☐	☐	☐
4. The course is intellectually stimulating	☐	☐	☐	☐	☐	☐
Assessment and feedback						
5. The criteria used in marking have been clear in advance	☐	☐	☐	☐	☐	☐

Figure 4.1. Segment of the National Student Survey displaying the survey format (HEFCE, 2011).

Ipsos MORI (a leading market research company in the UK), on behalf of HEFCE administers the NSS annually across all publicly funded HEIs in England, Wales, Northern Ireland, and participating HEIs in Scotland. The data generated by the survey is then distributed and presented in accordance with the main objectives of the NSS. As iterated above, two main purposes of publishing the NSS data is to increase the prospective student's knowledge of the likely student experience at a particular institution while providing HEIs an opportunity to identify areas of concern for quality assurance and improvement (Williams & Brennan, 2003). For these reasons the data from the NSS is available in two formats: publicly available data and institutional data.

The NSS data is publicly available mainly via the Unistats website (www.Unistats.com) which operates as a mode for potential students to review and compare universities and courses in the UK (see Figure 4.2). The website presents the results of each of the 22 NSS items for each institution that participated in the survey in a tabular form. (Figure 4.3b) A breakdown of the data by course for that institution is also provided. Additionally, the website allows the comparison of up to three different data sets (course/institution combinations) as shown in Figure 4.3a. The value displayed as 'Overall student satisfaction' is the percentage sum of students that rated item 22 ('Overall, I am satisfied with the quality of the course') as "*Definitely agree*" (Likert rating 5) and "*Mostly agree*" (Likert rating 4). Similarly, the result for each NSS items is also conveyed as the percentage of students who agree to each NSS statement (Figure 4.4).

a) **b)**

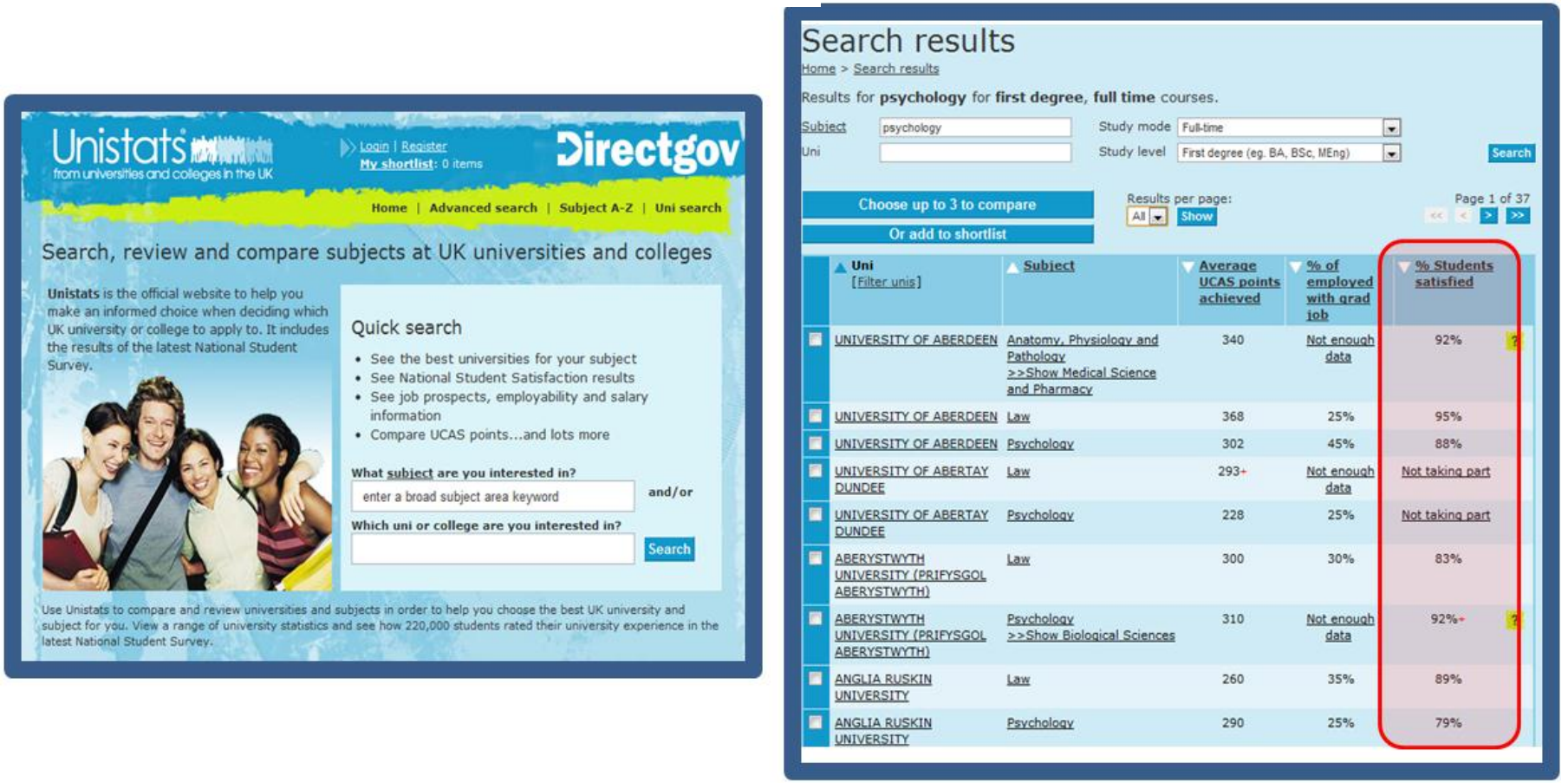
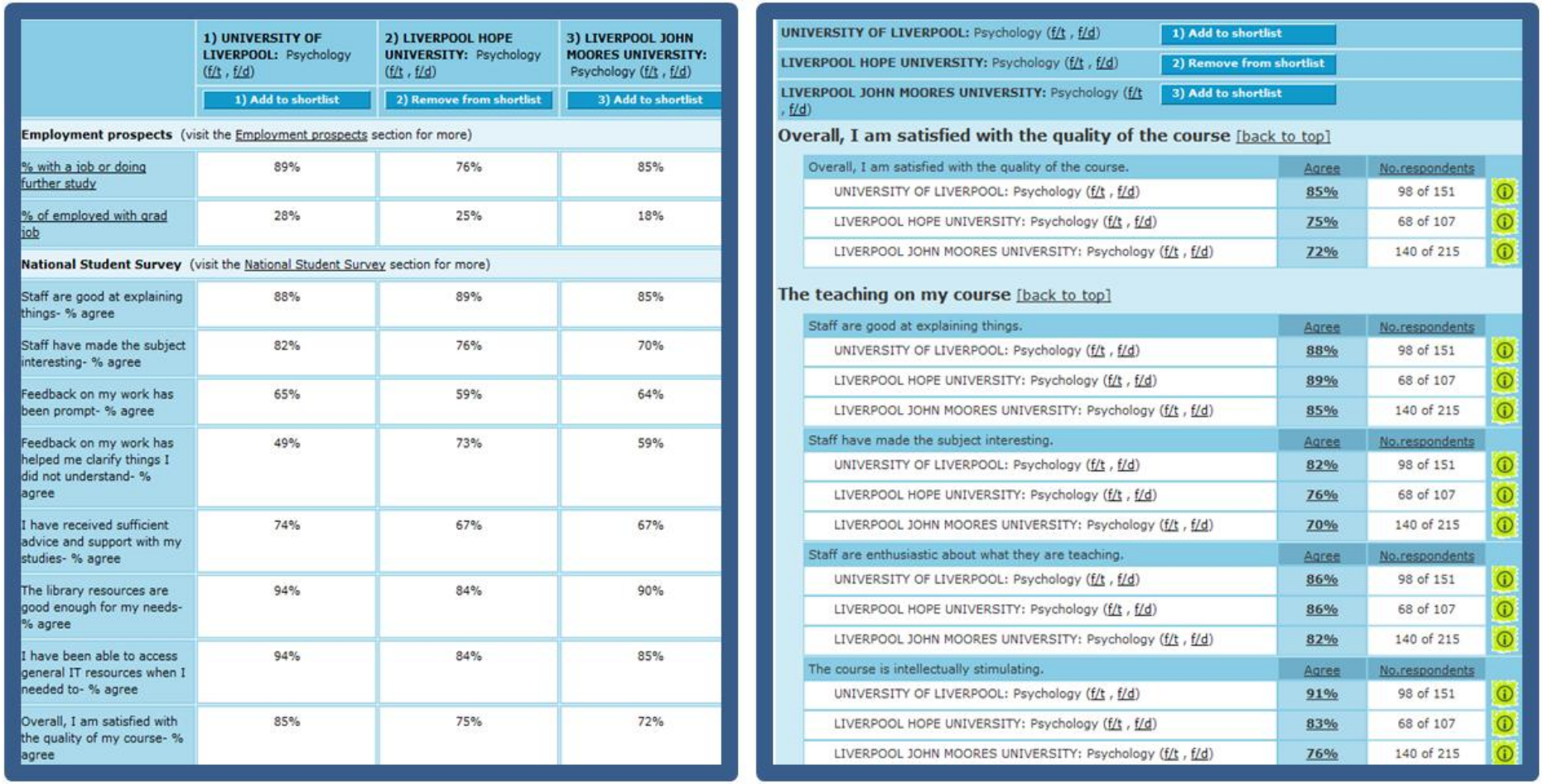


Figure 4.2. Unistats website layout for a) home page b) search results for a single subject across all institutions. (Unistats, 2011)

a) **b)**



	1) UNIVERSITY OF LIVERPOOL: Psychology (f/t , f/d)	2) LIVERPOOL HOPE UNIVERSITY: Psychology (f/t , f/d)	3) LIVERPOOL JOHN MOORES UNIVERSITY: Psychology (f/t , f/d)
	1) Add to shortlist	2) Remove from shortlist	3) Add to shortlist
Employment prospects (visit the Employment prospects section for more)			
% with a job or doing further study	89%	76%	85%
% of employed with grad job	28%	25%	18%
National Student Survey (visit the National Student Survey section for more)			
Staff are good at explaining things- % agree	88%	89%	85%
Staff have made the subject interesting- % agree	82%	76%	70%
Feedback on my work has been prompt- % agree	65%	59%	64%
Feedback on my work has helped me clarify things I did not understand- % agree	49%	73%	59%
I have received sufficient advice and support with my studies- % agree	74%	67%	67%
The library resources are good enough for my needs- % agree	94%	84%	90%
I have been able to access general IT resources when I needed to- % agree	94%	84%	85%
Overall, I am satisfied with the quality of my course- % agree	85%	75%	72%

UNIVERSITY OF LIVERPOOL: Psychology (f/t , f/d) — 1) Add to shortlist

LIVERPOOL HOPE UNIVERSITY: Psychology (f/t , f/d) — 2) Remove from shortlist

LIVERPOOL JOHN MOORES UNIVERSITY: Psychology (f/t , f/d) — 3) Add to shortlist

Overall, I am satisfied with the quality of the course [back to top]

Overall, I am satisfied with the quality of the course.	Agree	No.respondents
UNIVERSITY OF LIVERPOOL: Psychology (f/t , f/d)	85%	98 of 151
LIVERPOOL HOPE UNIVERSITY: Psychology (f/t , f/d)	75%	68 of 107
LIVERPOOL JOHN MOORES UNIVERSITY: Psychology (f/t , f/d)	72%	140 of 215

The teaching on my course [back to top]

Staff are good at explaining things.	Agree	No.respondents
UNIVERSITY OF LIVERPOOL: Psychology (f/t , f/d)	88%	98 of 151
LIVERPOOL HOPE UNIVERSITY: Psychology (f/t , f/d)	89%	68 of 107
LIVERPOOL JOHN MOORES UNIVERSITY: Psychology (f/t , f/d)	85%	140 of 215
Staff have made the subject interesting.	**Agree**	**No.respondents**
UNIVERSITY OF LIVERPOOL: Psychology (f/t , f/d)	82%	98 of 151
LIVERPOOL HOPE UNIVERSITY: Psychology (f/t , f/d)	76%	68 of 107
LIVERPOOL JOHN MOORES UNIVERSITY: Psychology (f/t , f/d)	70%	140 of 215
Staff are enthusiastic about what they are teaching.	**Agree**	**No.respondents**
UNIVERSITY OF LIVERPOOL: Psychology (f/t , f/d)	86%	98 of 151
LIVERPOOL HOPE UNIVERSITY: Psychology (f/t , f/d)	86%	68 of 107
LIVERPOOL JOHN MOORES UNIVERSITY: Psychology (f/t , f/d)	82%	140 of 215
The course is intellectually stimulating.	**Agree**	**No.respondents**
UNIVERSITY OF LIVERPOOL: Psychology (f/t , f/d)	91%	98 of 151
LIVERPOOL HOPE UNIVERSITY: Psychology (f/t , f/d)	83%	68 of 107
LIVERPOOL JOHN MOORES UNIVERSITY: Psychology (f/t , f/d)	76%	140 of 215

Figure 4.3. Unistats website layout for overall comparison of 3 institutions a) general results b) survey item by item. (Unistats, 2011)

a)

b)

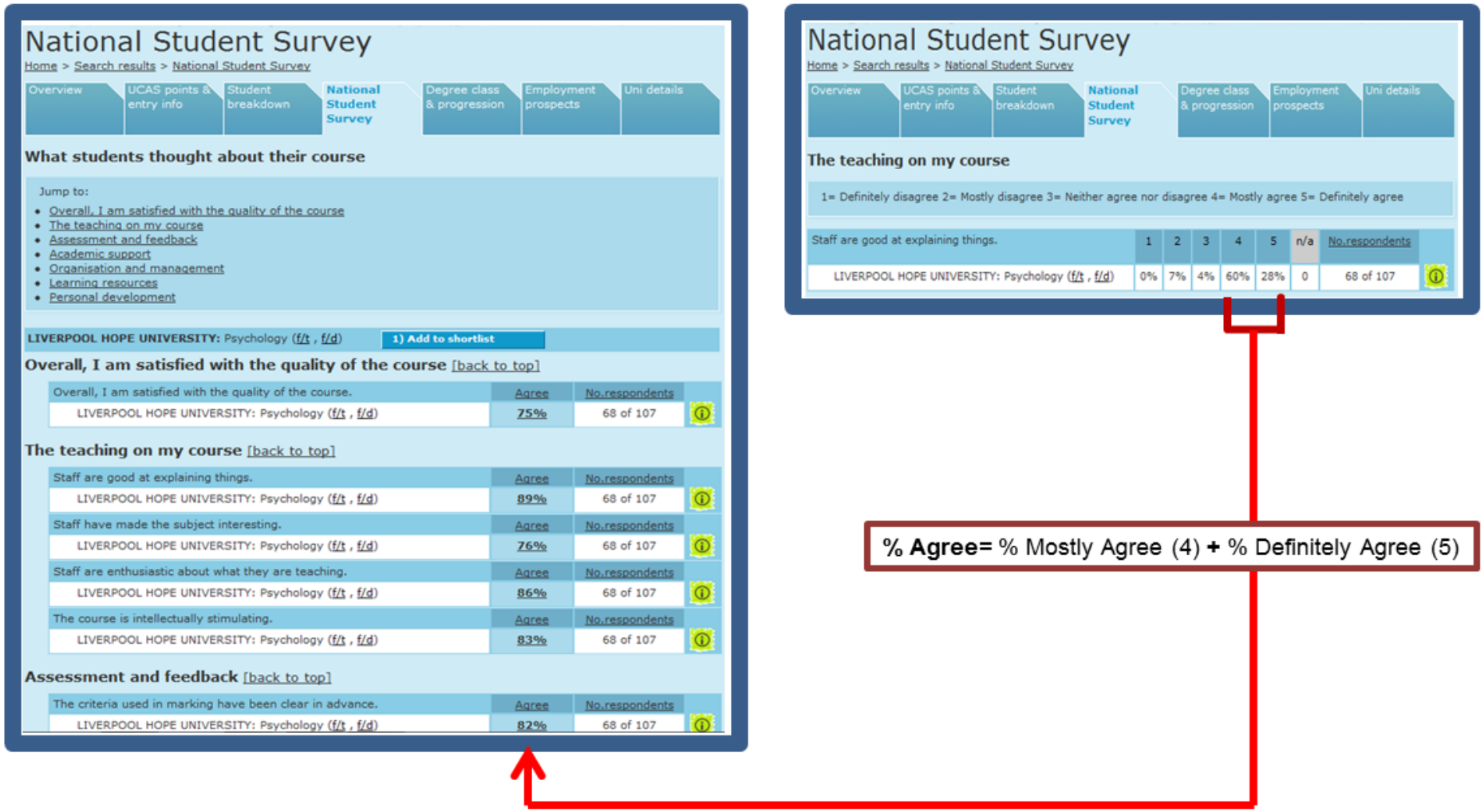


Figure 4.4. Unistats website detailed results layout for a) all 22 items b) response distribution for each item. (Unistats, 2011)

It has been argued that the NSS has become increasingly important in the decision making process for students in selecting a HEI (Asthana & Biggs, 2007). In response to this increasing importance of information about HE, a study was carried out by HEFCE (2010) to understand what information, primarily prospective students, want and need to support decisions. In the study (survey and focus groups), participants were presented with a list of relevant information items and asked to rate its usefulness for making decisions about going on to HE. Figure 4.5 represents the top 16 information items out of the 51 evaluated (items rated "very useful" by over 30% of the survey participants). A significant proportion of the information items considered "very useful" are seen to relate to student satisfaction, which corresponds to the data that can be provided via the NSS.

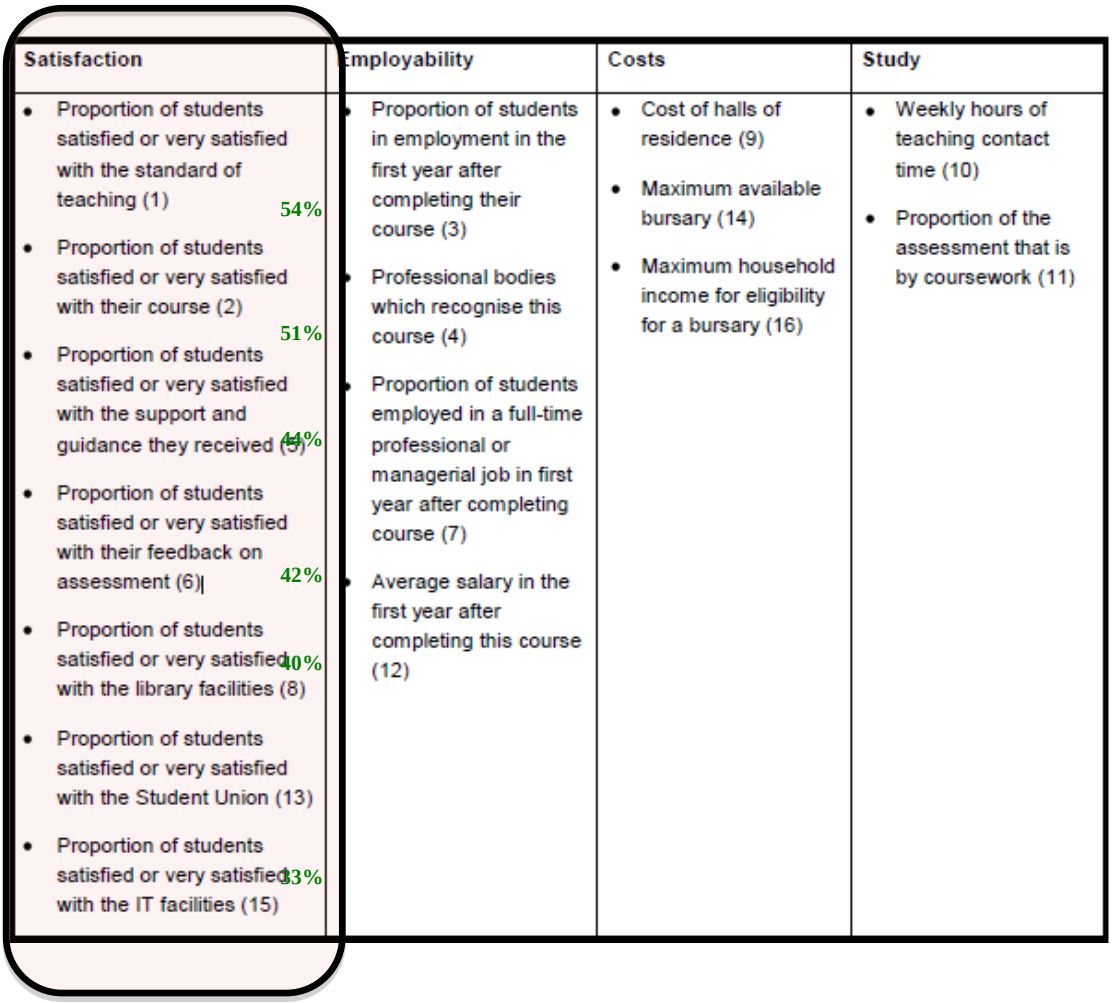


Figure 4.5. Top 16 "Very useful" items of information about going to HE ranked by the percentage of respondents indicating 'very useful' (HEFCE, 2010).

As a result of the above study a Key Information Set (KIS) concept has recently been developed as a supplement to the Unistats website. The KIS is a comparable set of

standardised information about undergraduate courses, which have been designed to meet the information needs of prospective students identified by the above study. This information includes student satisfaction data, course information, employment and salary data, accommodation costs, financial information and student union information (Figure 4.6). The student satisfaction data refers to the NSS data and attempts to portray the proportion of students satisfied or very satisfied. The value displayed as 'Overall student satisfaction' here is also the percentage sum of students that rated item 22 as "*Definitely agree*" (Likert rating 5) and "*Mostly agree*" (Likert rating 4). The rest of the information from the NSS is displayed as a bar chart that represents the percentage of students' agreement for eight NSS items that are regarded useful to prospective students for making HE choices. HEIs are expected to publish these KIS on their websites from September 2012 (HEFCE, 2011).

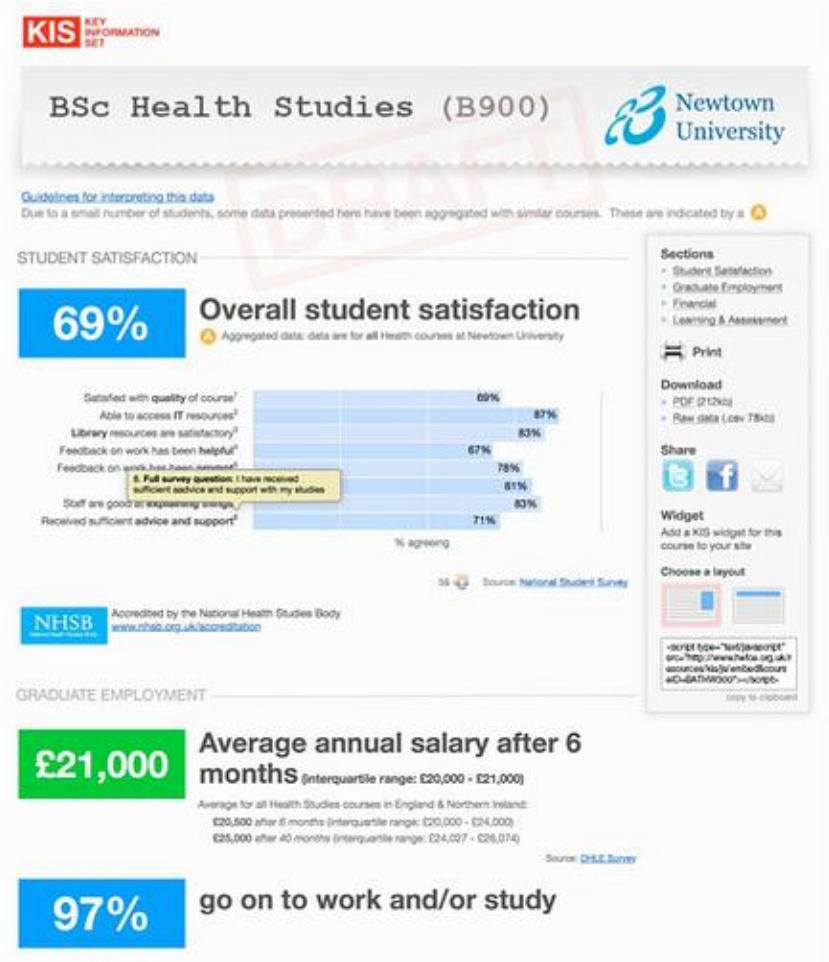
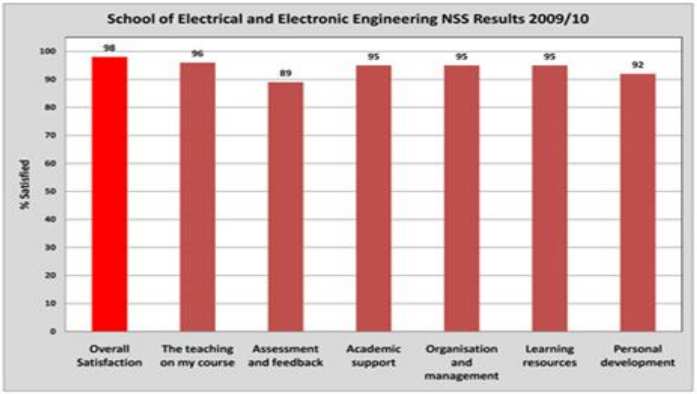


Figure 4.6. Mock-up of KIS page (HEFCE, 2011).



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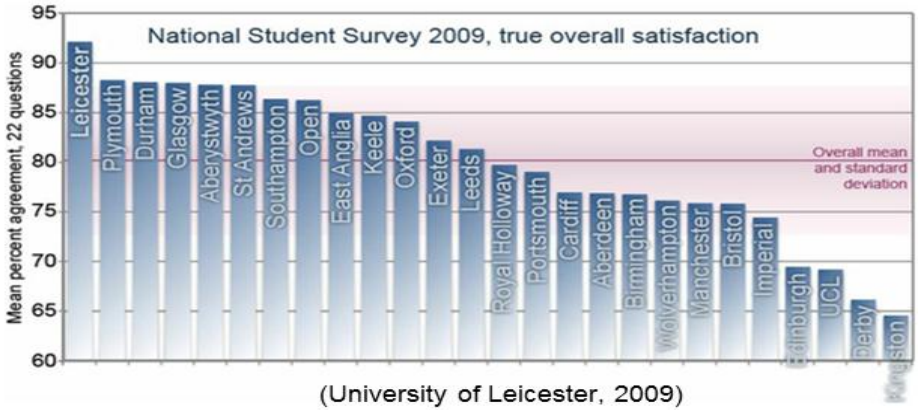

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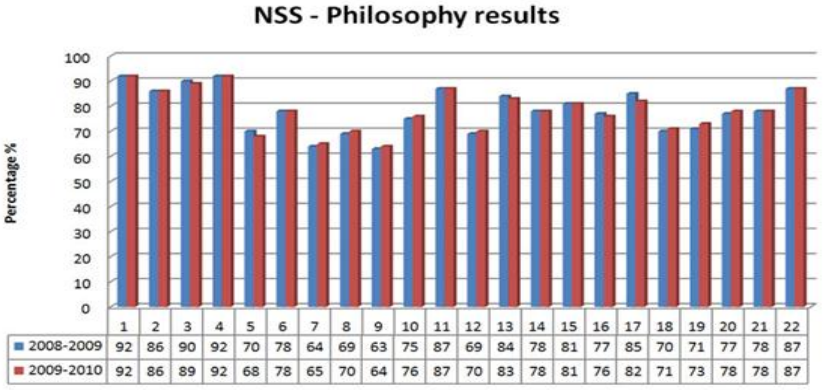

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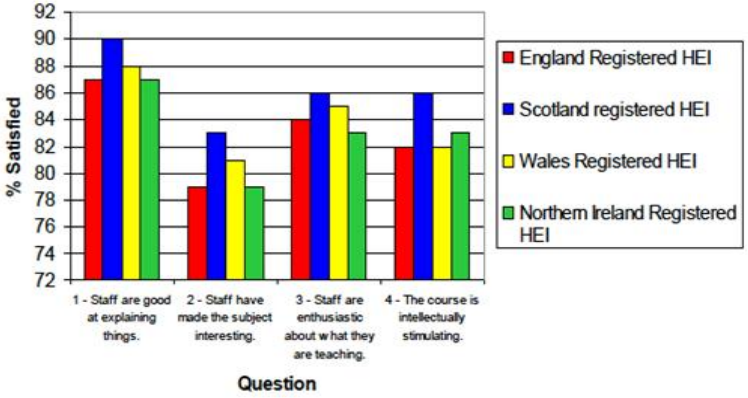


(The Scottish Government, 2010)

Figure 4.7. Graphical display of National Student Survey Results for different Institutions

In addition to this publicly available data, each institution is also provided a detailed version of the NSS data by Ipsos MORI. This consists of the raw data for each of the 22 items assessed quantitatively as well as the results for any optional items and responses to the qualitative questions. The data is broken down by discipline and by demographic categories. This demographic information is generated using a combination of Higher Education Statistics Agency (HESA) data and the NSS data. Data about every student enrolled in UK Higher Education is collected by HESA and used to create a unique 'student identifier'. This includes details such as the student's age, gender, ethnicity, disability and country of residence (Lamb, 2010). As every student's response to the NSS includes their student identifier, the combination of NSS data and HESA data allows answers to the NSS survey to be matched to individual characteristics. In order to protect student anonymity the individual data is not released to institutions but is used to generate data about how different demographic categories responded to items in the NSS and it is this aggregated data that is released to institutions (Lamb, 2010). The NSS item scores are usually further analysed by the Institution to produce faculty level, departmental level and course level feedback reports. Figure 4.7 depicts the presentation of this data by four institutions. This further indicates that bar charts are the most commonly used graphical mode for visualising student feedback data.

4.2.2 Implications of the NSS data

As highlighted in the sections above, the assessment of student perceptions has become vital in determining quality of HEIs. As a result HEIs across the UK consider inclusion and participation in the NSS to be highly desirable (Canning, 2011). Consequently, the NSS has become the UK's most widely used tool for obtaining student feedback on quality of the student learning experience. Harvey (2001, p. 2) distinguished the two main functions of student feedback as 'internal information to guide improvement' and 'external information for potential students and other stakeholders, including accountability and compliance to requirements'. Similarly, the NSS aims to provide information about the quality and standards of learning and teaching of an institute that would in turn be published to address the needs of students and other stakeholders.

However, since its introduction in 2005, the survey has raised a number of issues for HEIs in the UK. There are several criticisms and concerns about the survey instrument and methodology, the way the survey is presented to students and how results have been interpreted as student satisfaction ratings and used to construct league tables (Hewson, 2011; Prosser 2005). Prosser (2005) argues that such an interpretation is not particularly helpful as interpreting these results as satisfaction ratings, and using them to make changes to teaching practices and course design to improve the ratings, may actually be counterproductive to improving student learning experiences – and incidentally their satisfaction ratings. Prosser (2005) proposed that institutions should instead focus on interpreting the results as indicators of student experiences of the context in which their teaching and learning occur, and use these to ascertain areas of the student experience that may need further investigation.

MacDonald, Williams, and Schwarz (2003) criticised the survey, stating that the method is intrusive and provides misleading information. Swain (2009) also criticised the survey for being 'bland' and 'methodologically worthless' highlighting the inability of the survey to help detect important factors of the educational environment.

Due to the various criticisms faced by the NSS much work has been conducted to maximise the potential of the survey. Most of this work has focused on ensuring that the NSS achieves its goals of providing information for public accountability and quality assurance and improvement. Current numerical, tabular and graphical representations serve the purpose of comprehending quantitative information obtained by the NSS to HEIs and to prospective students. However, in line with the main objectives of the NSS it is unknown how effective this information is to the institution or to prospective students. Nevertheless, the role of league tables constructed from NSS data (based on Q22- '*Overall I am satisfied with the quality of my course*') in enhancing HEI reputation and informing student choice is evident.

A study by Gaffney-Rhys and Jones (2008) reported that some factors assessed in the NSS do not influence the overall student satisfaction measure as much as others in some institutions. Thus, ranking institutions using the overall satisfaction value was seen to be inconsistent with rankings based on the average mean score for each of the 6 factors assessed by the NSS. Gaffney-Rhys and Jones (2008) suggested that external factors might also influence student ratings of Q22. Therefore using only

the value of Q22 – without considering the multi-criteria nature of student satisfaction – as an indicator of quality of the learning experience at a HEI is questionable.

Yet, inclusion and participation in the NSS is considered to be desirable by senior managers and department colleagues in HEIs across the UK today (Canning, 2011). With the increment of tuition fees up to £9,000 per year in England from September 2012, understanding the student voice in higher education is becoming increasingly important for both HEIs and prospective students equally. At the moment the NSS is the most concise and uniform method of achieving this. However, Williams and Brennan (2003) remarked that the main purpose of gathering and publishing NSS data should be to increase the prospective student's knowledge of the likely student experience at a particular institution while providing HEIs an opportunity to identify areas of concern. At the moment the NSS is used as a criterion for rank ordering all HEIs in the country, yet the extent to which it achieves its main goals of providing information for public accountability and institution quality enhancement is unknown.

4.2.3 Theoretical framework for measuring and conveying student feedback

The previous sections have portrayed that the NSS is challenged in its ability to provide information about the actual quality of the students learning experience. In particular, there are questions and doubt as to whether the survey provides enough information to play a key role in the quality assurance system and help enhance the student learning experience. This can be attributed to the lack of methods for efficient data analysis and presentation of the NSS data. Interpreting the percentage of students agreeing as satisfaction ratings without a clear understanding of the influence the 21 NSS items have on overall student satisfaction. In addition, there are no standard methods that HEIs can use to easily and readily convert the data into actionable information in decision-making.

The increased perceived importance of the NSS in informing student choice means that it is more important than ever to understand how students who fill in the survey interpret the NSS items (Canning, 2011). With reports of low scoring programmes being terminated in some institutions the need for academic staff to better understand the NSS and its factors is crucial. It is worth recapping here that the ultimate purpose of the NSS is to capture and deliver information that will aid both

HEIs (for quality assurance and enhancement) and prospective students (for choosing course/HEI) decision-making concerning HE. Therefore, in order to maximise the potential of the NSS and student feedback in general, it is necessary to find a way to convert the student evaluations of quality into accurate, readily comprehensible, actionable information that is useful for both HEIs and potential students.

Quality of the student learning experience is generally defined as the difference between what a student expects to receive from their experiences associated with education and their perceptions of what is delivered to them (Grönroos, 1990; O'Neill & Palmer, 2004). Based on this traditional, one-dimensional perspective, quality is primarily judged according to perceived student satisfaction, where perceived quality (obtained from student feedback) is considered to be an antecedent to student satisfaction. Thus, the current view in HE is that the higher the quality of the student learning experiences the higher the level of student satisfaction. However, while there is no uniform definition of student satisfaction, the multi-dimensional nature of the construct is acknowledged unanimously (Hartman & Schmidt, 1995). Therefore to grasp the complexity of the learning experience, it is not enough to just know the degree to which students are satisfied. It is also necessary to understand the factors that contribute to student satisfaction (García-Aracil, 2008).

In Chapter 2, a two-dimensional model of quality – the Kano model of customer satisfaction – which defines satisfaction and quality as orthogonal to each other was described. Kano et al. (1984) highlighted the objective and subjective nature of quality and suggested that objective quality pertains to conformance to requirements (expressed by a state of physical fulfilment), while subjective quality pertains to customer satisfaction. In the case of using student feedback for improvement, failing to grasp this concept of two-dimensional quality can have consequences in terms of the outcome of decisions made based on student feedback data. This is due to the misunderstanding that satisfaction can be gained by simply improving NSS items that receive low quality ratings. Against this conceptual background the present study aims to identify those aspects assessed by the NSS that are associated with the expression of overall satisfaction. Determining which factors assessed by the NSS have the greatest influence on student satisfaction has the potential to provide information about which actions need to be taken to improve the quality of the student learning experience. In Chapter 2, a framework for applying the Kano model for evaluating multi-criteria type data was presented which can be used

to achieve this. This method provides a method for obtaining metric of student satisfaction which takes into account the non-linear relationship between satisfaction and quality items (for improvement and accountability) and has the ability to portray which aspects of the multiple criteria needs action.

While the above addresses the effective analysis of NSS data, the next challenge is the presentation of this data in a manner that that will maximise the potential of the NSS data and student feedback in general. In Chapter 1, the potential of FEs of emotion to convey non-verbal feedback 'at-a-glance' was highlighted. It is in this context that virtual FEs are proposed as a means of conveying student feedback. As described earlier, current presentation of NSS data is limited to numeric, tabular and bar chart formats. Conveying student satisfaction as a naturalistic face has the potential to convert the NSS data into actionable information that can be interpreted 'at-a-glance'. Based on Musterle and Rossler's (1986) idea of computer faces', outlines of faces which had affective content were mapped to numerical points in the one-dimensional and two dimensional satisfaction spaces in Chapter 3.

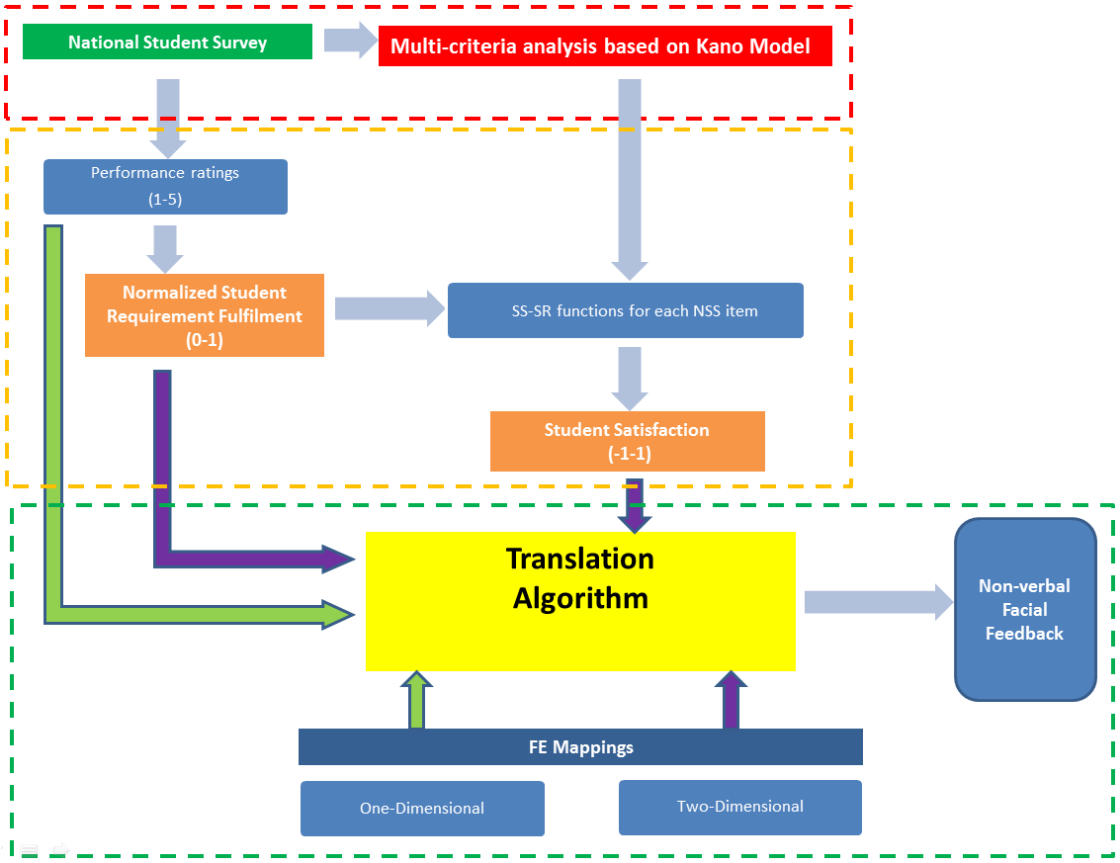


Figure 4.8. Proposed framework for analysing and presenting NSS feedback data

Using the framework depicted in Figure 4.8, the above theoretical concepts can be linked to convert numerical student feedback data obtained by the NSS into a FE depiction. This chapter is concerned with the first of stage of this framework which is concerned with the efficient analysis of the NSS data. The following section provides a case study which addresses this.

4.3 Measuring Student Satisfaction: Application of the Kano Model of Customer Satisfaction to the National Student Survey Data

4.3.1 Purpose

The purpose of this preliminary study was to demonstrate the applicability of the Kano model to investigate the impact of the student requirements (SR) assessed by the NSS on student satisfaction (SS). Based on the conceptual framework described in Chapter 2 this method can be used to obtain actual measures of SS that can then be conveyed using FEs based on the mappings obtained from Chapter 3. Thus the primary objective of the case study is to use the NSS to obtain an accurate metric for student satisfaction that can be successfully conveyed using a FE.
The study was conducted in three parts:

a) Transformation of the NSS to a Kano questionnaire
b) Administration of the Kano Questionnaire
c) Processing these results and applying the Kano qualitative and quantitative analysis
d) Using the results of the Kano analysis to calculate student satisfaction (SS)

Developing and administering the Kano questionnaire

As described in section 4.2.1, the NSS consists of 21 statements which assess 6 factors related to the quality of the student learning experience (Appendix 7). For the purpose of this study the 6 factors are classed as primary requirements and each of the 21 NSS items as secondary requirements. Table 4.1 represents the classification of the NSS in terms of primary and secondary requirements. A Kano questionnaire was developed based on these 21 secondary requirements. The questionnaire consisted of 42 questions which follows the standard format of the Kano questionnaire: functional

and dysfunctional forms of each of the 21 SRs. As described in Chapter 2, the functional form of the question asks the students how they will feel if the requirement was present and the dysfunctional form of the question asks how the student will feel if the requirement was not present. Participants were required to express their feelings on a 5- point Likert-like scale with the response alternatives: *I like it that way*, *It must be that way*, *I am neutral*, *I can live with it that way* and *I dislike it that way* (see Appendix 8 for full Kano questionnaire).

Table 4.1. *Classification of Primary and Secondary student requirements (SRs) based on the National Student Survey*

Primary Requirement	**Secondary Requirement**	
Teaching	SR1	Staff are good at explaining things
	SR2	Staff have made the subject interesting
	SR3	Staff are enthusiastic about what they are teaching
	SR4	The course is intellectually stimulating
Assessment and feedback	SR5	The criteria used in marking have been clear in advance
	SR6	Assessment arrangements and marking have been fair
	SR7	Feedback on my work has been prompt
	SR8	I have received detailed comments on my work
	SR9	Feedback on my work has helped me clarify things I did not know
Academic support	SR10	I have received sufficient advice and support with my studies
	SR11	I have been able to contact staff when I needed to
	SR12	Good advice was available when I needed to make study choices
Organisation and management	SR13	The timetable works efficiently as far as my activities are concerned
	SR14	Any changes in the course or teaching have been communicated effectively
	SR15	The course is well organised and is running smoothly
Learning resources	SR16	The library resources and services are good enough for my needs
	SR17	I have been able to access general IT resources when I needed to
	SR18	I have been able to access specialised equipment, facilities, or rooms when I needed to
Personal development	SR19	The course has helped me to present myself with confidence
	SR20	My communication skills have improved
	SR21	As a result of my course, I feel confident in tackling unfamiliar problems

The Kano questionnaire was then administered in three batches to a group of 42 postgraduate students. Following the completion of the Kano questionnaire the students were also required to complete the original NSS to provide feedback on their course. Table 4.2 provides details of the student sample and questionnaire administration method.

Table 4.2. *Properties of the student sample*

Group	**Administration Method**		**Total No. of Students**	**Overseas Students**	**UK/EU Students**
	Kano	***NSS***			
1	Written	Written	11	9	2
2	Written	Written	22	22	0
3	GUI Input	Written	9	9	0
Overall			42	40	2

4.3.2 Processing survey results

Based on the survey results, each of the 21 secondary SRs and the 6 primary SRs were classified according to the traditional Kano evaluation table (Figure 2.9b). Further to classifying the SRs into the Kano requirement types the satisfaction and dissatisfaction indexes ('for better' and 'for worse') were calculated for each of the secondary SR. For the purpose of this study these have been named *SSi* (Student Satisfaction index) and *SDi* (Student Dissatisfaction Index). As described in Chapter 2 these values indicate the impact of fulfilment of the SR on satisfaction and the impact of non-fulfilment of this SR on dissatisfaction respectively. Table 4.3 provides a summary of the data obtained from the above analysis.

A majority of the SRs (14) were classified as one-dimensional (O) implying that the fulfilment of these requirements results in satisfaction while non-fulfilment will result in satisfaction. Four SRs (SR4, SR5, SR8 and SR12) were classified as attractive or exciting (A) implying that the fulfilment of these requirements influences satisfaction while non-fulfilment will not result in dissatisfaction. Three SRs (SR6, SR7 and SR21) were classified as must-be (M) implying that the fulfilment of these requirements does not influence satisfaction greatly as these are expected. However, non-fulfilment of these requirements will result in dissatisfaction. It is worth noting that SR6 (*Assessment arrangements and marking have been fair*) is expected in HE

and the classification of this SR as a must-be requirement illustrates the ability of the Kano model to extract such relationships.

Table 4.3. *Summary Table of Qualitative and Quantitative Kano model based analysis of the National Student Survey student requirements.*

Secondary Requirement	A	M	O	R	Q	I	Total	Kano Category	SSi (For Better)	SDi (For Worse)
SR1	12	4	23	0	0	3	42	O	0.83	-0.64
SR2	11	5	18	1	1	6	42	O	0.73	-0.58
SR 3	11	9	13	1	1	7	42	O	0.60	-0.55
SR4	13	5	8	3	3	10	42	A	0.58	-0.36
SR5	15	7	4	3	3	10	42	A	0.53	-0.31
SR6	11	12	9	0	5	5	42	M	0.54	-0.57
S7	10	11	4	3	1	13	42	M	0.37	-0.39
SR8	20	3	4	0	6	9	42	A	0.67	-0.19
SR9	4	8	17	2	5	6	42	O	0.60	-0.71
SR10	13	6	16	1	3	3	42	O	0.76	-0.58
SR11	9	10	17	1	1	4	42	O	0.65	-0.68
SR12	15	12	8	0	1	6	42	A	0.56	-0.49
SR13	6	7	22	1	1	5	42	O	0.70	-0.73
SR14	8	10	20	0	1	3	42	O	0.68	-0.73
SR15	6	10	20	2	0	4	42	O	0.65	-0.75
SR16	10	9	14	0	2	7	42	O	0.60	-0.58
SR17	7	8	18	3	2	4	42	O	0.68	-0.70
SR18	11	4	16	1	5	5	42	O	0.75	-0.56
SR19	13	3	19	2	3	2	42	O	0.86	-0.59
SR20	8	3	26	1	3	1	42	O	0.89	-0.76
SR21	6	10	6	4	6	10	42	M	0.38	-0.50

The *SSi* and *SDi* for each SR was used to generate the two-dimensional representation of Kano categories shown in Figure 4.9. The satisfaction axis ranges from 0 to 1 while the dissatisfaction axis ranges from 0 to -1. The closer the SR is to 1 in this representation, the greater its influence on SS if the requirement is fulfilled. Similarly the closer the SR is to -1, the greater its impact on dissatisfaction if the requirement is not fulfilled. The cluster of SRs on the upper right hand corner of the plot represents the one dimensional requirements. As highlighted earlier, a majority of the SRs fall in this quadrant. They indicate that their fulfilment will result in SS and non-fulfilment will result in SS according to traditional satisfaction models. The SR4, SR5 and SR8 are seen on the upper left quadrant showing more impact on satisfaction and less impact on dissatisfaction which is a characteristic of attractive features. SR12 (*Good advice was available when I needed to make study choices*) although classified as attractive according to the traditional Kano model does have more impact on SS

compared to the other attractive SRs. On further analysis of the frequency of student classifications it is evident that SR12 was also classified as a must-be requirement by many students. This possible ambiguity of the classification this SR could be an indication of segmentation of the students. As the student sample consisted of postgraduate students, the students are expected to be independent learners. However in the present study this segmentation was not further investigated. A similar ambiguity is seen for SR7 (*Feedback on my work has been prompt*) which was classified as a must-be (M) requirement according to the Kano evaluation rule (M>O>A>I). Some students classified prompt feedback as attractive while others classified it as must-be. A similar number of students also classified this requirement as indifferent implying that this requirement does not have an impact of satisfaction or dissatisfaction. This ambiguity could also be a result of a student segmentation which was not investigated further here. As overstating satisfaction is more harmful and understating satisfaction, the classifications of SRs with ambiguities were always based on the original Kano evaluation rule.

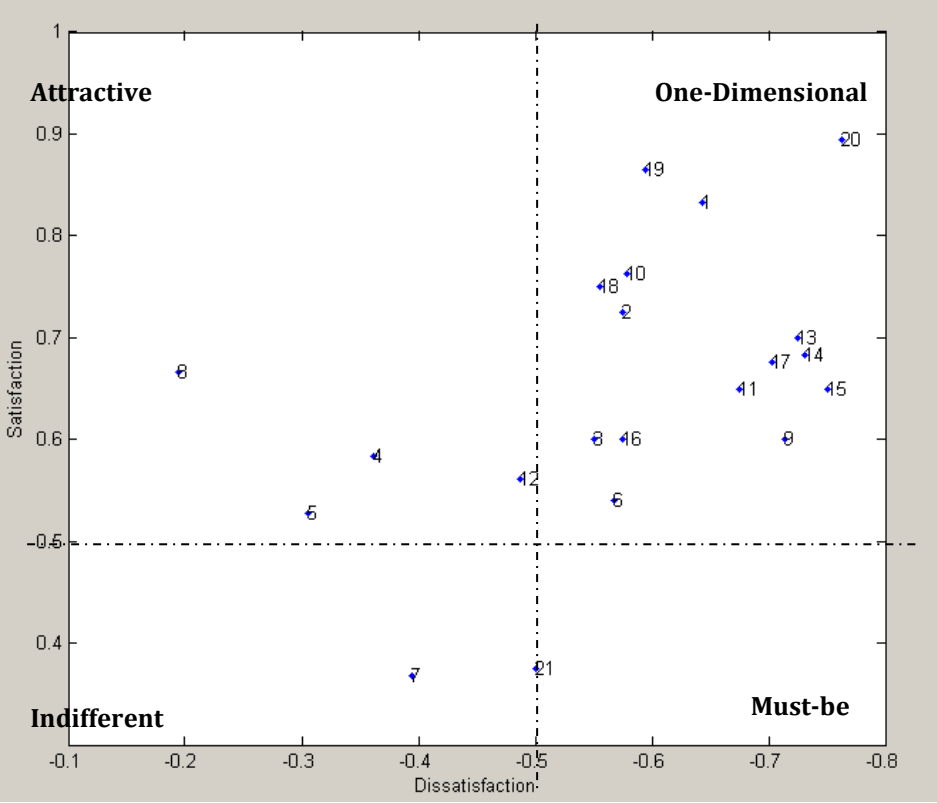


Figure 4.9. Influence of the 21 secondary student requirements assessed by the NSS on student satisfaction and dissatisfaction.

Figures 4.10-4.15 display the asymmetric relationship between the 21 secondary requirements and their respective 6 primary requirements. The red bar depicts the impact of the SR on student dissatisfaction if this requirement was not fulfilled. The blue bar depicts the influence of this SR on student satisfaction if fulfilled.

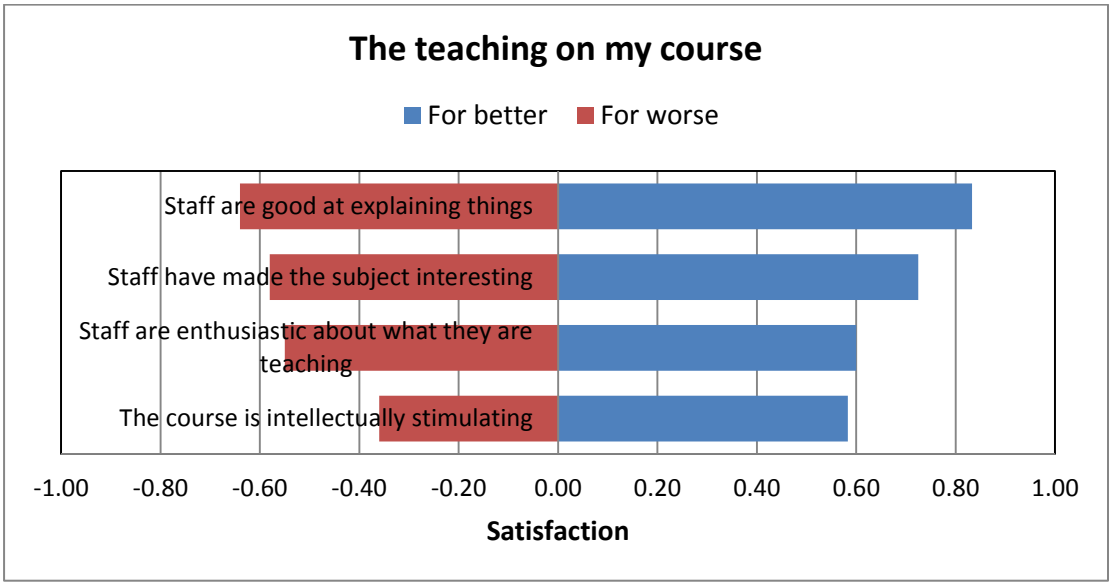


Figure 4.10. The asymmetric impact of secondary requirement performance on student satisfaction with Teaching (SRs =4)

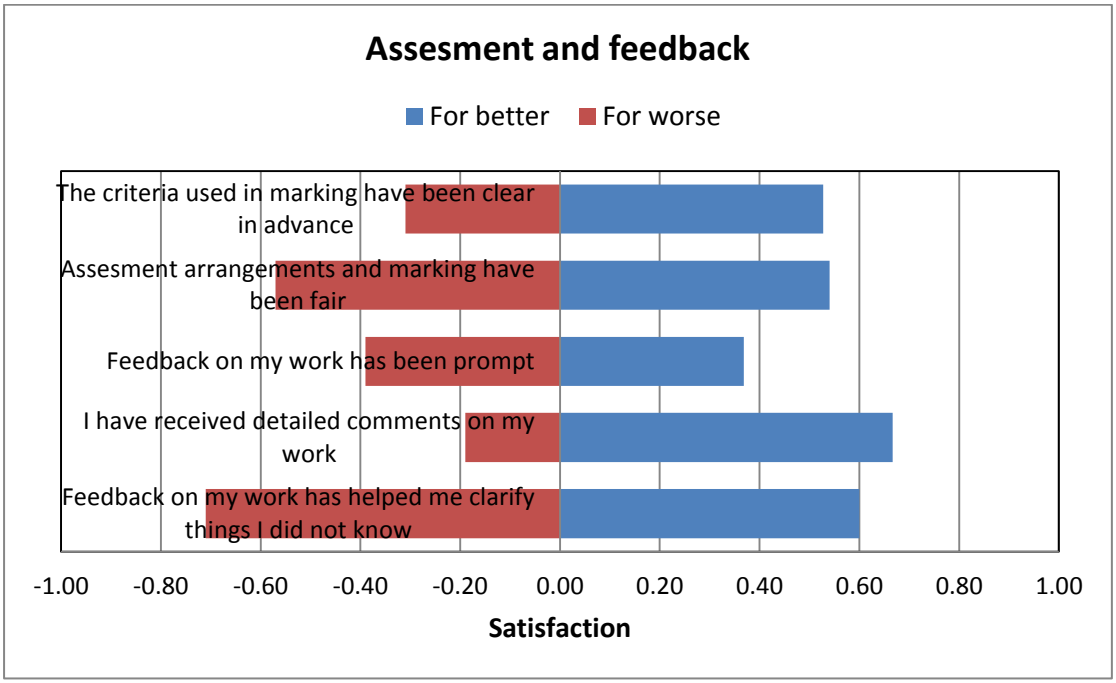


Figure 4.11. The asymmetric impact of secondary requirement performance on student satisfaction with Assessment and feedback (SRs = 5)

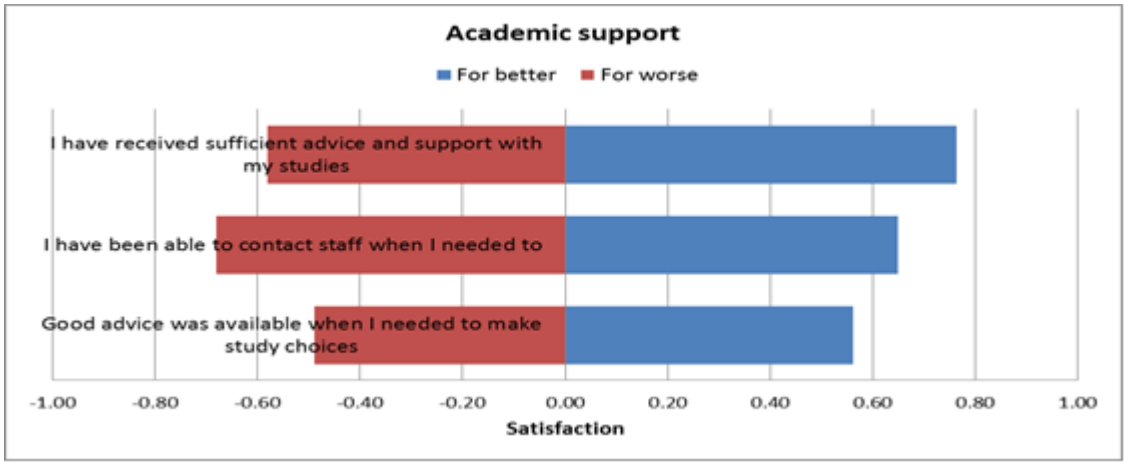


Figure 4.12. The asymmetric impact of secondary requirement performance on student satisfaction with Academic support' (SRs = 3)

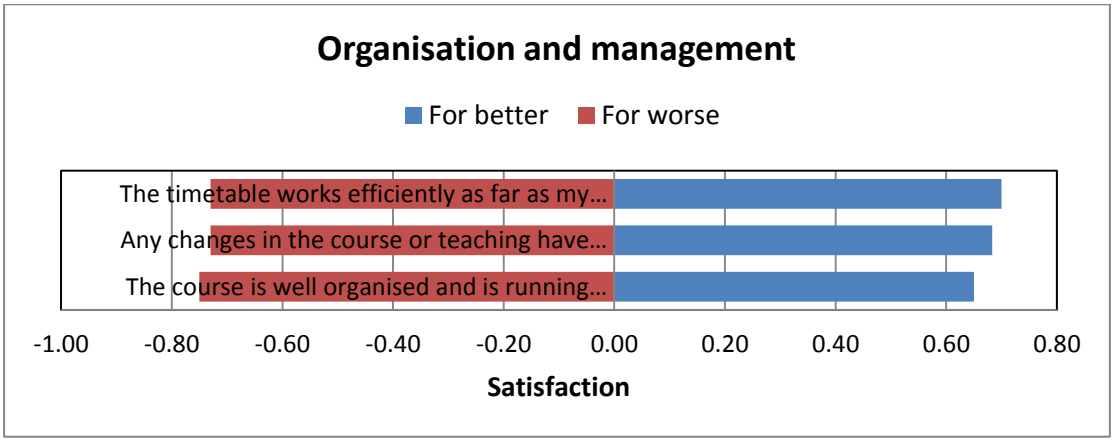


Figure 4.13. The asymmetric impact of secondary requirement performance on student satisfaction with Organisation and management (SRs = 3)

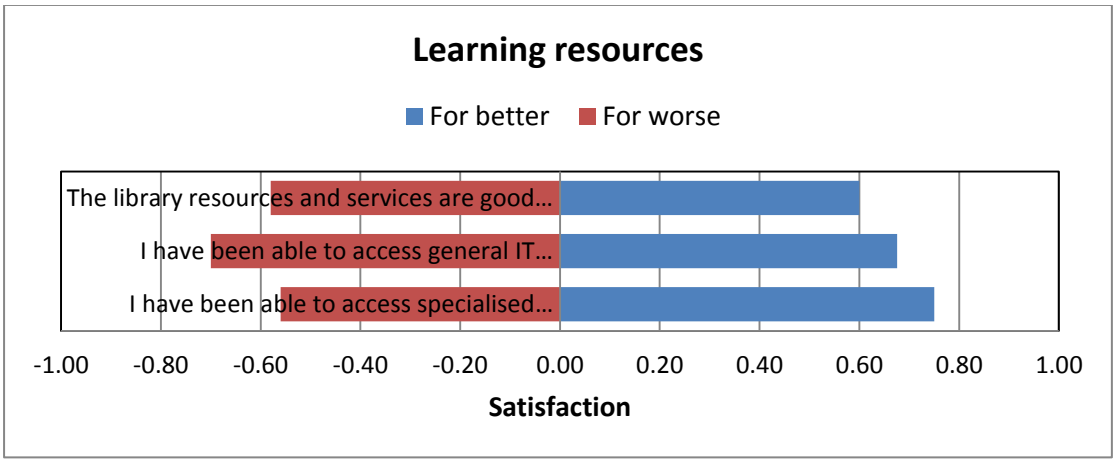


Figure 4.14. The asymmetric impact of secondary requirement performance on student satisfaction with Learning resources (SRs = 3)

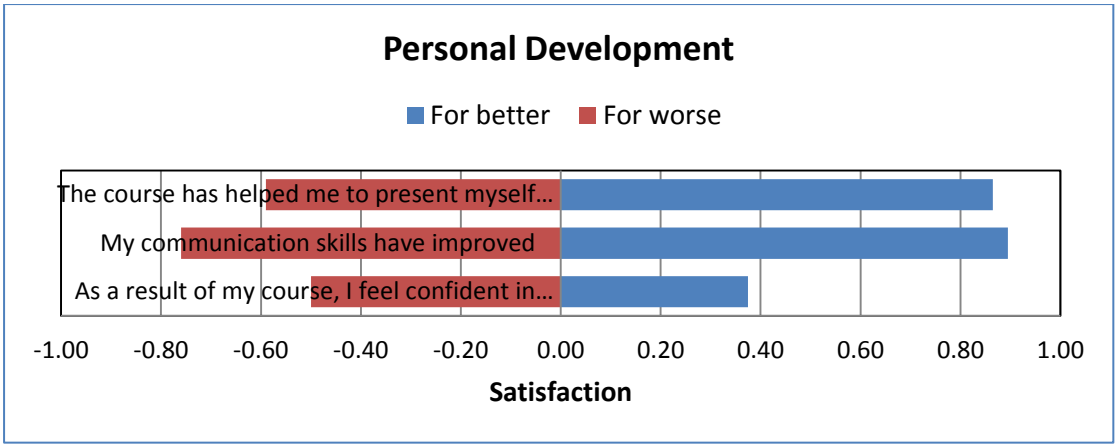


Figure 4.15. The asymmetric impact of secondary requirement performance on student satisfaction with Personal Development' (SRs = 3)

As the 6 primary requirements were not separately assessed in the Kano questionnaire, they were manually classified into Kano categories based on the sum must-be, attractive and one dimensional classifications of each SR under the category. Based on these values the CSi (for better) and DSi (for worse) values for each primary requirement was deduced. Figure 4.16 shows the impact of each of the 6 PRs on overall student satisfaction. The primary requirement '*Assessment and feedback'* was classified as an attractive requirement while the rest were all classified as one-dimensional.

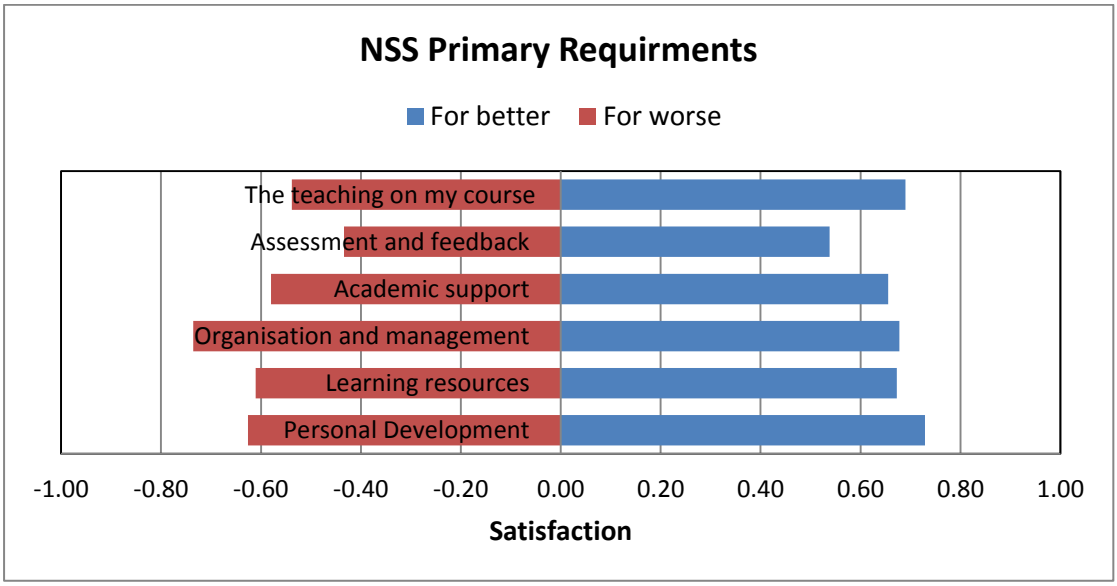


Figure 4.16. The asymmetric impact of primary requirement performance on overall student satisfaction (PRs = 6)

4.3.2.1 Identifying SS-SR relationship functions

In the previous step, two importance values (*SSi* and *SDi*) were calculated for each of the 21 secondary SRs and the 6 primary SRs in the NSS. Next, Wang and Ji's (2010) approach to identifying relationship functions described in Chapter 2 was used to derive a set of 21 functions for calculating satisfaction for the secondary SRs and 6 functions for calculating satisfaction for the primary SRs. The functions assume that the level of requirement fulfilment is a continuous measure ranging from 0 to 1. The *SSi* (for better) and *DSi* (for worse) values corresponds to the level of satisfaction where the requirement is fulfilled (RF=1) and not fulfilled (RF=0) respectively. Therefore the degree satisfaction is assumed to vary from -1 to 1. Using these assumptions and the Kano classifications, the *SS-SR* functions in Table 4.4 were deduced.

In addition, *SSi* and *SDi* values were calculated for each of the 6 primary SRs in the NSS. These were then used to derive the *SS-SR* functions for the 6 primary requirements presented in Figure 4.5. In order to portray the relationships, the requirement fulfilment scale was calibrated to an interval scale with the points 0, 0.25, 0.5, 0.75, 1. The degree of satisfaction corresponding to each level of requirement fulfilment was calculated using the SS-SR functions for the all student requirements. The relationship curves between student satisfaction and SR fulfilment are represented graphically in Figures 4.17- 4.19. The figures further portray the non-linear relationship between student satisfaction and fulfilment of the attractive and must-be requirements. In the case of the one-dimensional SRs, the impact on satisfaction is not equal for these requirements. This is portrayed by the different linear relationships obtained for each of the one-dimensional SRs.

In summary, so far, the relationship between student satisfaction and the student requirements assessed in the NSS have been deduced using the Kano method. The classifications and the *SS-SR* functions obtained can thus be used to calculate the level of Satisfaction for each secondary requirement, primary requirement and ultimately the overall student satisfaction. The next section provides a framework for calculating student satisfaction based on these findings.

Table 4.4. *SS-SR functions for the 21 secondary SRs assessed in the National Student Survey.*

Student Requirement	CS Point	DS Point	a	b	$f(x)$	$S = af(x) + b$
One-dimensional						
SR1	(1, 0.83)	(0, -0.64)	1.48	-0.64	x	$S = \mathbf{1.48}x - 0.64$
SR2	(1, 0.73)	(0, -0.58)	1.30	-0.58	x	$S = \mathbf{1.30}x - 0.58$
SR3	(1, 0.60)	(0, -0.55)	1.15	-0.55	x	$S = \mathbf{1.15}x - 0.55$
SR9	(1, 0.60)	(0, -0.71)	1.31	-0.71	x	$S = \mathbf{1.31}x - 0.71$
SR10	(1, 0.76)	(0, -0.58)	1.34	-0.58	x	$S = \mathbf{1.34}x - 0.58$
SR11	(1, 0.65)	(0, -0.68)	1.33	-0.68	x	$S = \mathbf{1.33}x - 0.68$
SR13	(1, 0.70)	(0, -0.73)	1.43	-0.73	x	$S = \mathbf{1.43}x - 0.73$
SR14	(1, 0.68)	(0, -0.73)	1.41	-0.73	x	$S = \mathbf{1.41}x - 0.73$
SR15	(1, 0.65)	(0, -0.75)	1.40	-0.75	x	$S = \mathbf{1.40}x - 0.75$
SR16	(1, 0.60)	(0, -0.58)	1.18	-0.58	x	$S = \mathbf{1.18}x - 0.58$
SR17	(1, 0.68)	(0, -0.70)	1.38	-0.70	x	$S = \mathbf{1.38}x - 0.70$
SR18	(1, 0.75)	(0, -0.56)	1.31	-0.56	x	$S = \mathbf{1.31}x - 0.56$
SR19	(1, 0.86)	(0, -0.59)	1.46	-0.59	x	$S = \mathbf{1.46}x - 0.59$
SR20	(1, 0.89)	(0, -0.76)	1.66	-0.76	x	$S = \mathbf{1.66}x - 0.76$
Attractive						
SR4	(1, 0.58)	(0, -0.36)	0.13	0.23	e^x	$S = \mathbf{0.13}e^x + 0.23$
SR5	(1, 0.53)	(0, -0.31)	0.13	0.18	e^x	$S = \mathbf{0.13}e^x + 0.18$
SR8	(1, 0.67)	(0, -0.19)	0.27	-0.08	e^x	$S = \mathbf{0.28}e^x - 0.08$
SR12	(1, 0.56)	(0, -0.49)	0.04	0.45	e^x	$S = \mathbf{0.04}e^x + 0.45$
Must-be						
SR6	(1, 0.54)	(0, -0.57)	-0.04	0.52	$-e^{-x}$	$S = -\mathbf{0.04}e^{-x} + 0.52$
SR7	(1, 0.37)	(0, -0.39)	-0.04	0.35	$-e^{-x}$	$S = -\mathbf{0.04}e^{-x} + 0.35$
SR21	(1, 0.38)	(0, -0.50)	-0.20	0.30	$-e^{-x}$	$S = -\mathbf{0.20}e^{-x} + 0.30$

Table 4.5. *SS-SR functions for the 6 primary SRs assessed in the National Student Survey.*

Primary Requirement	**CS Point**	**DS Point**	**a**	**b**	$f(x)$	$\boldsymbol{S = af(x) + b}$
One-dimensional						
The teaching on my course	(1, 0.69)	(0, -0.54)	1.23	-0.54	x	$\boldsymbol{S = 1.23}x - 0.54$
Academic support	(1, 0.73)	(0, -0.58)	1.30	-0.58	x	$\boldsymbol{S = 1.30}x - 0.58$
Organisation and management	(1, 0.68)	(0, -0.74)	1. 41	-0.74	x	$\boldsymbol{S = 1.41}x - 0.74$
Learning resources	(1, 0.67)	(0, -0.61)	1.28	-0.61	x	$\boldsymbol{S = 1.28}x - 0.61$
Personal Development	(1, 0.73)	(0, -0.63)	1.36	-0.63	x	$\boldsymbol{S = 1.34}x - 0.58$
Attractive						
Assessment and feedback	(1, 0.54)	(0, -0.43)	0.57	-1.00	e^x	$\boldsymbol{S = 0.57}e^x - 1.00$

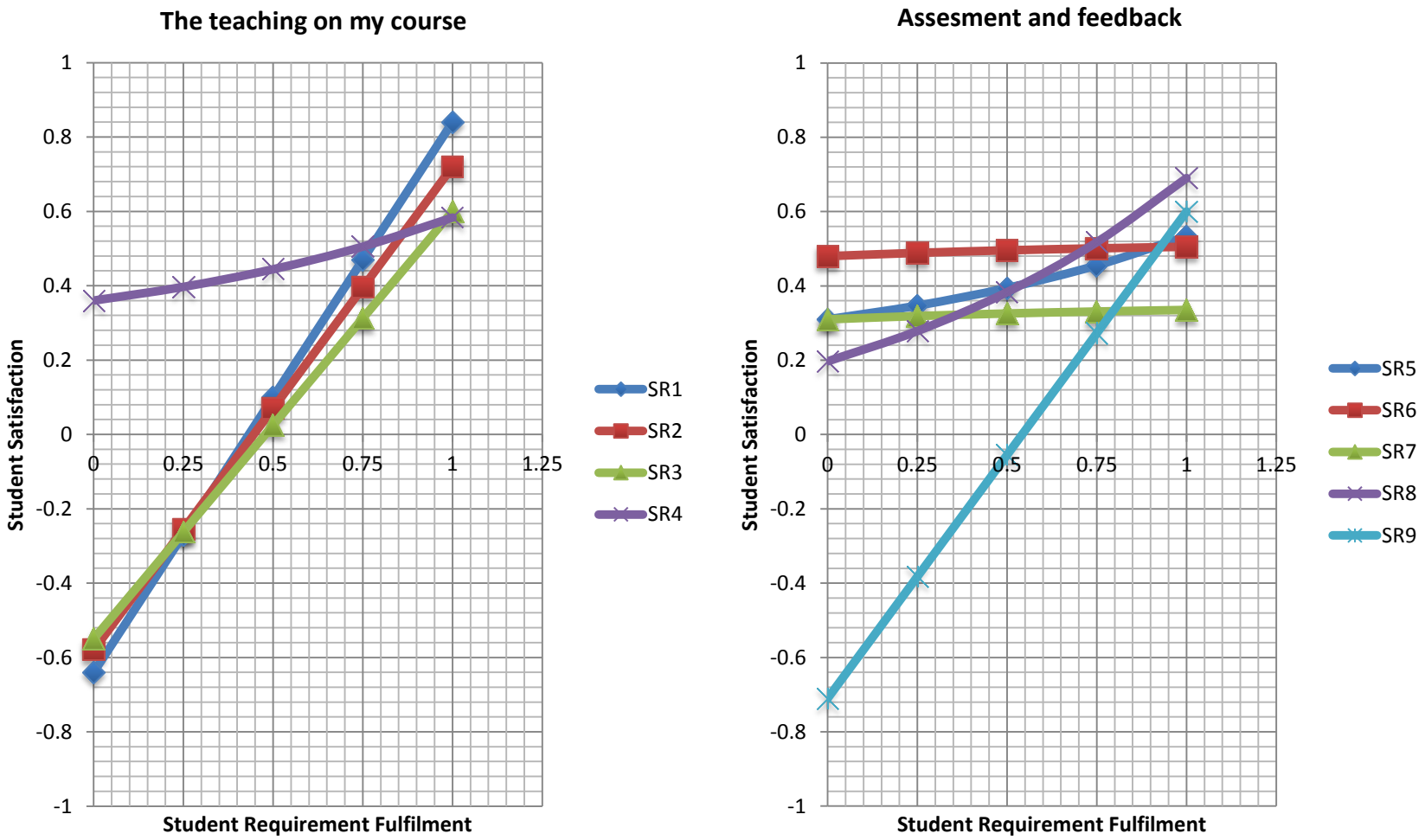


Figure 4.17. Graphical representation of SS-SR functions

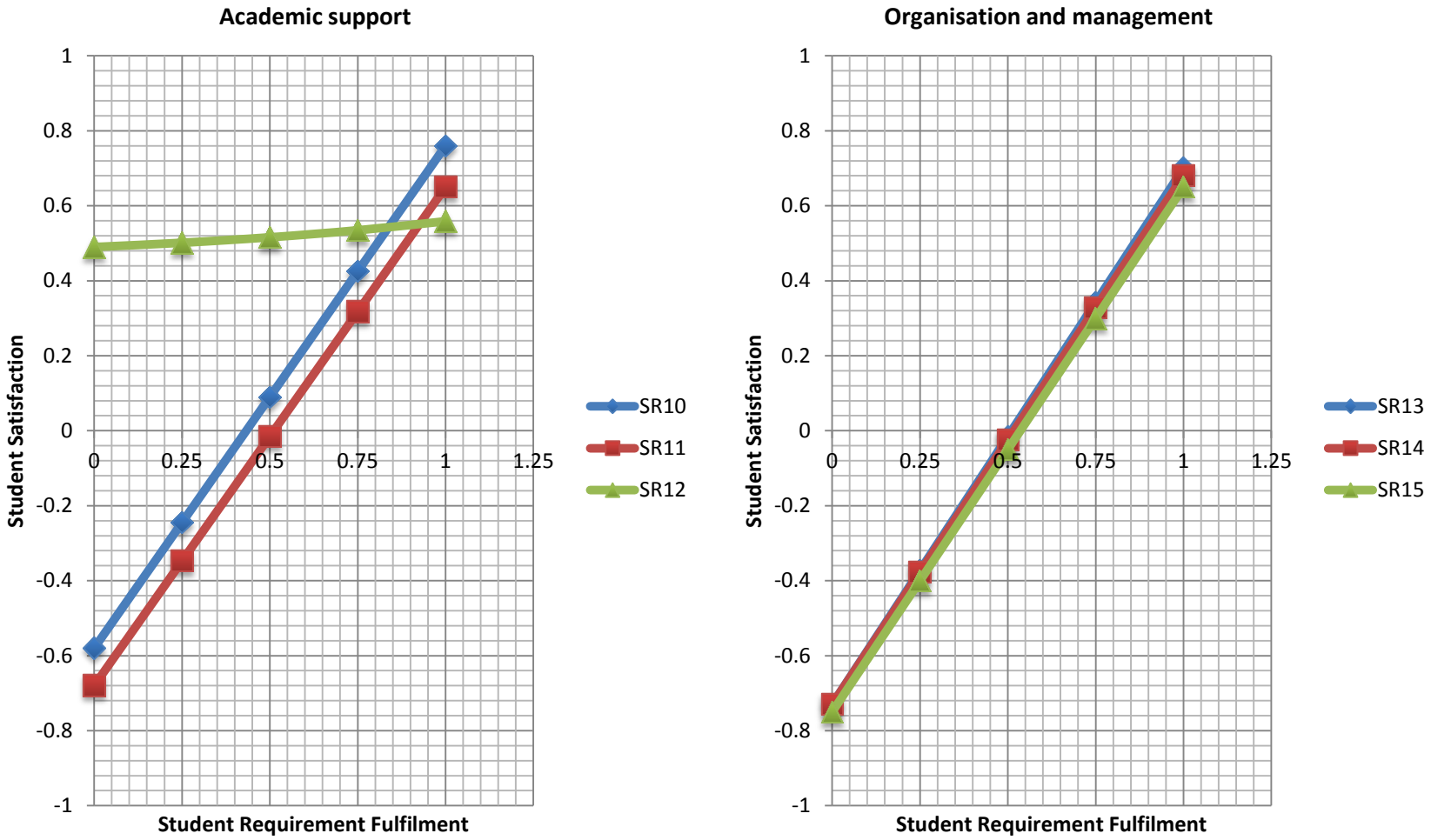


Figure 4.18. Graphical representation of SS-SR functions

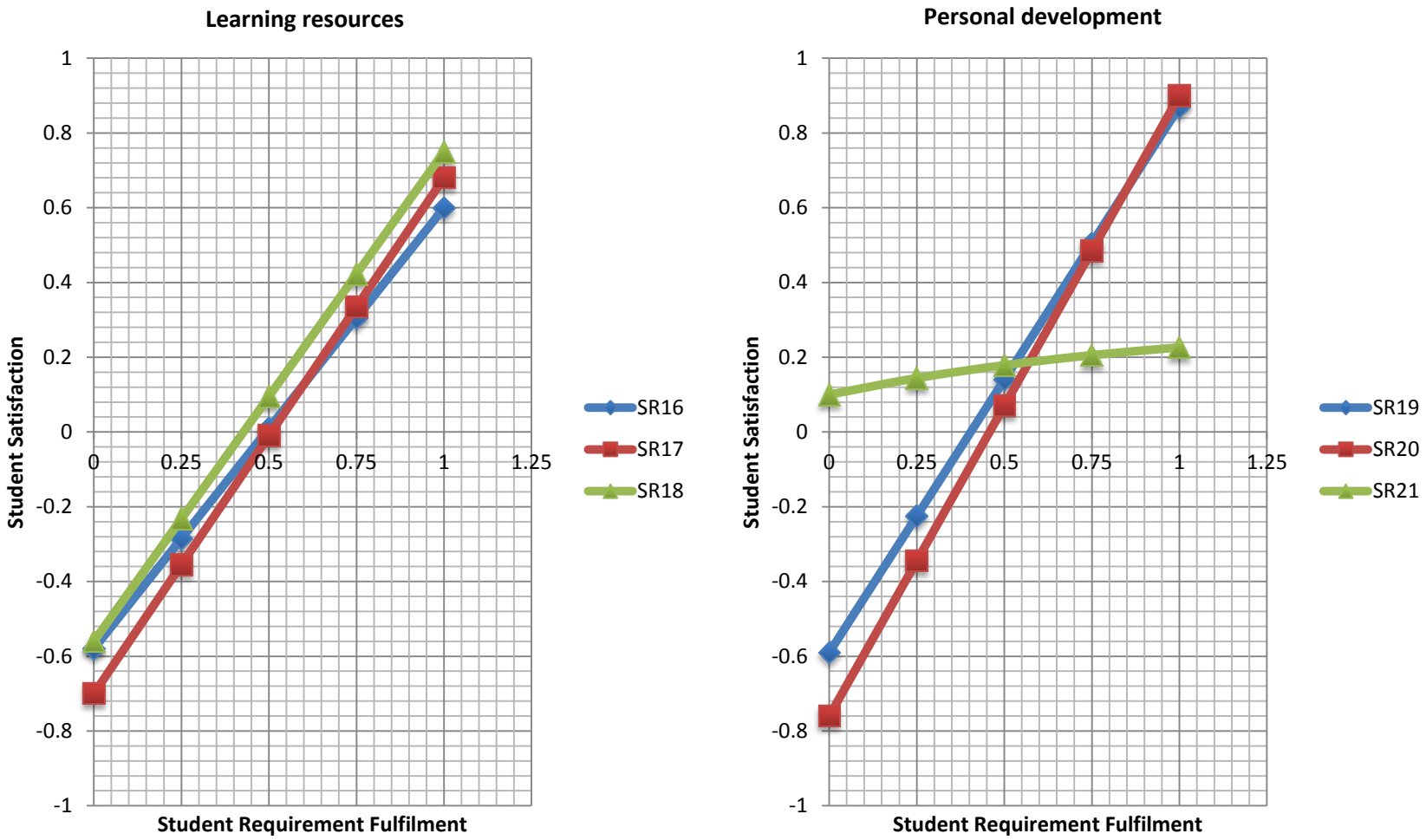


Figure 4.19. Graphical representation of SS-SR functions

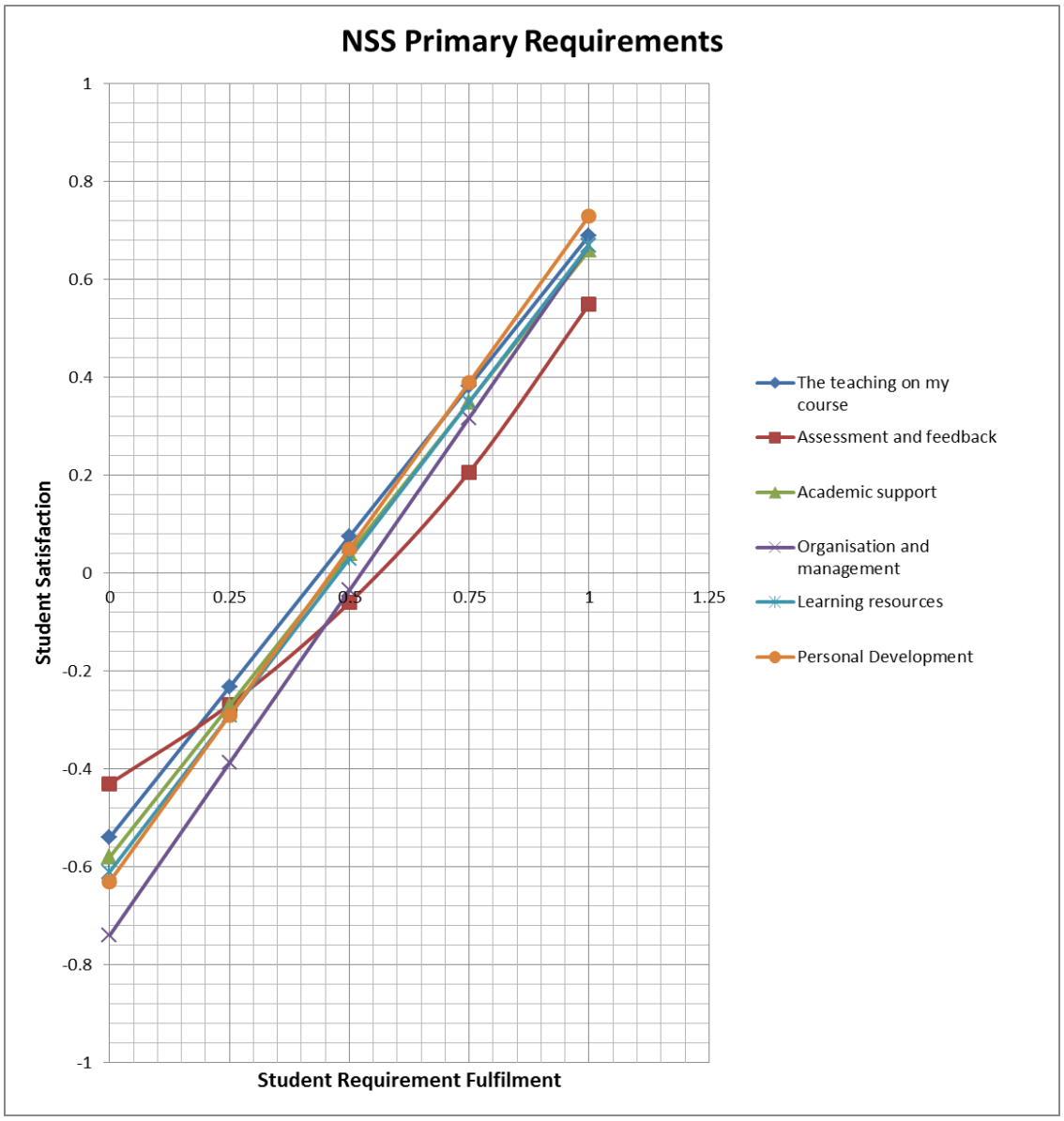


Figure 4.20. Relationship curves between student satisfaction and student requirement fulfilment for the 6 primary requirements.

4.3.3 Measuring Student Satisfaction

As described in section 4.2.1 the NSS measures the quality of the student learning experience for 6 factors using 21 Likert items. In addition the overall student satisfaction with the quality of the learning experience is also assessed (Q22). Based on the above preliminary study the 21 items were classed as secondary requirements and their respective factors as primary requirements. The next section of the study aims to use student evaluations obtained using the NSS to compute student satisfaction (SS). The NSS assumes that all SRs have the same impact on SS. As highlighted in Chapter 2 assuming

this type of linearity between requirements and satisfaction neglects the possible influence of different SRs on SS. Therefore the accuracy of the measures obtained are questionable. This can also pose problems in effective decision-making based on the NSS results as the degree of SS could be overestimated or underestimated.

In the previous section, the Kano method was used to identify the impacts of the 21 secondary SRs and 6 primary SRs on SS. The results showed that different SRs have a different and varying impact on SS. In order to enable the efficient handling of the NSS data, the following framework is proposed that can be used to compute the level of SS taking into account the asymmetric relationship between SR fulfilment and SS.

Students respond to the NSS statements (SRs) using a 5- point Likert scale (*Definitely agree* to *Definitely disagree*). The 21 statements in the NSS are all functional statements of the SRs therefore the student response entails the agreement or disagreement regarding the fulfilment of a SR. Thus, it is assumed here that the Likert scale ratings represent the level of SR fulfilment, where a rating of '*definitely agree*' corresponds to requirement fulfilment and a rating of '*definitely disagree*' corresponds to requirement non-fulfilment. Based on this the Likert scale ratings from 1-5 can be normalised to an interval scale of requirement fulfilment ranging from 0-1 (Figure 4.21). Assuming an interval level of measurement here allows the computation of a mean. The normalised RF rating for each SR can then be used as the value of *x* in the *SS-SR* equations deduced above to find the level of satisfaction for each NSS item (4.22).

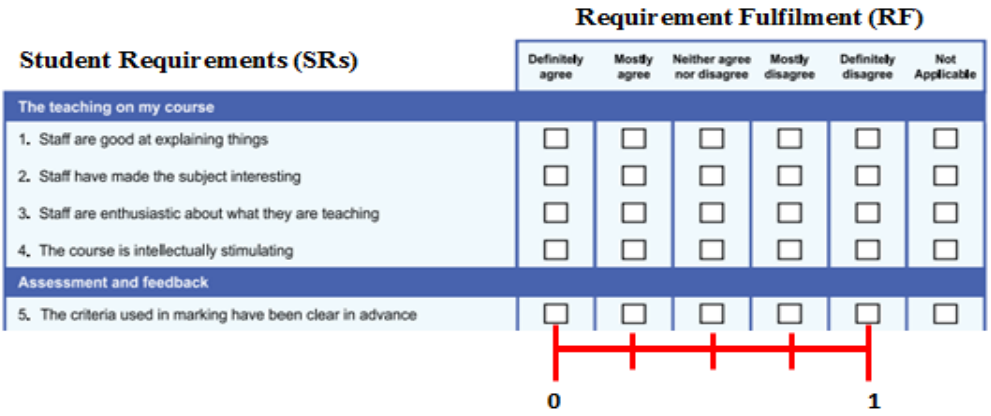


Figure 4.21. Section of the National Student Survey displaying the Student Requirements and the response format (HEFCE, 2011).

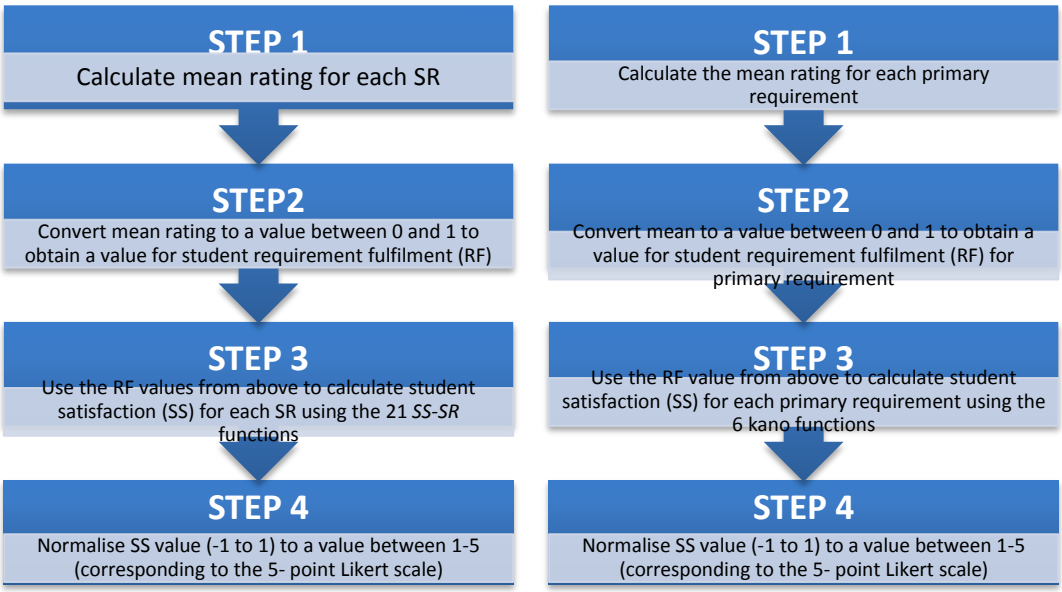


Figure 4.22. Framework for computing overall student satisfaction

In addition to computing the SS with each of the 21 NSS items it is important to compute SS with each of the 6 NSS factors and also obtain a measure of overall SS. The mean SS of the secondary SRs can be used as a measure of SS with the corresponding primary SR. In addition, the above framework can also be applied to calculate overall satisfaction with each of the 6 primary SRs using the 6 *SS-SR* functions obtained (Table 4.5). In Step 1, the mean rating for each primary SR should be calculated. Following the calculation of satisfaction with each primary requirement, these values can be used to calculate the overall level of student satisfaction.

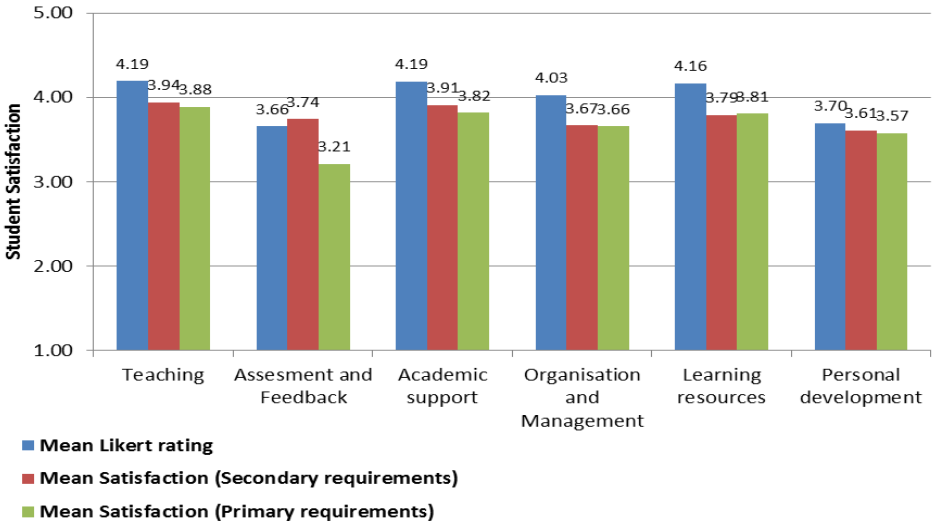


Figure 4.23. Comparison of mean of student satisfaction for each primary requirement obtained from NSS Likert ratings and using the proposed framework

Figure 4.23 shows the values obtained for the satisfaction with each NSS primary requirement using the above framework and the values obtained using the mean of the NSS student ratings. Differences are observed between the three values compared. Except for the primary requirement assessment and feedback which was classified as an attractive requirement by the Kano evaluation, all other primary requirements indicate that the mean of just the NSS ratings show a higher level of student satisfaction. The values obtained as a mean of secondary requirements and primary requirement were found close to each other except in the case of assessment and feedback.

A paired sample T-Test was carried out to compare the level of satisfaction obtained using the primary requirements with that obtained by NSS ratings alone. The T-test computes the difference between the two variables for each case, and tests to see if the average difference is significantly different from zero. The null hypothesis is that there is no significant difference between the means of the two variables. A significance value of *p* less than 0.05 means that there is a significant difference between the two variables while a *p* value greater than 0.05 indicates that there is no significant difference. Table 4.6 displays the results of this evaluation. Except for personal development, the value of satisfaction obtained for all other primary requirements were significantly different for these two methods.

Table 4.6. *Paired sample T-test used to compare the mean of student ratings and Kano method based satisfaction for primary requirements*

T-test	**Primary requirement**					
	Teaching	Assessment & feedback	Academic support	Organisation and management	Learning resources	Personal development
t	10.638	-8.886	-7.596	9.075	-5.939	-1.209
p	0	0	0	0	0	0.243

Next, using this framework, two values for overall satisfaction were computed. One corresponded to the mean of all 21 SRs (secondary mean) while the other corresponds to the mean of all 6 primary requirements (primary mean). In order to test the validity accuracy of these values in determining overall student satisfaction the secondary mean and primary mean were compared to the mean response to the NSS Q22 (‘*Overall I am satisfied with the quality of my course*’). The mean of the standard NSS scores was also computed. The results shown in Figure 4.24 show that the mean obtained for the rating of

Q22 are much higher than those obtained by the methods that take into account the other 21 NSS items.

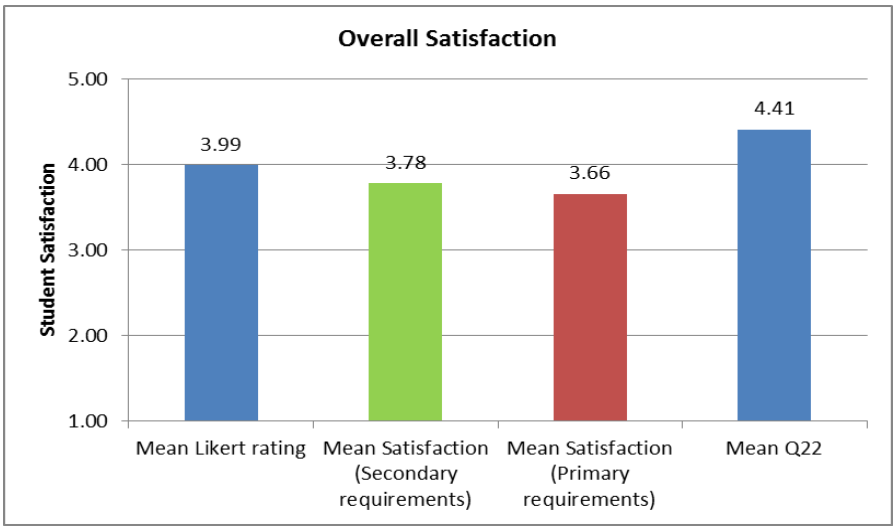


Figure 4.24. Comparison of overall student satisfaction values obtained from the mean NSS Likert ratings and using the proposed framework with the NSS Q22 ('*Overall I am satisfied with the quality of my course*')

As the responses for NSS Q22 were not normally distributed a paired samples T-test cannot be applied to compare these values. Instead a Spearman correlation was calculated to observe the relationships between these values (Table 4.7). The results show a positive correlation between the NSS Q22 and the value of satisfaction obtained from the proposed framework using the mean of primary requirements.

Table 4.7. *Correlations between the overall satisfaction scores obtained using the NSS Likert ratings and values obtained by applying the proposed framework with NSS overall satisfaction Q22*

	Overall Satisfaction measure		
Correlation	NSS Mean	Primary Mean	Secondary Mean
Spearman's rho	-0.093	.487*	-0.272
p	0.68	0.022	0.221

This result indicates that the proposed framework has the ability to obtain a measure of satisfaction which is more related to the students ratings obtained from NSS Q22 obtained using conventional mean ratings.

Chapter 5

Prototyping and Evaluation of an Affective Interface

"Design is a funny word. Some people think design means how it looks. But of course, if you dig deeper, it's really how it works", Steve Jobs

5.1 System Specification

In the current information age, more and more organisations and the general public rely on feedback data for decision-making. With the continued increase in the volume of feedback data generated, the need for systems that enable efficient analysis and comprehension of this data has grown. As a result, visualisation of multivariate feedback data has become a highly researched topic in the interactive design community. In line with this need, the present study aims to create a system that can simplify the presentation of feedback data by allowing for a means of handling and conveying multivariate data accurately for its rapid assimilation and understanding. The main feature of the proposed system and framework is that it will exploit affective interface technologies and concepts in order to appeal to the emotional perspective of the end-user for improved capture, comprehension, and ultimately efficient analysis of feedback data for effective decision-making.

As highlighted in Chapter 4, student feedback on the quality of higher education plays a central role in the HE sector. In particular, the National Student Survey (NSS) has become a vital tool for informing decision-making in both HEI management and prospective student course/HEI choice. It is evident that the current presentation of NSS data is limited to numerical, tabular and bar charts formats which are the traditional data presentation formats. The study has thus hypothesised that conveying student feedback as a naturalistic face has the potential to convert feedback data into accurate actionable information that can be interpreted 'at-a-glance'. Therefore, in line with the main aims of the NSS, and student feedback in general, the proposed system needs to ensure that the information provided informs system users about the quality of HE in a particular institution and also gives prospective students information that will help them choose what and where to study.

In this chapter, the findings from Chapter 3 and 4 are incorporated to inform the development of an affective interface that attempts to convey student satisfaction data accurately. Compared to conventional representations of the NSS data in a form of numerical values (means and percentages), tables and diagrams, the proposed Affective Interface Feedback System (AIFS) aims to have a crucial benefit in terms of its impact on legibility of the data display, as measured by accuracy and speed. Specifically, unlike diagrams that usually represent disparate portion of piecemeal information, the proposed AIFS will represent a combined outcome of student feedback data in a holistic way in the form of a pictorial FE display. It is anticipated that this system, will have a positive impact on the representation mode of student feedback data making it 'at-a-glance' and accurate with regard to affective content. Another benefit of this system will be the flexibility of its final product, which will allow the adjustment of its conceptual solution to specific end-user needs. This encompasses giving the end-users the ability to manipulate the level of importance of underlying variables or evaluation criteria in the feedback data.

Based on the above system specification, three main classes of requirements (*Functional*, *Usability* and *Technical*) were identified for the Affective Interface feedback system and are summarised in Table 5.1. The functional requirements are concerned with the accuracy of the data display and the system's ability to handle multi-criteria type data. The usability requirements are concerned with the efficiency of the AIFS in terms of the legibility of the interface data display. Technical requirements of the system are concerned with the system capabilities in terms of providing the users a system that is readily and easily usable without the need for prior training.

Table 5.1. *Main Requirements of the Affective Interface Feedback System*

Type of Requirement	Key Requirements
Functional Requirements	• Conveys student satisfaction data to users accurately (Accuracy). • Conveys the student feedback with regard to affective content (Accuracy). • Offers users an intuitive fast way of understanding student feedback (Speed) • Enables the effective analysis and handling of multi-criteria feedback data (Accuracy and Flexibility)
Usability Requirements	• Design should be intuitive so that users can use the system with little or no special training (Efficiency) • Allows users to access features through minimal system interactions (Efficiency) • The visual feedback of the system should be well received by the users (Effectiveness)
Technical Requirements	• System needs to be portable in order to be readily accessible to users (Flexibility & Efficiency) • System needs fast and intuitive means of acquiring input data from the users (Adaptability & Efficiency) • System needs to have a clear way of representing the results and output to the users (Effectiveness)

5.1.1 System Users and User Tasks

As the main purpose of the proposed AIFS is to convey student feedback data, two system user groups were identified. These user groups are consistent with the main objectives of student feedback distinguished by Harvey (2003): internal information to guide improvement and external information for potential students and other stakeholders, including accountability and compliance requirements. Table 5.2 depicts the two main user groups of the system: HEI academic staff and prospective students. As the two user groups are distinct, the AIFS should be able to cater to a wide range of users varying from statistically and mathematically literate quantitative data experts (Expert users) to less mathematically literate individuals (Non-expert users). Lacking expertise in quantitative data analysis does not mean that an individual will not need to use the feedback system. In fact this class of users are anticipated to benefit the most from the proposed AIFS. On the

other hand, quantitative data experts would require more than a facial expression depiction to convey feedback data.

Table 5.2. *AIFS potential users and user tasks*

System Users	**Main Task**
HEI academic staff	Gain Information for improvement and Quality assurance Multi-criteria analysis
Prospective students & public	Gain Information for making choices

Making the system highly sophisticated with many statistical functions and terms could risk the inaccessibility of the system to lower level non-expert system users, while over simplifying the system could avert expert users. Therefore it can be hypothesised that the user's mathematical and statistical background would affect their acceptance of the system as the user would expect more statistical data compared to a FE depiction.

Due to the unpredictable nature of end users' statistical background careful consideration had to be taken in order to make the interface flexible to any user class while exploiting the full capacity of the system to effectively convey feedback data for the purpose of this study.

An additional feature is proposed for the HEI academic staff user group. This a user task related to dealing with the multi-criteria nature of the underlying dataset. This task is labelled weight criteria and enables the user to weight each evaluation criterion in the data set according to the user's perceived level of importance for that criterion in contributing to the overall satisfaction score. For example, academic staff might want to focus on the impact of 'Teaching' on the overall level of student satisfaction. The user can then weight this criterion as important and reduce the weight of any other criteria that are not of interest.

5.1.2 System Functions

Conveying student feedback involves converting numerical raw data obtained from the NSS into a form useful for the user. Based on functional requirements deduced above, two main top level tasks were identified. These are visualising the feedback data and secondly

dealing with multiple criteria within the data (multi-criteria evaluation). The multi-criteria evaluation was described in detail in Chapter 4 thus this section focuses on the next stage which is conveying the student feedback.

Conveying student feedback

Irrespective of the user type the main task a user will use the AIFS to perform is data visualisation according to the system specification. This task involves the overall process of transforming the NSS feedback data into a readily comprehensible format in the form of FE depictions and other relevant graphical sub modes (bar charts/numerical values). Figure 5.1 shows the underlying functional architecture of the proposed AIFS that is used to select a specific FE corresponding to the numerical values obtained from the feedback data. The first function of the system is to calculate the mean (Compute Mean). The framework for achieving this was presented in Figure 4.22 where the level of satisfaction for each NSS item and the satisfaction with the primary requirement can be computed.

The research presented in Chapter 3 was aimed at building the foundation for the proposed AIFS to provide meaningful mappings between numerical satisfaction values and the dimensions of FEs (*Valence* and *Reactivity*). In the two studies carried out in Chapter 3, participants assigned emoticons to four one-dimensional *Satisfaction-Dissatisfaction* scales (corresponding to 5-, 7-, 9- and 10- rating scales) and the two-dimensional *Satisfaction/Requirement fulfilment* space. Three mappings for the dimensions of *Satisfaction* and *Valence* and *Satsifaction* and *Reactivity* were obtained for each of the one-dimensional scales. Each mapping consists of the central tendancy of *Valence* and *Reactivity* for a certain level of satisfaction (S[1:5], S[1:7], S[1:9], S[0:10]). The mappings were classified as overall (mappings obtained from results of 48 participants), and gender which contained the central tendancy of *Valence* and *Reactivity* based on the results obtained for male and female participants.

For the two-dimensional satisfaction space, each mapping consisted of the central tendancy for *Valence* and *Reactivity* for all *Satisfaction/Reqirement Fulfilment* combinations (S[-1:1] & RF[0:1]). In addition to the mappings obtained for the whole sample, four aditional mappings were identified based on the partcipant characteristics gender, ethnicity and the LoC. The affective interface translation algorithms relies on the values of *Valence* and *Reactivity* deduced from the above mappings to assign the numerical data parameter to a FE depiction (Locate emoticon function).

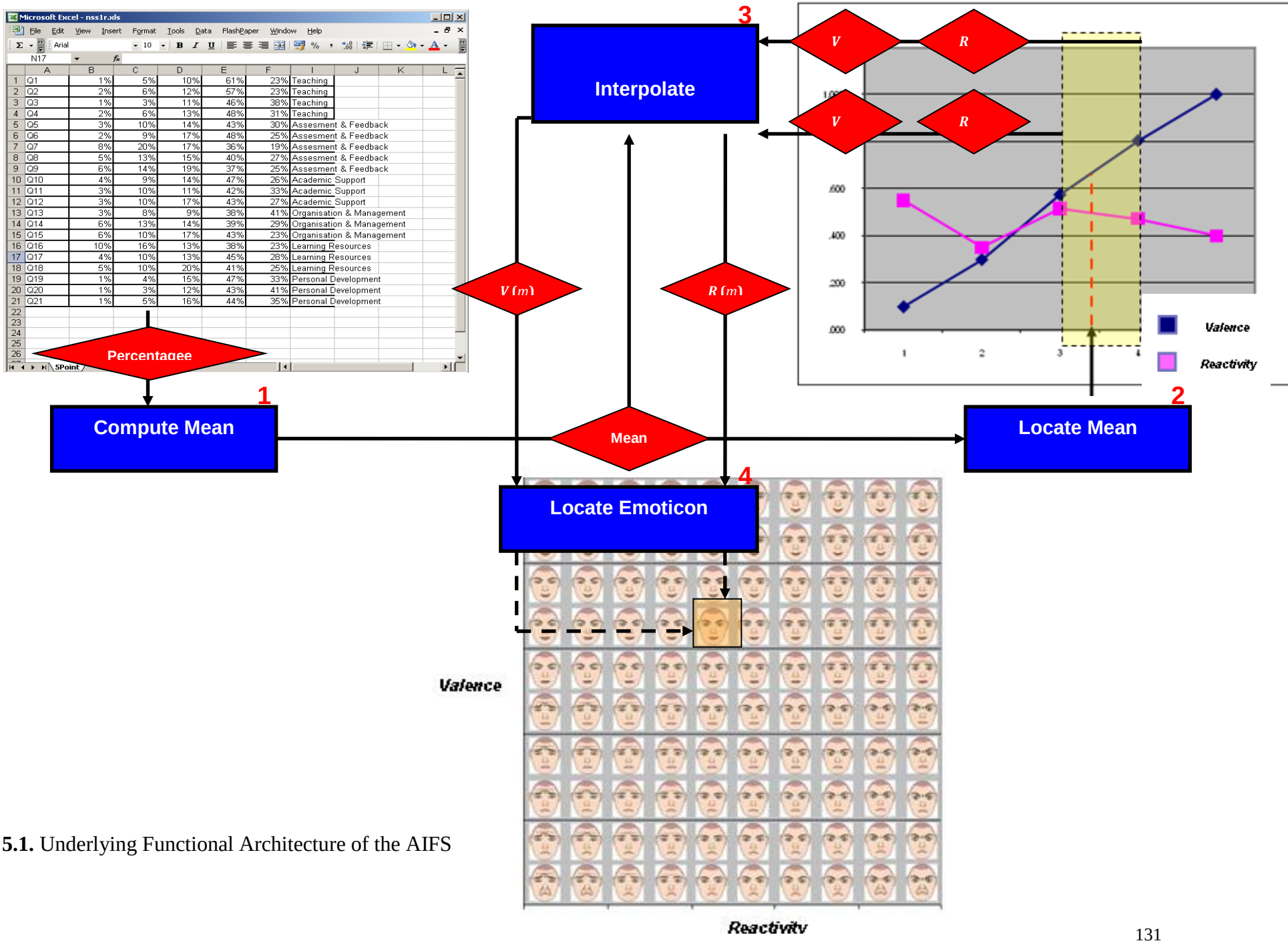


Figure 5.1. Underlying Functional Architecture of the AIFS

Several data vectors were crerated which contained the values of *Valence* and *Reactivity* corresponding to numerical satisfaction measures for each of the classifications described above. The system translation function can be adjusted according to the feedback data features and used to map a numerical value to a FE using any one of these methods at a time. Figure 5.2 depicts the basis behind the system translation function.

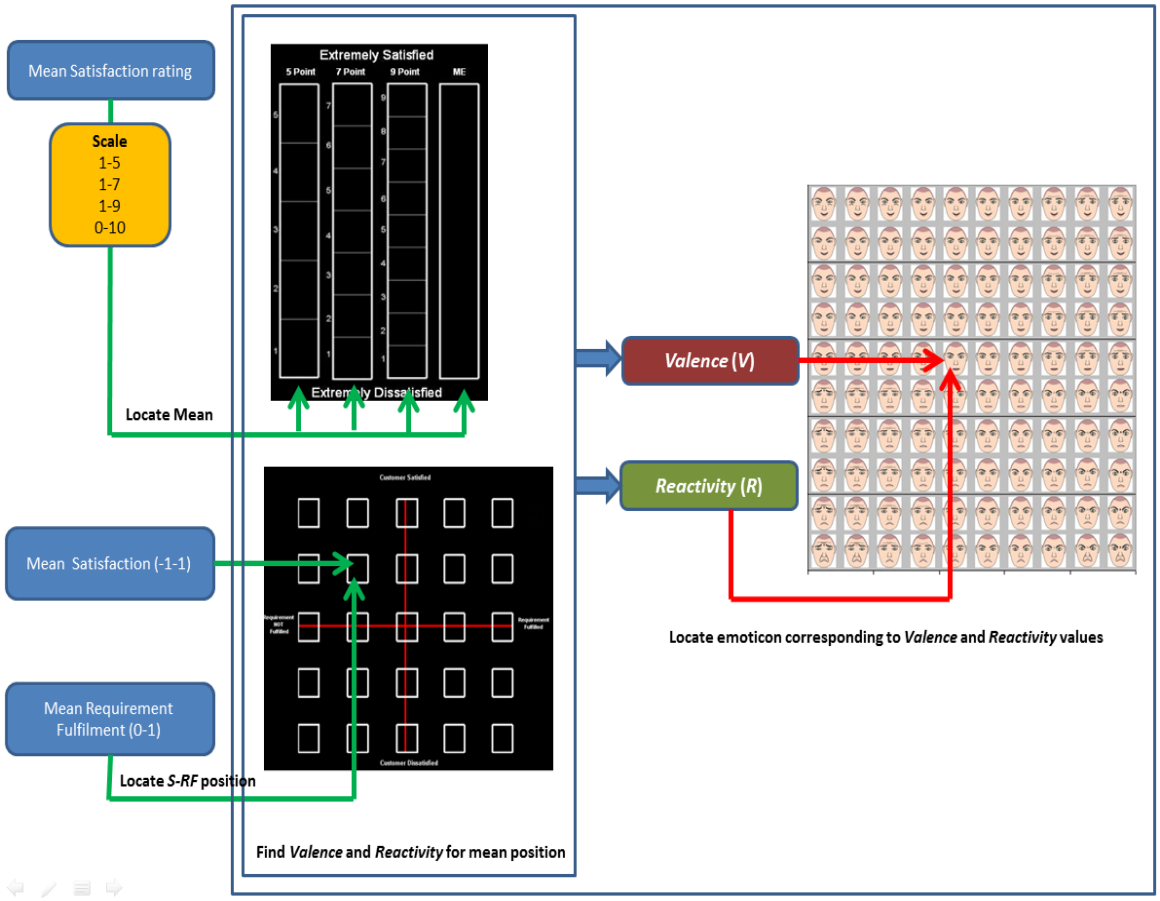


Figure 5.2. System translation function architecture for mapping NSS feedback data to a FE depiction (Locate emoticon function).

For mappings to be made to the one-dimensional vectors, two important values are required. The number of scale points and the mean satisfaction rating (m) computed in the earlier step. The number of scale points is used to select a specific vector (e.g. 5 scale points refers to a vector with 5 values for *Valence* and *Reactivity*). Next the system translation algorithm identifies the upper bound (x_u) and lower bound (x_l) of the interval where the mean (m) is located on the rating scale used. The *Valence* and *Reactivity* for these values are obtained using the mapping vectors. The system translation function then

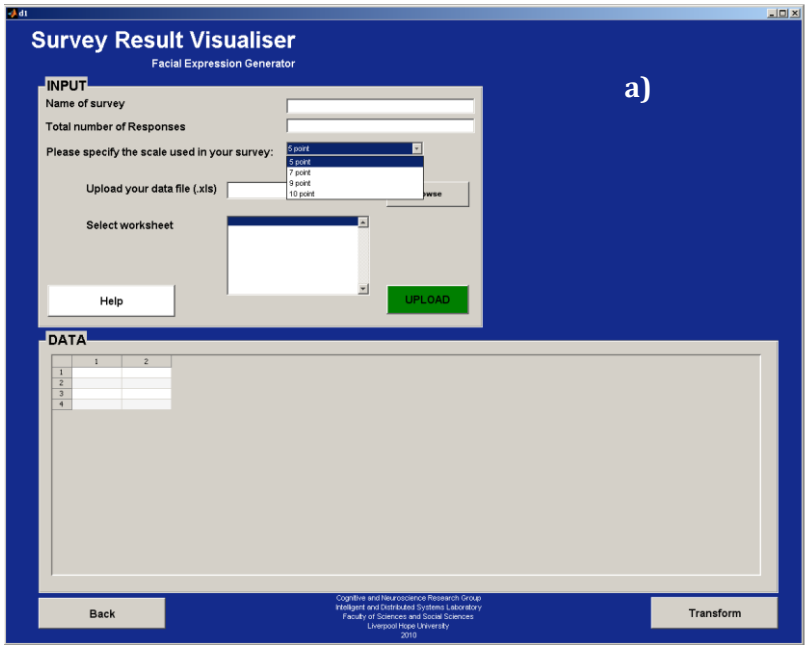
carries out an interpolation to generate 2 new values of *Valence* (V) and *Reactivity* (R) that correspond to the mean satisfaction rating (*m*). This function then uses the *Valence* (V) and *Reactivity* (R) values computed from the Interpolation function as coordinates and locate the emoticon that fits these values on the 10x10 emoticon set used (Appendix 1).

For mappings to be made to the two-dimensional vectors not only the mean level of *Satisfaction* (S) computed by the system, but also the level of *Requirement fulfilment* (RF) is required. The translation function then locates the point of intersection between these two values. The corresponding values of *Valence* and *Reactivity* and then used as the coordinates to locate the emoticon.

5.2 Prototyping

The main aim of this Chapter was to develop a proof-of-concept prototype of an Affective Interface Feedback System (AIFS) that can demonstrate the feasibility and usefulness of conveying feedback in the form of facial expression depictions to its users. A proof-of-concept prototype is usually considered to be a milestone on the way to a fully functioning system, thus the main purpose of the interface design and development stages should be aimed at verifying that the proposed concept is viable.

Based on the requirements established above, the first proof-of-concept prototype of the AIFS was developed using Matlab GUIDE (Graphical User Interface Development Environment) under a resolution of 1280x1024 pixels to make the most of the screen space available. Figure 5.3 displays the typical data input screen of the AIFS before and after data input. This page allows the specification of data parameters and allows the uploading of a data (Microsoft excel format: .xls) and selection of data (Microsoft excel worksheet). Following the data input the data is visualised via the main output screen. This page contains additional functions for visualising data as well as dealing with multi-criteria (Figure 5.4). Figure 5.5 displays a typical output screen generated for the National Student Survey data. This is the system primary output and displays the overall student satisfaction with the course or Institution and the student satisfaction with each of the 6 NSS primary student requirements.



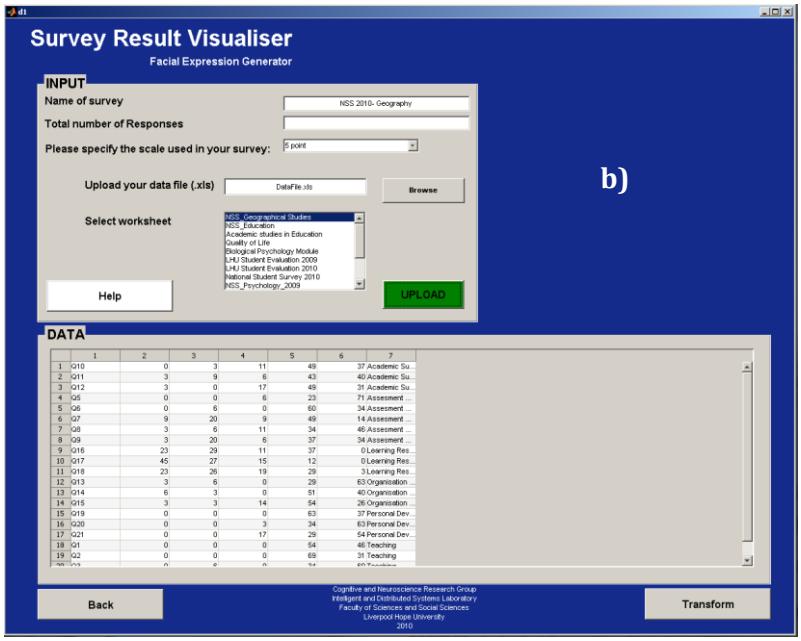


Figure 5.3. Instances of the Data Input Screen a) before uploading data b) after uploading data

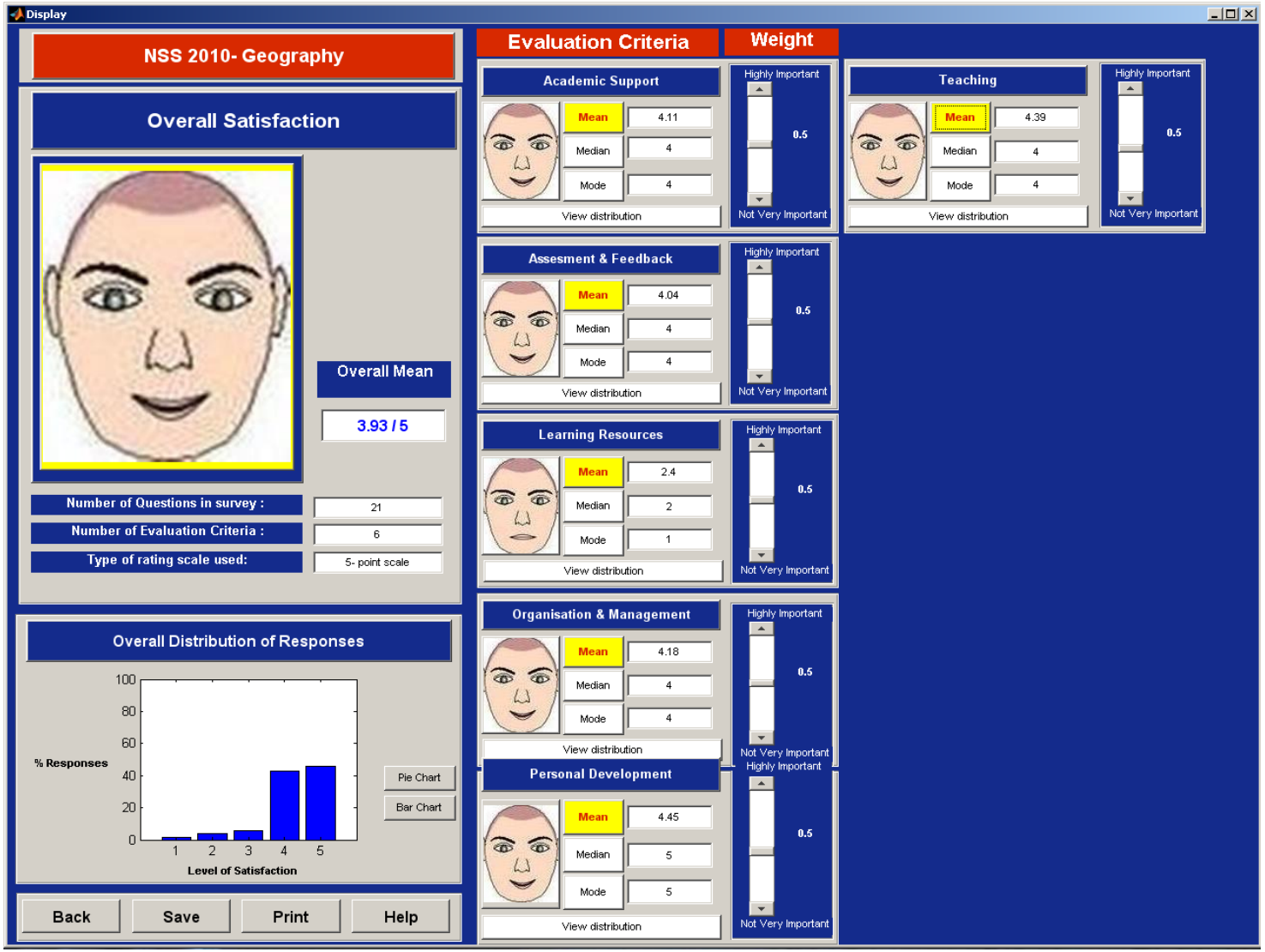


Figure 5.4. Data Output Screen of the Affective Interface Feedback System

Figure 5.5 illustrates the user functions available through the interface for effectively understanding the data. As displayed, the system output is organised into 2 sections. The left hand side of the interface displays the overall level of satisfaction along with information about the questionnaire used to capture the feedback. The right hand side of the screen is available for displaying levels of satisfaction with underlying criteria.

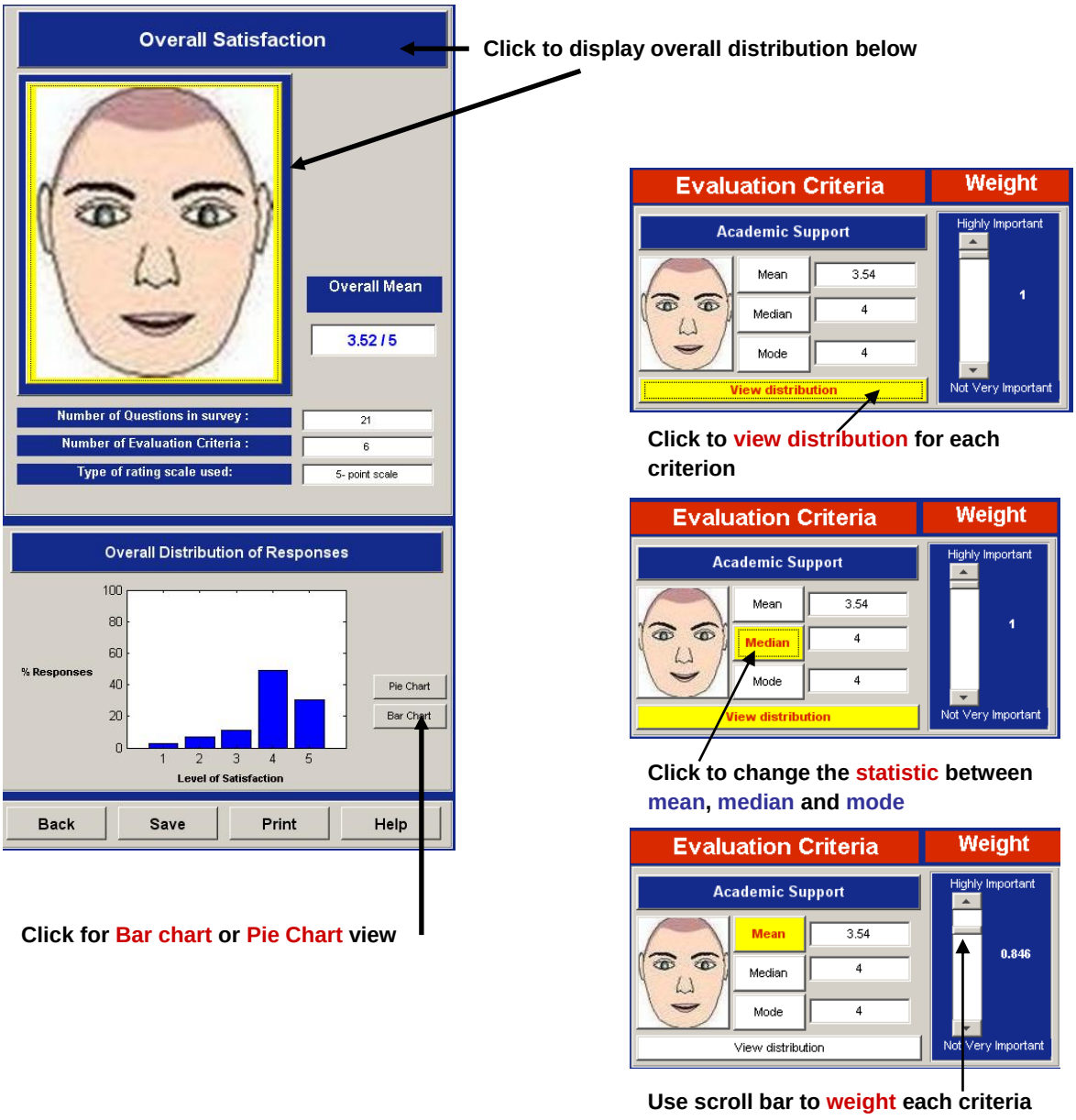


Figure 5.5. System breakdown displaying different system features accessible to the user

The system also provides users with a bar chart displaying the frequency distribution of the responses. The user has the option of switching between bar chart or pie chart mode to

look at the data. Each evaluation criterion of the data is provided a screen section where the central tendencies (mean, median and mode) for the criteria (based on NSS data) are displayed. Each criterion is also provided with a view distribution button which enables the user to view the distribution of responses for that criterion. Alongside each criterion data is a scroll bar which the user use to manipulate the importance of the specific criteria. Figure 5.6 shows an example how different features can be manipulated by the user and the resulting changes in FEs conveying the level of satisfaction for the data set. The display here represents the secondary data output which provides a question by question (secondary requirement) breakdown of each NSS primary student requirement.

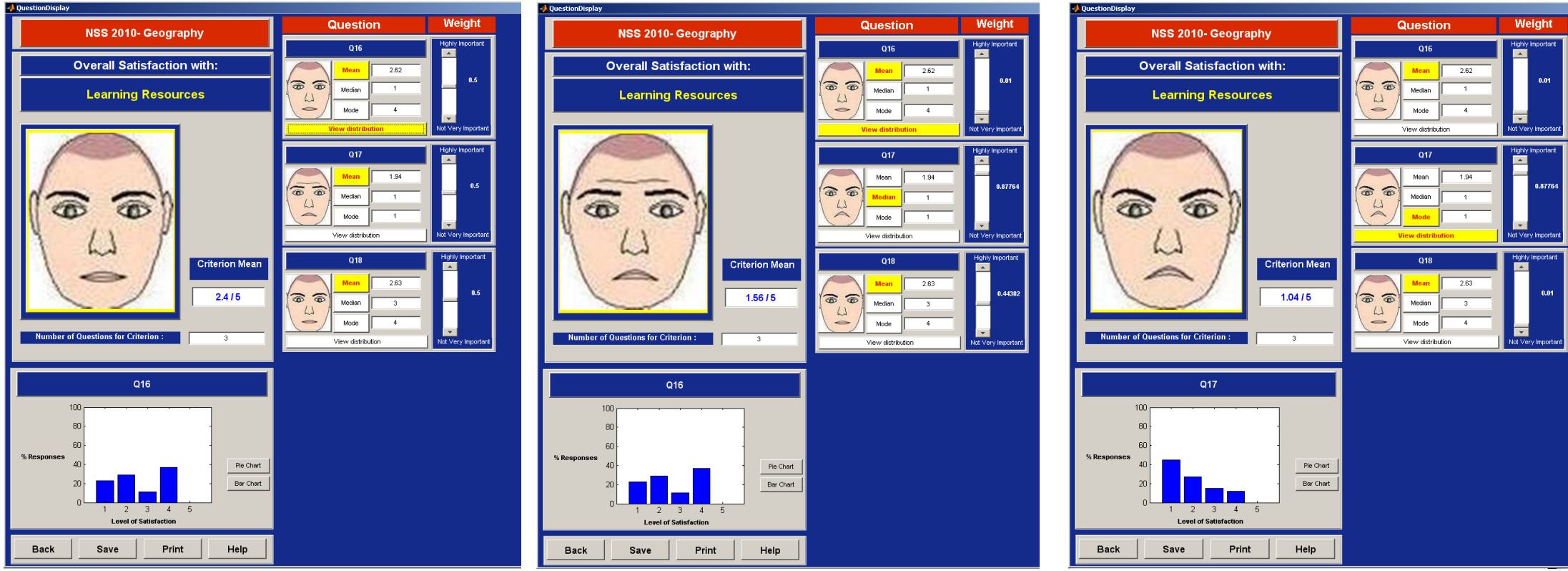


Figure 5.6. Screen shots displaying the influence of different user parameters on the FE selected to display levels of Satisfaction.

5.3 Evaluation

The above proof-of-concept prototype was evaluated in line with the two main objectives of the present study. The questions addressed by the evaluation procedure are concerned with the accuracy of the data displayed and the effectiveness of the facial feedback for conveying student feedback, which are the main functional requirements of the affective interface.

To answer these, the evaluation of the affective interface was conducted in two parts:

- testing the accuracy of the system output (functional requirement)
- testing the effectiveness of the affective interface: investigating if the use of FEs conveys student feedback 'at-a-glance' and has the ability to convey affective content (functional and usability requirements).

5.3.1 Testing Affective Interface output accuracy

The accuracy of the system output is the extent to which the FE generated by the system to convey a level of satisfaction is similar to actual assignments of FEs for that value of satisfaction (extent to which the system conveys what is intended). As one of the main requirements of the affective interface is the accuracy of the data display, the system performance and output needs to be verified in order to verify the appropriateness of the FE assignment to the satisfaction domain. Therefore the purpose of this evaluation was to obtain empirical data to verify the accuracy of the student satisfaction display.

5.3.1.1 Method

Participants

Opportunity sampling was used to recruit 48 first year students (24 male and 24 female) (Table 5.3).

Table 5.3. *Participant demographic characteristics*

Ethnicity	**Number of participants**	**Gender**		**Age (Mean ± SD)**	
		Male	Female	**M**	**F**
Caucasian	48	24	24	18.6±0.67	19.1±1.23
Non Caucasians	0	0	0	0	0
Total	**48**	**0**	**0**	18.9±1.03	

Procedure

Each student was first provided a questionnaire which consisted of two parts (Appendix 9). The first part of the questionnaire consisted of the NSS containing the 22 items and the Likert scale response format. The second part of the questionnaire consisted of the same 22 NSS items but the response format provided was the 10x10 emoticon set which is the basis for the system mappings. For the first section participants were required to rate each NSS item on the 5- point Likert scale. For the second section participants were required to select the emoticon that best represented their level of satisfaction with each item. Following this the participants were required to fill in the Rotters (1966) *LoC* assessment questionnaire (Appendix 6) presented on a computer. This was the same personality assessment that was carried out when FEs were assigned to the two-dimensional satisfaction scale.

5.3.1.2 Results of system accuracy evaluation

Due to the timing of the survey many participants had not received feedback on their assignments. Due to this several participants had not provided any ratings for NSS items in this category. Any other NSS items that had no ratings were also omitted. As a result only questions 1, 2, 3, 4, 10, 13, 15, 16, 17, 19, 20 and 21 were used for testing the accuracy of the system output. The student ratings were formatted according to the system input requirements and used as the input data. Q22 was not included in this input data set.

Several system runs on the data were carried out by adjusting the system translation algorithm to use different mappings each time. The translation algorithm used a total of 12 mappings (6 one-dimensional and 4 two-dimensional) based on the descriptions provided in section 5.1.2. The values of *Valence* and *Reactivity* obtained for each of the 21 NSS items were recorded for each mapping. In addition, the student assignments of emoticons for each of the 22 NSS items (from part two of the questionnaire) were converted to values of *Valence* (-0.5-0.5) and *Reactivity* (0-1.0). The mean *Valence* and *Reactivity* for each NSS item was calculated. The means of the 12 questions (with no missing data) were then compared with the system generated values for *Valence* and *Reactivity* for these questions using different mappings. Figures 5.7 and 5.8 display the results of this analysis.

It can be observed from the bar charts that the value for *Valence* calculated by the system using the two-dimensional mappings (Kano) was closest to the mean manual *Valence* of the data. On the other hand, the value for *Reactivity* calculated by the system using the one-dimensional mappings for the 9- point scale and the 5- point scale was closest to the mean manual *Reactivity* of the data.

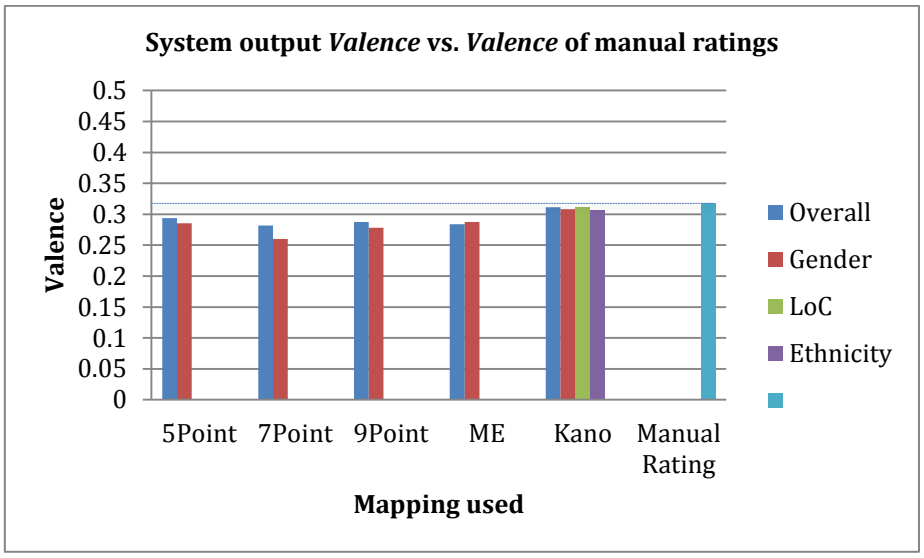


Figure 5.7. Comparison of system output *Valence* with mean *Valence* of manual ratings

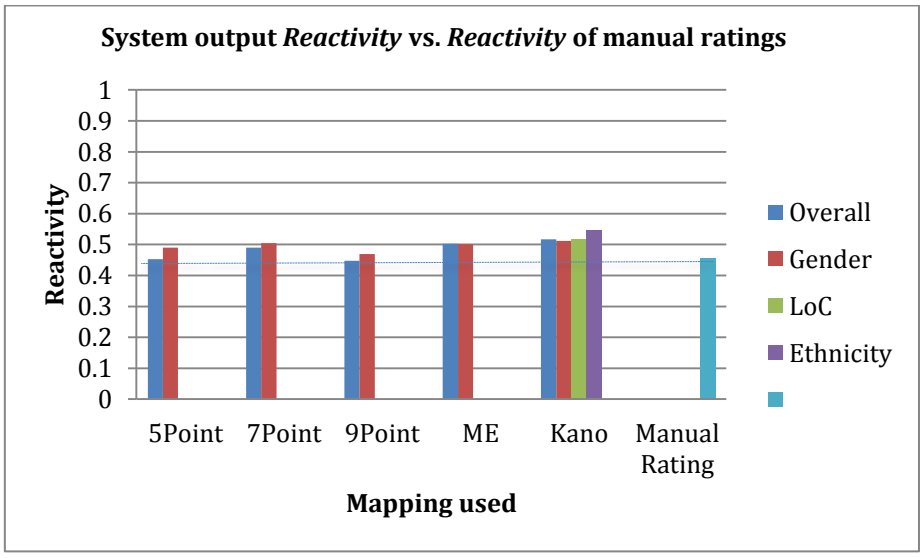


Figure 5.8. Comparison of system output *Reactivity* with mean *Reactivity* of manual ratings

In order to see the statistical significance of the above observations, a paired sample T-test was carried out to compare the means of the *Valence* and *Reactivity* to manual ratings of students. Table 5.4 displays the results of this.

Table 5.4. *Paired samples T-test comparing the Valence and Reactivity obtained by the system with the mean Valence and Reactivity of manual rating*

Comparison of System output *Valence* (*V*) with manual ratings												
	T-Test	**One-dimensional mappings**							**Two-dimensional mappings**			
Mapping Used		5- Point	7- Point	9- Point	ME	5-Point /Gender	7- Point/ Gender	9- Point/ Gender	ME/Gender	Overall	Gender	LoC	Ethnicity
	t	3.267	4.647	3.956	4.087	5.148	7.240	5.018	3.616	.932	1.304	.861	1.744
	p	.008	.001	.002	.002	.000	.000	.000	.004	.372	.219	.407	.109
Comparison of System output *Reactivity* (*R*) with manual ratings												
	T-Test	**One-dimensional mappings**							**Two-dimensional mappings**			
Mapping Used		5- Point	7- Point	9- Point	ME	5-Point /Gender	7- Point/ Gender	9- Point/ Gender	ME/Gender	Overall	Gender	LoC	Ethnicity
	t	.059	-2.375	.408	-2.911	-2.383	-3.255	-1.137	-2.827	-3.543	-3.166	-3.551	-4.551
	p	.954	.037	.691	.014	.036	.008	.280	.016	.005	.009	.005	.001

The null hypothesis is that there is no significant difference between the means of the *Valence* and *Reactivity* obtained by the system and the mean *Valence* and *Reactivity* assigned manually. The results of the T-test support the above observation by accepting the null hypothesis that there is no significant difference between the values of *Valence* obtained by the two dimensional system mappings and the manual ratings. For *Reactivity*, there is no significant difference between the values obtained by the system mappings using the one-dimensional 5- point, 9- point and the 9- point/gender mappings and the manual *Reactivity* ratings. These finding indicate two things. Firstly, the capacity of the proposed framework in computing and accurate metric of student satisfaction is seen. The basis behind this conclusion is that *Satisfaction* is seen as a function of *+Valence* and *Dissatisfaction* a function of *-Valence*. The indication that students assigned values for Valence are significantly similar to those obtained by the proposed multi-criteria data analysis shows that the method has computed a value of student satisfaction which is accurate. In addition these findings also show the discriminative power of the 9- point scale in measuring satisfaction accurately. The results obtained for the 5- point scale are also enlightening as this provides evidence for the use of 5- point scale for measuring satisfaction.

In order to further analyse the significance of the above observation, the ratings of each student was formatted and fed to the system individually. Each participant data set was run 12 times by adjusting the system translation algorithm. The same procedure as above was followed, and the values of *Valence* and *Reactivity* (for each run) deduced by the system was recorded for each student. Figures 5.9 – 5.13 displays the comparisons of the mean *Valence* and *Reactivity* obtained using the system for each question with the manual ratings for these questions.

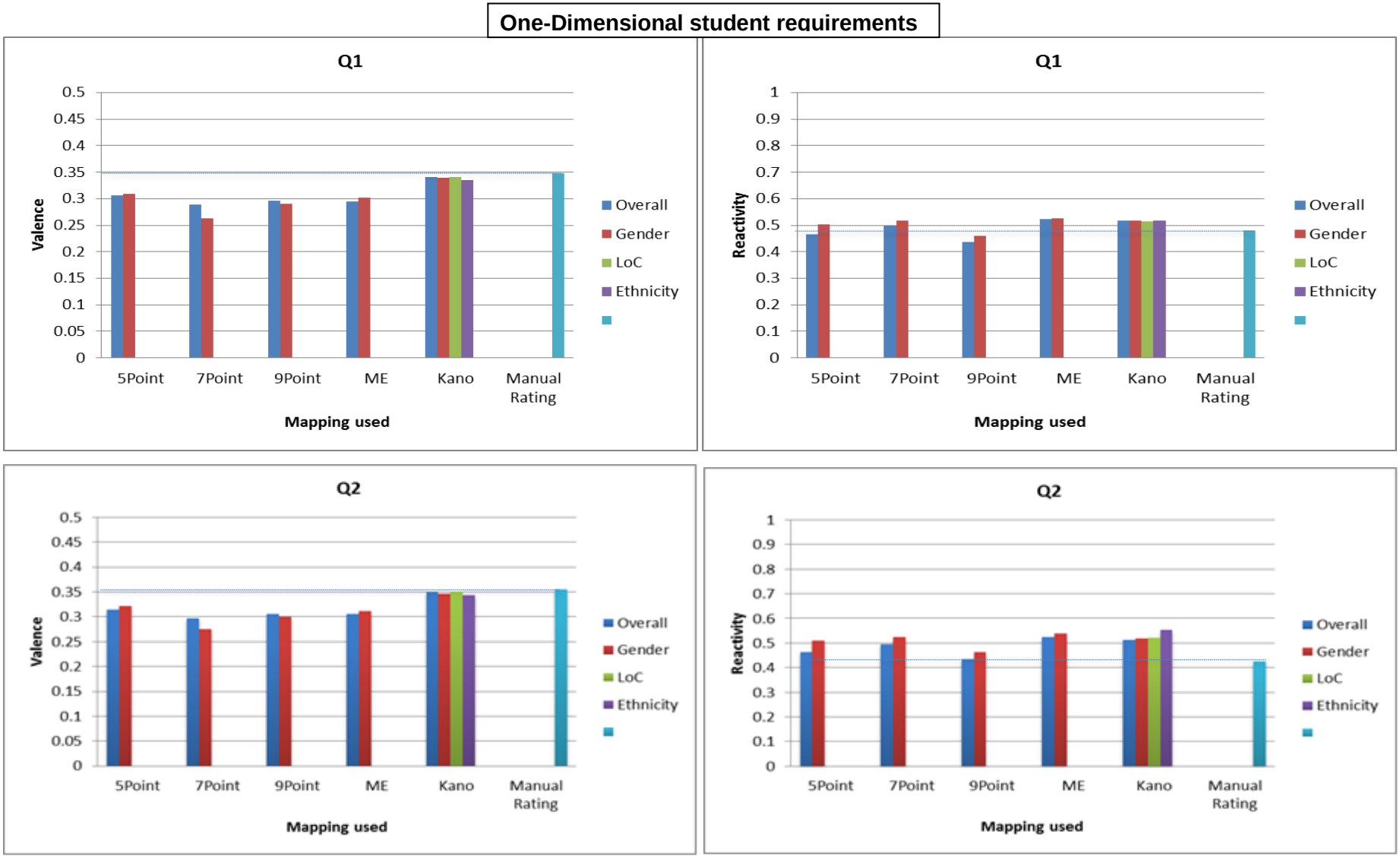


Figure 5.9. Comparison of Valance and Reactivity obtained by different system translation functions with manual FE assignments (Q1 & Q2)

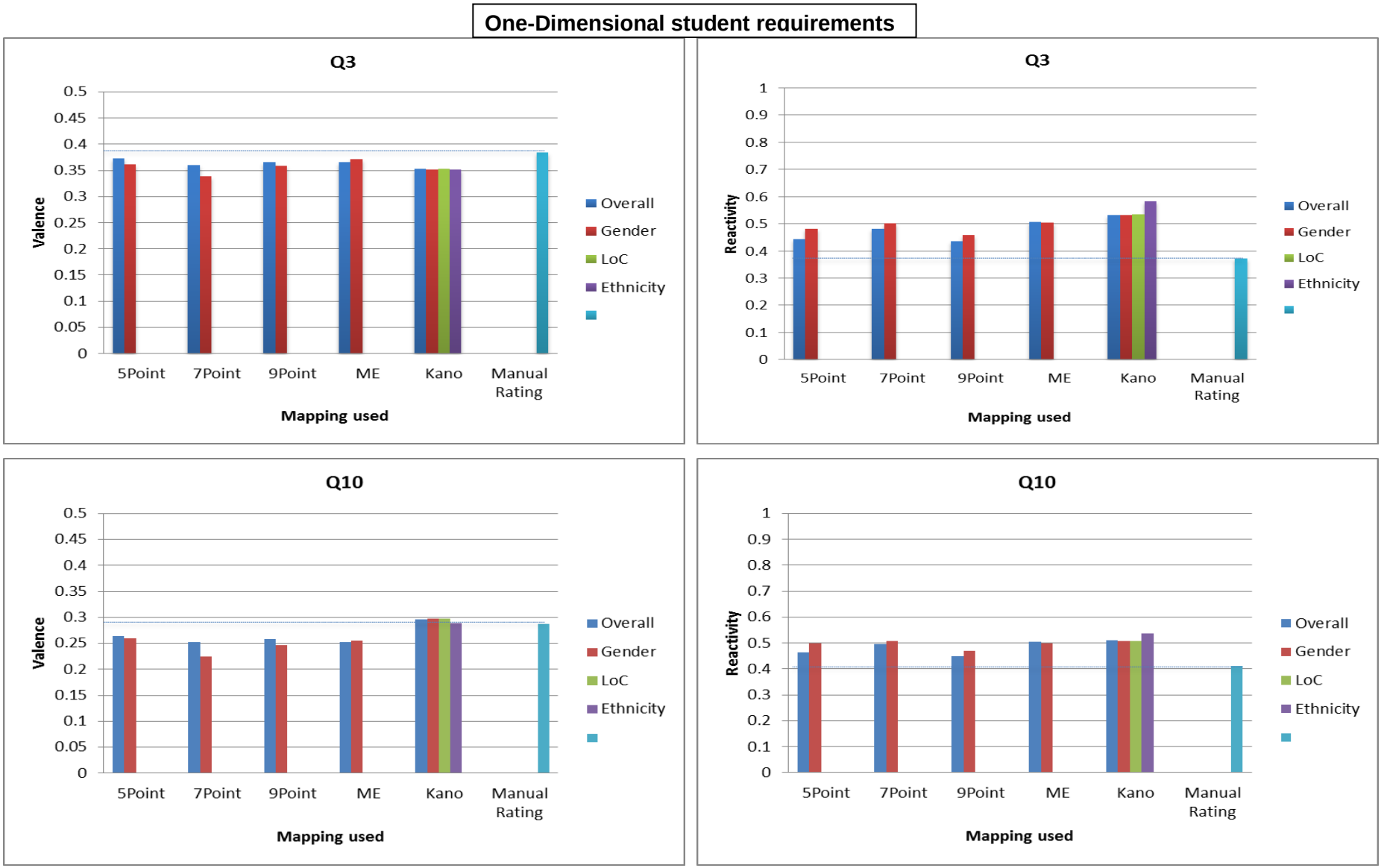


Figure 5.10. Comparison of Valance and Reactivity obtained by different system translation functions with manual FE assignments (Q3 & Q10)

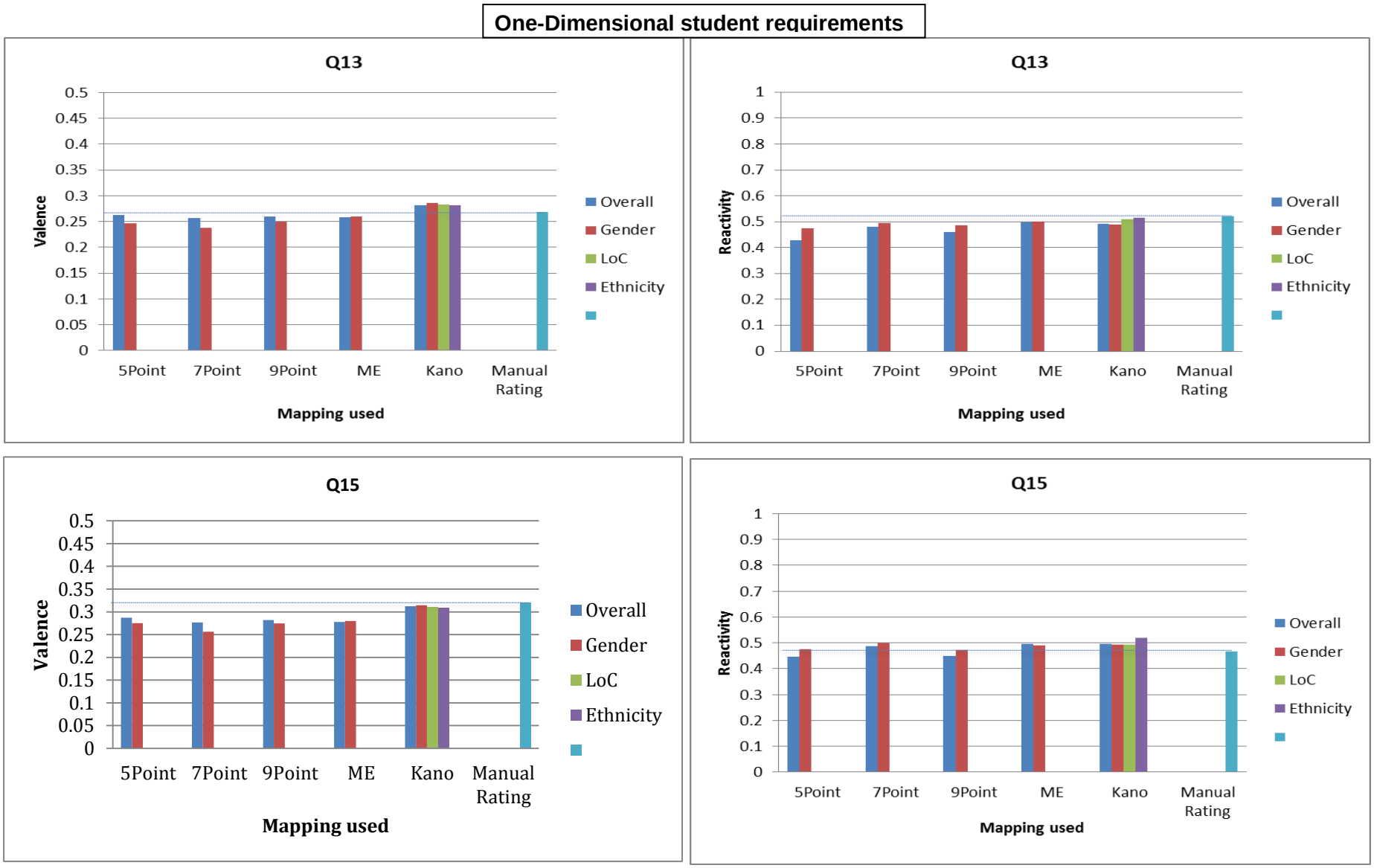


Figure 5.11. Comparison of Valance and Reactivity obtained by different system translation functions with manual FE assignments (Q13 & Q15)

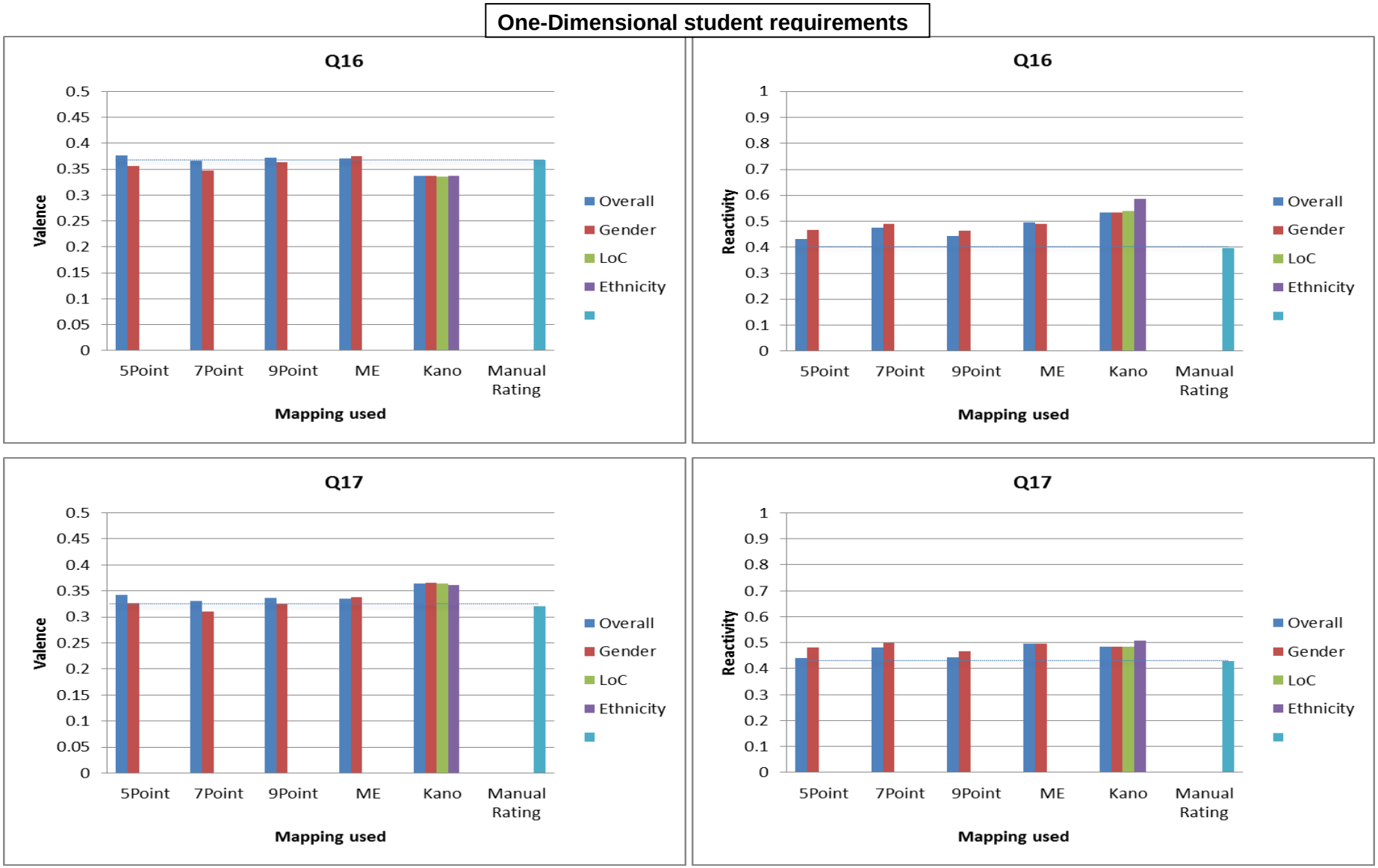


Figure 5.12. Comparison of Valance and Reactivity obtained by different system translation functions with manual FE assignments (Q16 & Q17)

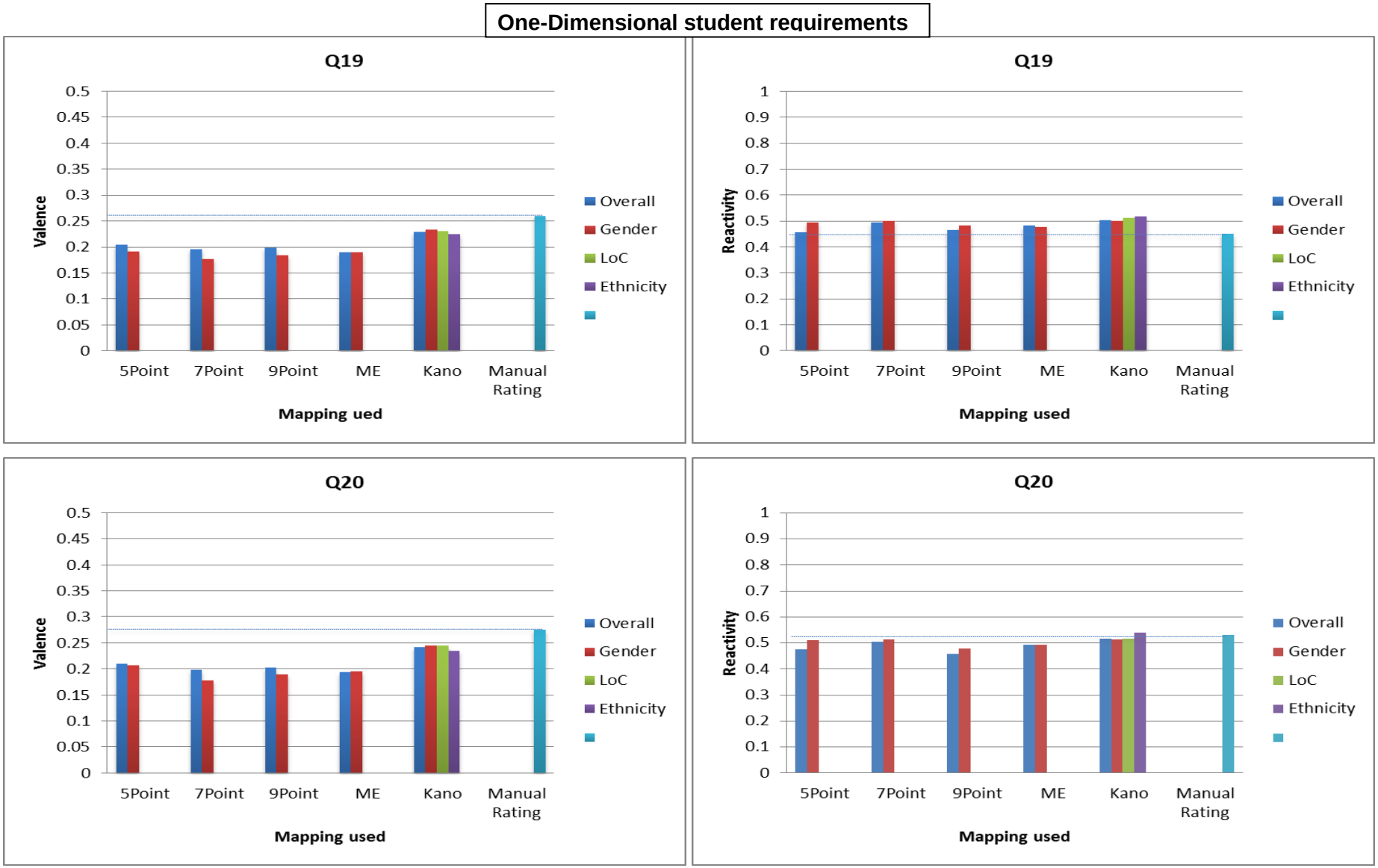


Figure 5.13. Comparison of Valance and Reactivity obtained by different system translation functions with manual FE assignments (Q19 & Q20)

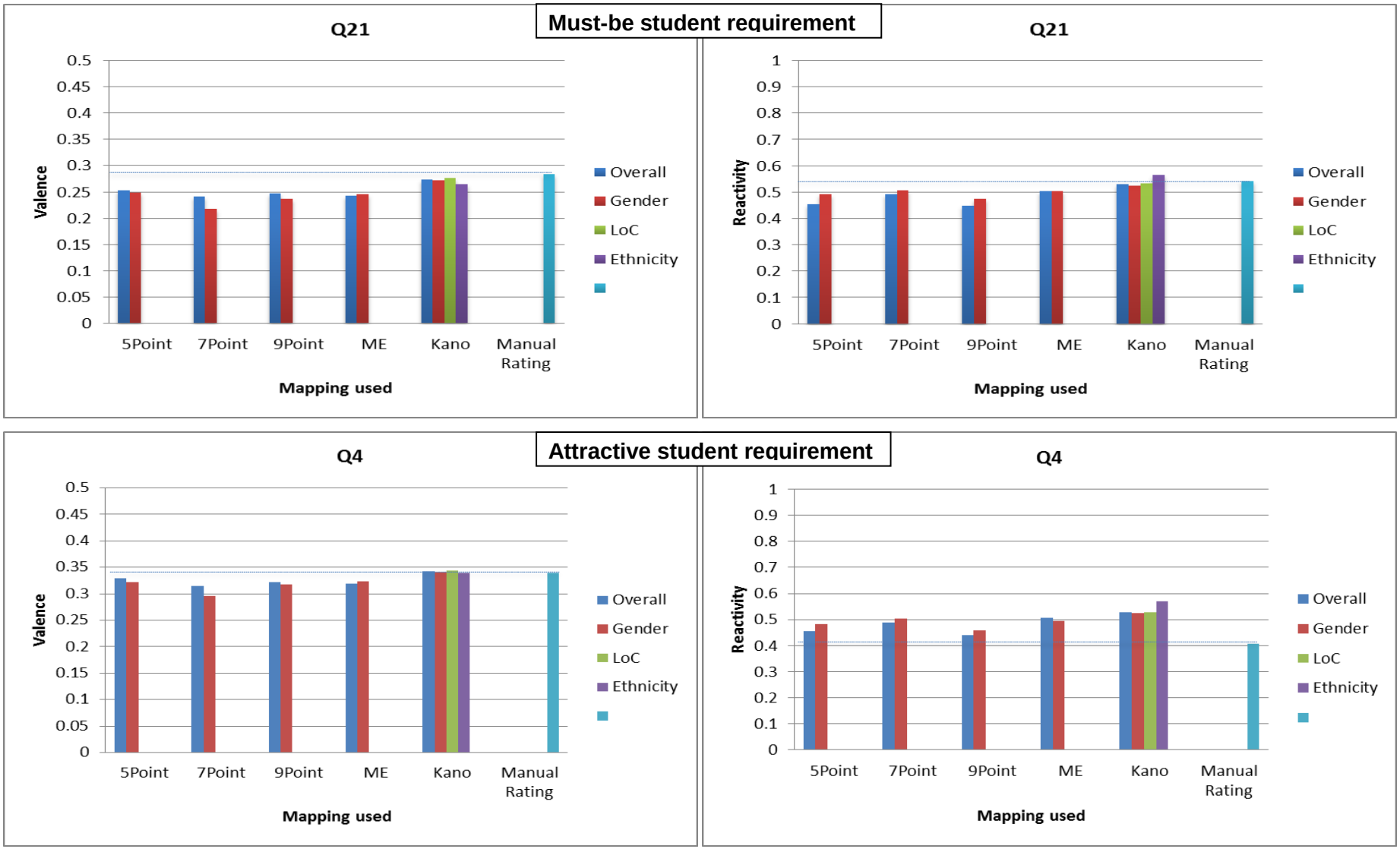


Figure 5.14. Comparison of Valance and Reactivity obtained by different system translation functions with manual FE assignments (Q19 & Q2)

Table 5.5. *Paired samples T-test comparing the Valence obtained by the system with the Valence of manual ratings for each question*

Comparison of System output *Valence* (*V*) with manual ratings													
Student Requirement	**T-Test**	**One-dimensional**								**Two-dimensional**			
Mapping used		5- Point	7- Point	9- Point	ME	5-Point /Gender	7- Point/ Gender	9- Point/ Gender	ME	Overall	Gender	LoC	Ethnicity
One-dimensional													
1	t	1.953	2.667	2.33	2.387	1.916	3.799	2.531	2.148	-6.363	-6.363	-6.363	0.632
	p	0.063	0.013	0.029	0.025	0.067	0.001	0.018	0.042	0	0	0	0.534
2	t	1.912	-7.616	2.285	2.322	1.812	3.592	2.533	2.056	0.299	0.431	0.261	0.569
	p	0.068	0	0.031	0.029	0.082	0.001	0.018	0.051	0.768	0.671	0.796	0.574
3	t	0.569	1.122	0.853	0.853	1.239	2.009	1.141	0.632	1.598	1.655	1.61	1.73
	p	0.574	0.273	0.402	0.402	0.227	0.056	0.265	0.534	0.123	0.111	0.12	0.096
10	t	1.024	1.383	1.359	1.233	1.268	2.089	1.536	1.262	0.134	0.062	0.079	0.317
	p	0.316	0.18	0.187	0.23	0.217	0.047	0.138	0.219	0.894	0.951	0.938	0.754
13	t	0.043	0.238	0.127	0.21	0.696	0.881	0.498	0.141	-0.694	-0.865	-0.728	-0.645
	p	0.966	0.814	0.9	0.835	0.493	0.387	0.623	0.889	0.494	0.395	0.474	0.525
15	t	1.221	1.508	1.374	1.469	1.726	2.051	1.592	1.403	0.485	0.437	0.529	0.612
	p	0.234	0.144	0.182	0.155	0.097	0.051	0.124	0.174	0.632	0.666	0.602	0.547
16	t	1.418	-0.303	0.058	-0.133	-0.119	0.505	0.738	0.203	-0.255	1.417	1.431	1.457
	p	0.169	0.765	0.954	0.895	0.907	0.618	0.468	0.841	0.801	0.169	0.165	0.158
17	t	-.549	-.277	-.410	-.357	-.169	.258	-.134	-.451	-1.202	-1.208	-1.199	-1.089
	p	.588	.784	.686	.724	.867	.798	.895	.656	.241	.239	.242	.287

Comparison of System output *Valence* (*V*) with manual ratings (Contd.)

Student Requirement	**T-Test**	**One-dimensional**								**Two-dimensional**			
Mapping used		5- Point	7- Point	9- Point	ME	5-Point /Gender	7- Point/ Gender	9- Point/ Gender	ME	Overall	Gender	LoC	Ethnicity
19	t	1.266	1.440	1.373	1.555	1.630	1.858	1.678	1.551	.702	.620	.661	.828
	p	.218	.163	.182	.133	.116	.075	.106	.134	.490	.541	.515	.416
20	t	2.292	2.651	2.507	2.737	2.613	3.287	2.860	2.693	1.235	1.142	1.207	1.486
	p	.031	.014	.019	.011	.015	.003	.009	.013	.229	.265	.239	.150
Attractive													
4	t	0.37	0.772	0.59	0.653	0.632	1.347	0.71	0.53	-0.113	-0.058	-0.125	0.061
	p	0.715	0.448	0.561	0.52	0.533	0.191	0.485	0.601	0.911	0.954	0.902	0.952
Must-be													
21	t	.907	1.286	1.099	1.205	1.060	1.934	1.335	1.112	.334	.393	.219	.588
	p	.373	.211	.283	.240	.300	.065	.194	.277	.741	.698	.828	.562

Table 5.6. *Paired samples T-test comparing the Reactivity obtained by the system with the Reactivity of manual ratings for each question*

Comparison of System output *Reactivity* (*R*) with manual ratings													
Student Requirement	**T-Test**	**One-dimensional**								**Two-dimensional**			
Mapping used		5- Point	7- Point	9- Point	ME	5-Point /Gender	7- Point/ Gender	9- Point/ Gender	ME	Overall	Gender	LoC	Ethnicity
One-dimensional													
1	t	0.428	-0.485	1.254	-1.271	-0.717	-1.106	0.617	-1.352	-5.985	-5.985	-5.985	-2.178
	p	0.672	0.632	0.222	0.216	0.48	0.28	0.543	0.189	0	0	0	0.039
2	t	-0.854	-1.607	-0.152	-2.313	-1.857	-2.241	-0.831	-2.513	-2.081	-2.19	-2.125	-2.973
	p	0.402	0.121	0.88	0.03	0.076	0.035	0.414	0.019	0.048	0.038	0.044	0.007
3	t	-2.233	-3.395	-1.998	-4.119	-3.041	-3.806	-2.589	-3.7	-4.948	-4.944	-5.126	-6.462
	p	0.035	0.002	0.057	0	0.006	0.001	0.016	0.001	0	0	0	0
10	t	-1.617	-2.405	-1.389	-2.371	-2.518	-2.7	-1.957	-2.232	-2.6	-2.536	-2.569	-3.036
	p	0.119	0.024	0.178	0.026	0.019	0.013	0.062	0.035	0.016	0.018	0.017	0.006
13	t	2.015	1.036	1.587	0.666	1.042	0.708	0.897	0.596	0.821	0.898	0.472	0.314
	p	0.055	0.31	0.126	0.512	0.308	0.486	0.378	0.557	0.42	0.378	0.641	0.756
15	t	0.884	-0.056	0.802	-0.294	0.171	-0.303	0.26	-0.111	-0.262	-0.191	-0.192	-0.779
	p	0.385	0.955	0.43	0.771	0.866	0.764	0.797	0.913	0.796	0.85	0.849	0.444
16	t	-0.949	-1.874	-1.236	-2.279	-1.672	-2.213	-1.767	-2.134	-3.126	-3.036	-3.259	-4.123
	p	0.352	0.073	0.228	0.032	0.107	0.037	0.09	0.043	0.005	0.006	0.003	0
17	t	-.284	-1.149	-.368	-1.406	-1.168	-1.519	-.899	-1.349	-1.208	-1.200	-1.245	-1.645
	p	.779	.262	.716	.173	.254	.142	.378	.190	.239	.242	.225	.113

Comparison of System output *Reactivity* (*R*) with manual ratings (Contd.)													
Student Requirement	**T-Test**	**One-dimensional**								**Two-dimensional**			
Mapping used		5- Point	7- Point	9- Point	ME	5-Point /Gender	7- Point/ Gender	9- Point/ Gender	ME	Overall	Gender	LoC	Ethnicity
One-dimensional													
19	t	-.104	-1.111	-.315	-.735	-1.086	-1.216	-.731	-.566	-1.297	-1.240	-1.451	-1.638
	p	.918	.278	.756	.470	.288	.236	.472	.577	.207	.227	.160	.114
20	t	1.130	.584	1.582	.805	.421	.366	1.186	.831	.316	.367	.303	-.134
	p	.270	.565	.127	.429	.677	.717	.247	.414	.755	.717	.764	.894
Attractive													
4	t	-1.147	-1.962	-0.818	-2.352	-1.667	-2.304	-1.242	-2.036	-2.926	-2.928	-3.074	-3.964
	p	0.263	0.061	0.421	0.027	0.108	0.03	0.226	0.053	0.007	0.007	0.005	0.001
Must-be													
21	t	2.130	1.312	2.749	.953	1.144	.870	1.977	.863	.359	.447	.272	-.612
	p	.044	.202	.011	.350	.264	.393	.060	.396	.723	.659	.788	.547

On comparison of the differences in mean between manual ratings and system output for each question, more revelations were made. Two-dimensional mappings had significantly accurate results (for both *Valence* and *Reactivity*) for the questions regarding the one-dimensional requirements 13, 15, 17 19 and 20. In addition, compared to the one-dimensional mappings, two dimensional mappings almost always produced significant similarities in *Valence* with the manual ratings. However Reactivity was best predicted by the one-dimensional mappings. The mappings based on the 7- and ME scales performed worst for predicting *Reactivity.* The 7- scale with gender mappings also performed worst in predicting *Valence.* The 5- and the 9- scale mappings performed best overall.

The questions 13, 16 and 17 had highly significant similarities with all the system output mappings. On observation of the figures 4.18 and 4.19, it can be seen that these requirements are perfectly one-dimensional.

Further analysis on the questions where the two-dimensional mappings did not perform well was carried out (1, 2, 3, 10 and 16). When looking at Table 4.3, it is evident that these questions represent secondary requirements whose Kano analysis resulted in ambiguities. For all these questions the number of participants who had classified the requirement as one-dimensional was very close to those who had classified this requirement as an attractive feature. The Kano category for these requirements were based on the Kano evaluation rule (M>O>A>I). However, not addressing these ambiguities can result in the low performance of the two-dimensional mapping functions as witnessed above.

For the must-be student requirement (21), the two-dimensional mappings produced significantly accurate results. This indicates that the Kano classification of SR21 regarding 'the tackling of unfamiliar problems' is accurate.

For the attractive student requirement (4) the two-dimensional mappings were able to predict *Valence* accurately. However the two-dimensional mappings failed to accurately predict *Reactivity*. On the other hand, the 5- point and the 9- point one-dimensional mappings produced highly accurate *Valence* and *Reactivity* predictions for this question. The failure of the two-dimensional mappings to predict Reactivity accurately for this attribute can again be redirected to the ambiguity observed in Table 4.3 for SR4. Therefore it is evident that the first stage of Kano evaluation has a huge impact on the final system output accuracy more than the FE assignments efficiency. It is the accurate evaluation of multi-criteria that in turn affects the system output accuracy.

5.3.2 Testing Affective Interface effectiveness

According to the International Organization for Standardization (ISO), standards related to usability state that interactive systems should be *Effective*, *Efficient* and *Satisfying*. According to ISO standards, Effectiveness is about whether tasks specified for the system can be accomplished and is based on the quality of the system output (as perceived by the end user) and is independent of time taken to accomplish the task. Efficiency is time dependent and is a measure of the time taken to accomplish the system specified tasks. An efficient system is thus said to require as little effort as possible to achieve the users' goals. The third factor, user satisfaction depends on the acceptance of the system by its users and their readiness to continue the use of the system. Based on these standards the following Evaluation matrix (Table 5.7) which specifies the expected goals for the proof-of-concept AIFS was formulated.

Table 5.7. *Evaluation Matrix for the Affective Interface Feedback System*

Category/Type	**Measures**
Interface	Aesthetically pleasing Clarity Flexibility Organisation and presentation of information Navigation Ease of use
Efficiency	**Data Visualisation** Accuracy Speed Effectiveness **Multi-Criteria Evaluation** Flexibility Effectiveness
Usefulness	Support individual's tasks Can do some tasks which cannot be done otherwise Extend one's capability Fulfilment Increased individual productivity Speed
Satisfaction	Effectiveness Recommendation Fulfilment Satisfying

A user informed evaluation protocol was used to evaluate the effectiveness of the system, where potential end-users' opinions of the interface are. A system evaluation questionnaire

consisting of 31 rating questions assessing the Interface, Data Visualisation, Multi-criteria evaluation, Usefulness and Satisfaction was designed based on the above evaluation matrix.

5.4.2.1 Method

Participants

The evaluation user groups were divided according to the main users of the NSS data: Institutional Staff (Academic and Higher management) and Prospective students. Opportunity sampling was used to recruit the participants for the study. The evaluations of these two user groups were conducted separately.

Table 5.8*Classification of System users according to computer proficiency*

User Group	Computer Expertise	Number	Total
Institution Staff	Novice	2	
	Some Experience	20	
	Expert	8	30
Prospective Students	Novice	5	
	Some Experience	23	
	Expert	2	30

Evaluation of Staff User Group

The AIFS was presented to the users on a computer. The users were then asked to use the system to view the results of the NSS for the institution (overall Institution results) and/or the results for a specific course they are interested in. They were then requested to fill in the system evaluation questionnaire. The aims of the project and the AIFS were explained to the user and the user was given control of the system along with a copy of the NSS questionnaire. First the user was prompted to upload the pre-processed data file of interest. Once the system output was generated, different features of the system and the purpose of different options were explained to the user. The user was given a few minutes to navigate around the system on their own before the data collection process.

The system evaluation questionnaire developed in line with the evaluation matrix in Table 5.7 was presented to the users (Appendix 8). The users were required to rate each of the 31 evaluation questions using a 5 point Likert scale (*Strongly Disagree- Strongly Agree*). Five open ended questions were also presented for the users to fill out.

Evaluation of Student User group

The student user group were given a timed list of tasks which matched the information needs of the students identified by the HEFCE research (Appendix 11). The following usability metrics were computed for the student user group. The aim of the tasks was to find out if this user group can find the level of student satisfaction through the interface in a fast and efficient manner. At the beginning and at the completion of the task the students were advised to prompt to the evaluator so that the time interval can be recorded.

Task Completion Rate

Completion rate is the percentage of test participants who successfully completed the task without critical errors. A critical error is defined as an error that results in an incorrect or incomplete outcome. In other words, the completion rate represents the percentage of participants who, when they are finished with the specified task, have an "output" that is correct. Note: If a participant requires assistance in order to achieve a correct output then the task will be scored as a non-critical error and the overall completion rate for the task will be affected.

Error-free rate

Error-free rate is the percentage of test participants who complete the task without any errors (critical **or** non-critical errors). A non-critical error is an error that would not have an impact on the final output of the task but would result in the task being completed less efficiently.

Time on Task (TOT)

The time to complete a scenario is referred to as "time on task". It was measured from the time the participant began the scenario to the time he/she signaled completion. The TOT was measured for all five user tasks. The users were also advised to provide a rating of perceived time on task using a scale: *Slow*, *Fairly slow*, *Fairly fast*, *Fast*.

Subjective Measures

Following the task analysis, subjective measures were obtained for the student user group using the same questionnaire administered to the staff user group.

5.3.2.2 Results of system effectiveness evaluation

The main measure of effectiveness of the AIFS was concerned with the speed of the data comprehension and accuracy in terms of whether the system conveyed any affective content to system users. The results of the system evaluation were analysed in order to address these

factors. However due to possible biases in the subjective ratings about the interface, these evaluation results were not used to inform the effectiveness of the Affective interface. Instead the answers to interview questions were analysed in order to obtain more qualitative results that might indicate the Affective interfaces effectiveness in conveying student feedback with regard to affective content.

Affective Interface Data Display

In order to identify how the system users perceived the different combinations of data visualisation modes and to get an insight into what aspects of the interface were most informative and eye catching the answers to two of the open ended questions were analysed for each user group (Table 5.10 and 5.11).

Table 5.9. *User answers to: What information type in the interface did you pay most attention to?*

Staff user group			
	Numerical Data	Bar Chart	Facial Expression
Numerical Data	9	3	0
Bar Charts		6	2
Facial Expressions			5
Student User group			
	Numerical Data	Bar Chart	Facial Expression
Numerical Data	18	1	8
Bar Charts		10	7
Facial Expressions			1

These results indicate that a significant number of users were captured by the FE output while bar charts and numerical data remain the most important to the users. It can be inferred from the answers to these questions that FEs were more informative than numerical data but less informative than Bar Charts. Combinations of numerical data and bar charts seem to offer users more information than FEs alone. Few users also implied using combinations of all three data modes (bar chart, numerical data and FEs) were informative and intuitive. One particular comment on this question stated that it was *'Useful to have the data represented*

using different types'. In addition it is observed that the student user group paid more attention to the FE feedback in comparison to the staff user group. However, it was an interesting finding that some (5) participants from the staff user group the FE feedback alone informative in comparison to the student user group (0).

Table 5.10. *Staff: User answers to: Which information type/types in the interface was the most informative?*

Staff user group			
	Numerical Data	Bar Chart	Facial Expression
Numerical Data	5	7	1
Bar Charts		6	1
Facial Expressions			5
Student user group			
	Numerical Data	Bar Chart	Facial Expression
Numerical Data	12	0	4
Bar Charts		9	2
Facial Expressions			0

Speed and Effectiveness of Affective Interface

The initial testing conducted on HEI staff did not have the capacity to obtain a measure of speed. However the speed and efficiency of the system for this user group was assessed using the responses to the interview questions. Table 5.13 provides some of these comments. The speed of inferring the underlying data was a characteristic of the AIFS that was acknowledged by a majority of system users, even those that were cynical about the use of facial expressions (FEs) as a mode of displaying student feedback. The use of words that imply speed such as 'immediate', 'fast', 'quick', 'impromptu', 'easy' and 'at-a-glance' further support the hypothesis that Fes can be used to convey student feedback 'at-a-glance'.

Table 5.11. *Staff User group comments indicating speed of data comprehension*

'Easy to get a quick impression of the level of feedback.'
'It was slightly quicker than scanning the means.'
'It quickly showed overall satisfaction and identified specific questions.'
'Provided 'at a glance' comparisons between sections/questions.'
'For a quick glance is ok, but not valuable for detail.'
'No- and it should not. It is an easy to use, impromptu, fast method for communicating data. '
'Again it conveys a very immediate idea as to which areas/questions students were happy/not happy with.'

For the student sample, objective measures of speed were obtained through a timed exercise. Table 5.9 displays the task completion rate. All tasks were completed by the student participants except task 5 which was not completed by 24 students. This task requested students to use the system to find the level of student satisfaction with learning resources. As learning resources is a secondary requirement, this is not presented in the main data display screen. Students found it difficult to identify the interface features such as the button label names which would have enabled them to have a question by question view. Therefore the failure of this task is attributed to the layout of the interface.

Table 5.12. *Task Completion Rate and Error-free rate for prospective student user group*

Task	**No Users Completed**	**No. Users Failed task**	**Completion rate (%)**	**No. of critical errors**	**Error-free rate (%)**
1	30	0	100	0	100
2	30	0	100	0	100
3	30	0	100	0	100
4	30	0	100	0	100
5	6	24	20	6	0

Table 5.13. *Measured and Perceived Time on Task (TOT) for the five student user tasks.*

Task	**Measured TOT**	**Perceived Time (No. of users)**			
	Mean (s) ± sd	*Slow*	*Fairly slow*	*Fairly fast*	*Fast*
1	90.42 ±56.29	6	17	3	4
2	28.04 ±22.60	0	2	16	12
3	19.52 ±11.50	0	2	9	19
4	14.66 ±9.10	0	1	6	23
5	63.51 ±42.50	15	7	4	4

Table 5.10 displays the measured of TOT for the student participants. Task 1 and 5 were the slowest. As discussed above, the reason for the student users taking a longer time to complete Task 5 was due to an interface design issue. The student users took the most time to complete task one. This was mainly due to the students having to first understand the data layout and figure out how the interface operates. Following the completion of the first task subsequent tasks were completed much quicker. Spearman's rank order correlation was run to find the correlation between the measured TOT and users perceived TOT. There was a strong, negative correlation between the measured TOT and the user perceived TOT for all 5 tasks. These correlations are statistically highly significant: Task 1 ($r_s(28) = -.579$, $P = .001$); Task 2 ($r_s(28) = -.647$, $P = .000$); Task 3 ($r_s(28) = -.799$, $P = .000$); Task 4 ($r_s(28) = -.641$, $P = .000$); Task 5 ($r_s(28) = -.724$, $P = 000$). In addition 16 participants from the student user group stated that the Facial feedback was something that they paid most attention to (Table 5.9). These results indicate that the feedback can be conveyed easily using the proposed affective interface. Although initially time is taken to understand the system layout. The student sample showed great speed in comprehending student feedback using the interface.

Conveying affective content

A thematic analysis was carried out on the open ended questions. The responses were separated in terms of if the response indicates the speed of data comprehension, assimilation of affective content or any other relevant areas. The comments indicating that the student feedback was conveyed affectively are displayed in Table 5.14 and Table 5.15.

Table 5.14. *Staff user group comments indicating the assimilation of affective content*

'What I already knew about students' satisfaction and made me infer on the key areas I can work on.'
'Provided an indication of satisfaction.'
'Overall Satisfaction.'
'The bar chart gave perspective and context. I only saw 3 possibilities with the face: Happy, Ok, Unhappy.'
'Whether the students were content or dissatisfied.'
'It was useful in understanding the student perceptions.'
'In the main students showed a good level of satisfaction with just one area showing more evidence of dissatisfaction.'
'Helped to show it in an emotional way.'

'It gave a positive message.'
'It seemed to display a positive image.'
'They are broadly happy with the section shown.'
'It was a useful indication of students' perceptions.'
'In the main it was positive, most were 'smiley' faces.'
'They appear happy.'
'It gives an impression.'
'More expressive.'
'Enabled me to very readily make a judgement on which were positive and negative aspects to the students of their learning experiences.'
'Generally positive.'
'It did help convey a sense of student satisfaction, implying a feeling of satisfaction in addition to more conventional means of representation.'

Table 5.15. *Student user group comments indicating the assimilation of affective content*

'Whether they enjoyed it or not.'
'Happy.'
'It showed me that most people were happy with the criteria and gave good marks.'
'I felt it was good.'
'They are happy with the learning experience.'
'This gives a good perception and easy to identify.'
'They are pleased.'

User comments such as '*indication* of student satisfaction', 'gave and *impression* of student satisfaction' and 'helped understand student *perceptions*' justify the ability of FEs to convey student feedback data in an effective manner. The reference to the output as 'positive', 'negative', 'happy', 'pleased' and 'good' provides an indication that the users have inferred an emotional content from the data. It was suggested by several staff users that the presence of the FE depiction allowed them to readily make a judgement on aspects of the subject or course that needed improvement. Some user comments from both user groups suggested that more variation in the FEs with the numerical means is necessary to make the FE display of the AIFS effective (Table 5.16).

Table 5.16 *Suggestive User Comments on the acceptance of FEs as a means of Feedback*

'It would if the expressions would be slightly more different'
'It could provided the faces changes were more obvious as key averages changed.'
'For a quick glance is ok, but not valuable for detail'

Table 5.17 *Positive user comments on the Usefulness of the AIFS*

'Providing a personal, almost qualitative 'face' to the statistics- could be used as an effective way to communicate the results to students, as opposed to one loading statistics/Figures.'
'It did help convey a sense of student satisfaction, implying a feeling of satisfaction in addition to more conventional means of representation'.
'a different way of illustrating the meaning.'
'Again it conveys a very immediate idea as to which areas/questions students were happy/not happy with'
'It is an easy to use, impromptu, fast method for communicating data.'
'Achieves the purpose'
'Yes, and when weighting changed the faces changed too which was useful.'

Table 5.17 provides some of the positive comments relating to the Facial feedback further indicating the ability of the face to display student feedback 'at-a-glance' with respect to affective content.

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Chapter 6

Conclusions and Future Work

If patience is worth anything, it must endure to the end of time. And a living faith will last in the midst of the blackest storm. – Mahatma Ghandi

6.1 Conclusions

In the current information revolution, feedback plays a crucial role in people's lives may it be to about a product one is anticipating buying or about a movie one wants to see. While word of mouth and direct recommendations have played a role in informing choice and decision-making in the past, in the current virtual and electronic world people rely more and more electronic media. While organisations continue to collect feedback, how well this information is transferred into actionable information is not well known. In this regard, the importance of enabling effective analysis and comprehension of feedback data is an area of wide potential.

In this thesis, the need for effective methods for handling multi-criteria type feedback data was addressed. In particular, two aspects of the feedback data which can influence effective decision-making were addressed. First and foremost it was suggested that the presentation of the data in a form that allows its rapid assimilation and understanding would increase the effectiveness of the feedback data in informing decision-making. However, presentation of the data is not the only factor that is important for decision-makers. The accuracy of the data presented is also essential for ensuring the effective decision-making. Therefore, it was suggested that more analysis on the feedback data – which usually entails large amounts of interrelated information – prior to its presentation, would enable the conveying of accurate and actionable information for decision makers. Based on these the thesis set out to use current information communication technologies to enable the facilitation of the afore-named aspects.

It was hypothesised that the application of virtual FEs to convey feedback data would enable faster processing of these data at the human side by relying on easy, legible and emotion appealing display. While Chernoff (1973) attempted to achieve the same purpose using his Chernoff faces, the method was deemed inefficient due to the arbitrary mappings

between the underlying data and the facial features. These mappings had no underlying basis thus time and effort was needed by the interpreters to understand the mappings before trying to understand the data. In contrast, the proposed method used mappings based on the relationship between the level of satisfaction and the underlying dimensions that characterise emotional FEs (supported by experiments in Chapter 3). Thus the perceptual validity attributed to the FE depictions used to convey levels of satisfaction through the AIFS does not require the user to have any prior knowledge to understand what the FE depiction implies. As highlighted in the research on the perception of FEs in Chapter 1, humans have an innate ability to decode emotional FEs. Thus no specific training is necessary to understand what the FE depiction represents compared to Chernoff faces making the output of the AIFS 'at-a-glance'.

Two, experiments were carried out to map FEs of emotion to one-dimensional and two dimensional satisfaction spaces. FEs in the experiments were defined as varying along two dimensions: the affective dimension of *Valence* and the behavioural tendency dimension of *Reactivity*. All experiments carried out found that + ve *Valence* was positively related satisfaction and –ve Valence negatively related to satisfaction. This is in line with the current view that customer satisfaction and dissatisfaction results in positive and negative emotions respectively. In addition satisfaction can be best defined by the *Valence* dimension. This finding thus adds to current literature with empirical findings that show satisfaction related to *pleasure-displeasure* (which is the general definition of Satisfaction).

Reactivity on the other hand varied with satisfaction. In particular the active behaviour at extreme dissatisfaction was observed. The findings related to Reactivity indicate that reactivity is more closely linked to requirement fulfilment or objective quality. Another finding from these experiments was the discriminating power of the 9- point scale. The results of this study can be used to support the use of the 9- point scales for the effective assessment of satisfaction.

Applying these results into the context of the study, the National student survey was used as a case study for measuring satisfaction and understanding the effectiveness of the frameworks proposed in this study. A study was carried out to build on the framework proposed for handling multi-criteria based data based on the Kano model of satisfaction. The value of student overall satisfaction calculated by the proposed method was found to be positively correlated to the answer to the NSS item 22 which is regarding the overall quality of the course. However to improve the predictability and the accuracy of this value, more testing using NSS data sets need to be carried out.

In line with the main objectives of this research project it was vital to infer from the evaluation process that the proof-of-concept AIFS prototype achieves its goals. The evaluation process was mainly concerned with the accuracy of the data display (in terms of whether the interface conveys what is intended) and the effectiveness of the facial feedback (in terms of speed of data interpretation as well as communication of affective content).

Testing on the accuracy of the system output produced convincing results as to the ability of the system to convey accurate non-verbal signals representing the underlying data. In cases where accurate mapping were not obtained, especially for the two-dimensional mappings used, the cause of the inaccuracy was pinned to the Kano qualitative analysis. This can be addressed in future work by using developments on the Kano model that have designed better classification matrices. However, the accuracy of the facial expression assignment to the Must-be requirement provides more evidence for supporting the accuracy of the proposed method. All in all the results of the system accuracy tests indicate two things. Firstly, the capacity of the proposed framework in computing and accurate metric of student satisfaction is seen. The basis behind this conclusion is that *Satisfaction* is seen as a function of +*Valence* and *Dissatisfaction* a function of -*Valence*. The indication that students' assigned values for *Valence* are significantly similar to those obtained by the proposed multi-criteria data analysis shows that the method has computed a value of student satisfaction which is accurate. In addition these findings also show the discriminative power of the 9-point scale in measuring satisfaction accurately. The results obtained for the 5- point scale are also enlightening as this provides support for the use of 5- point scale for measuring satisfaction.

The results support the two dimensional view of satisfaction proposed by Kano et al. (1984). The evidence for this was based on two aspects. Firstly, the similar patterns in *Valence* and *Reactivity* observed for both one-dimensional mappings. Secondly the shared accuracy of the two-dimensional and one-dimensional mappings in system output generation.

Evaluation of the system in terms of conveying student feedback with affective content and at-a-glance also produced promising results. Although more evaluation needs to be conducted to support this, the majority of user comments implied the speed of understanding the data using the system and the emotional message inferred. The ability of the face to convey student feedback was agreed on unanimously, however the use of a Face alone to display such sensitive data was not accepted by many users mainly the HEI staff.

However, in line with the main objectives of the present study, the affective interface has displayed that student feedback can be conveyed accurately and effectively using virtual FEs.

6.2 Future Work

Future work, first and foremost, needs the validation of the current results of Facial feedback using a different FE set. This is due to the lack of proper underlying psychological basis behind the current emoticons set. Results from similar studies carried out in this thesis using a more psychologically valid FE set would provide a basis for building more effective and accurate mappings between the data parameter and the Fes depictions.

Another issue that needs to be addressed is the use of a user-centred approach in developing the interface. A user-centred approach was not used in the present study although potential end users were involved at the final system evaluation stage. Using such a user-centred approach has the capacity to provide insight into how the Facial feedback can best be incorporated into current modes used in understanding student feedback. This can lead to the development of an Interface that will be more acceptable by potential end users.

Following the acquisition of enhanced FE mappings and a better interface, the system can be integrated with e-voting technologies which would allow the instant capture of feedback data. The Affective interface can then be used as a method of instantly conveying result of such assessments.

The proof of concept prototype could be further developed and adjusted for the purposes of specific to business, management and Enterprise (eg in supporting advertising business to optimise customer reach and business potential; or to help companies experiencing efficiency problems); and as such this concept and development of this system has the potential to offering product to business and community end users while adjusting to specific needs. In this wider context the AIFS could provide businesses organisation management teams a fast an easy way of understanding their customers on a regular basis. The use of the AIFS to visualise the results of the system evaluation further highlights the potential use of the AIFS in wider organisational domains. The proposed method, for both effective data analysis and data display can also expanded to other application domains such as e-commerce, e-health and e-governance.

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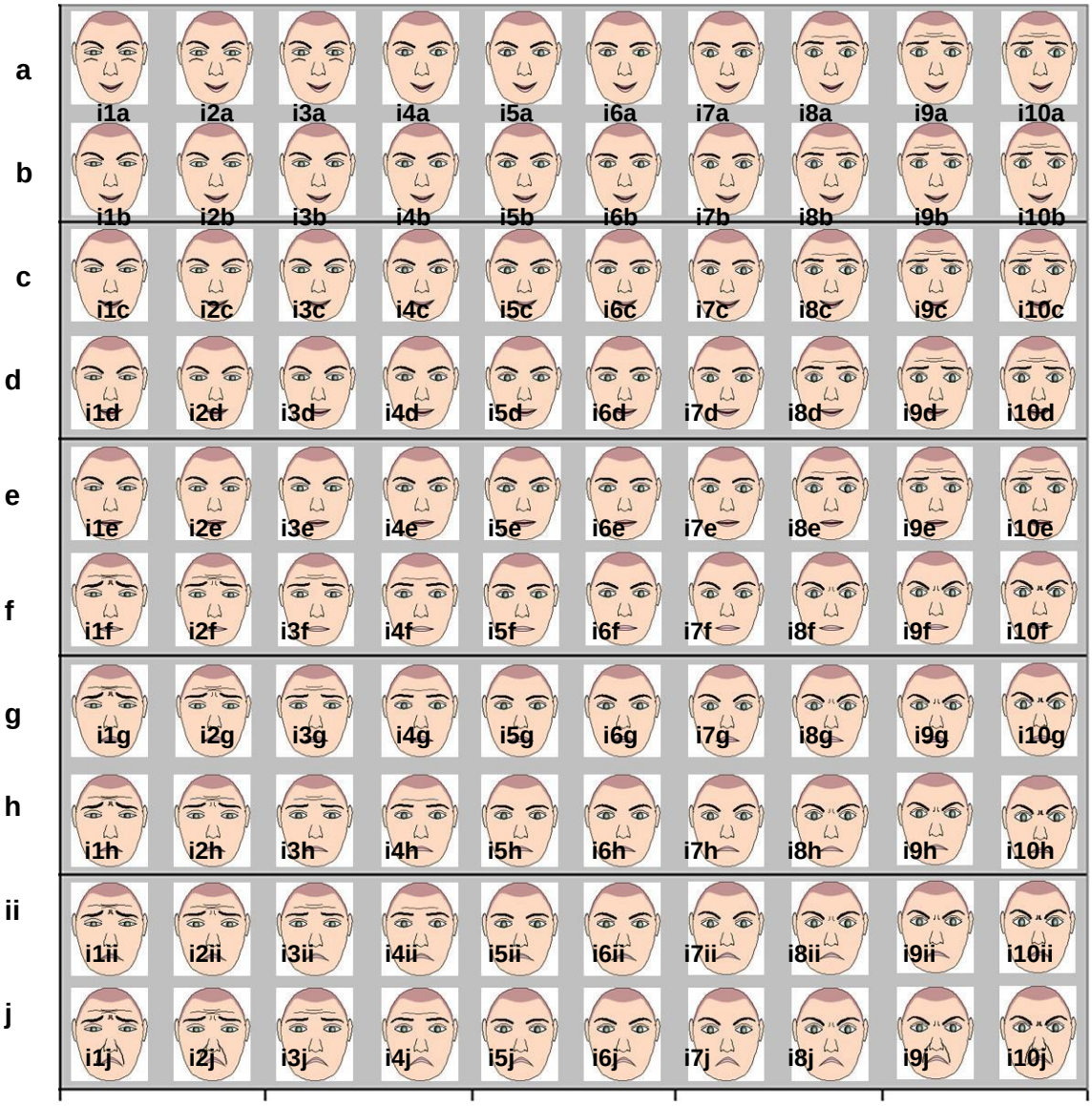
Appendices

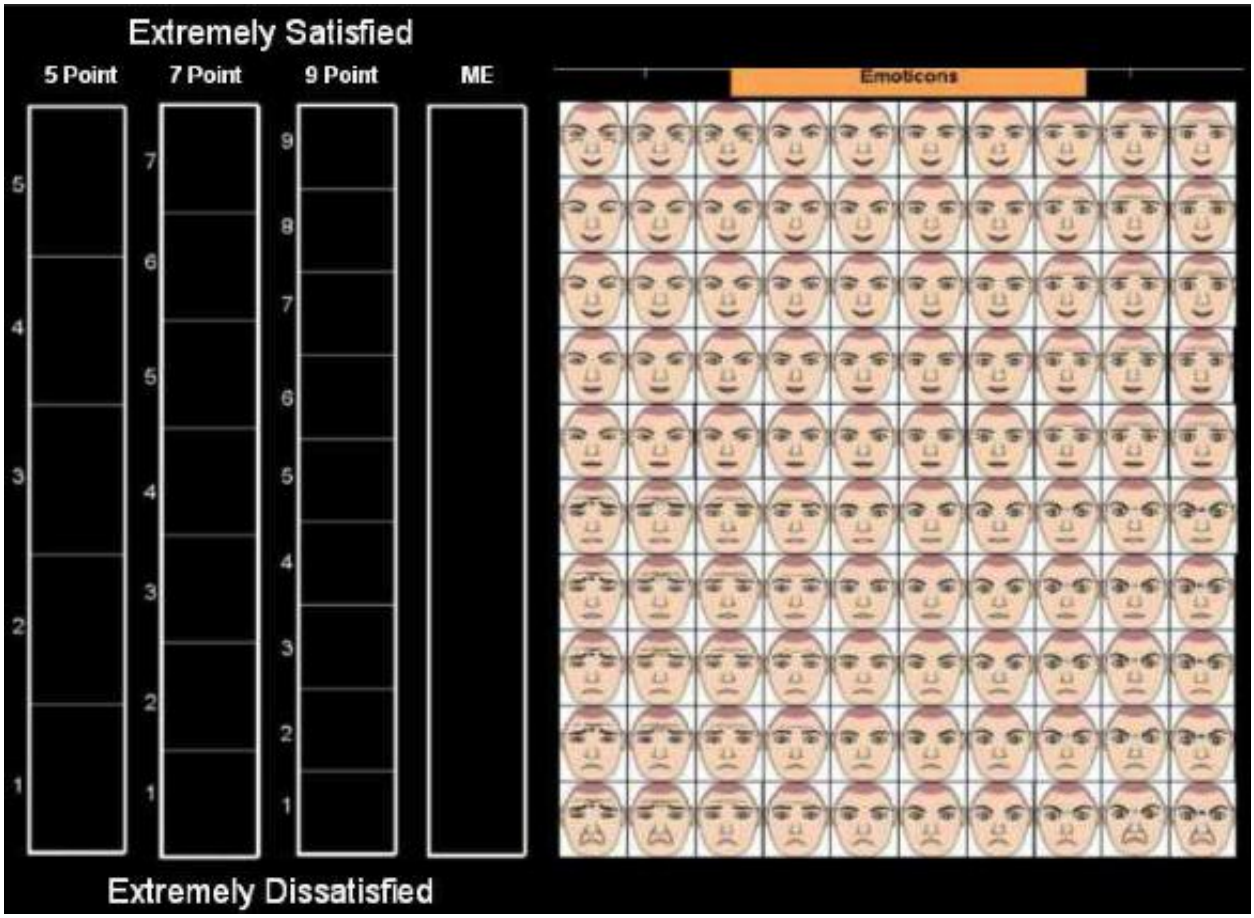
Appendix 1

Emoticon Reference Set



Appendix 2

Set-up of the Experiment 1



Appendix 3

Selection of Anchor Emoticons

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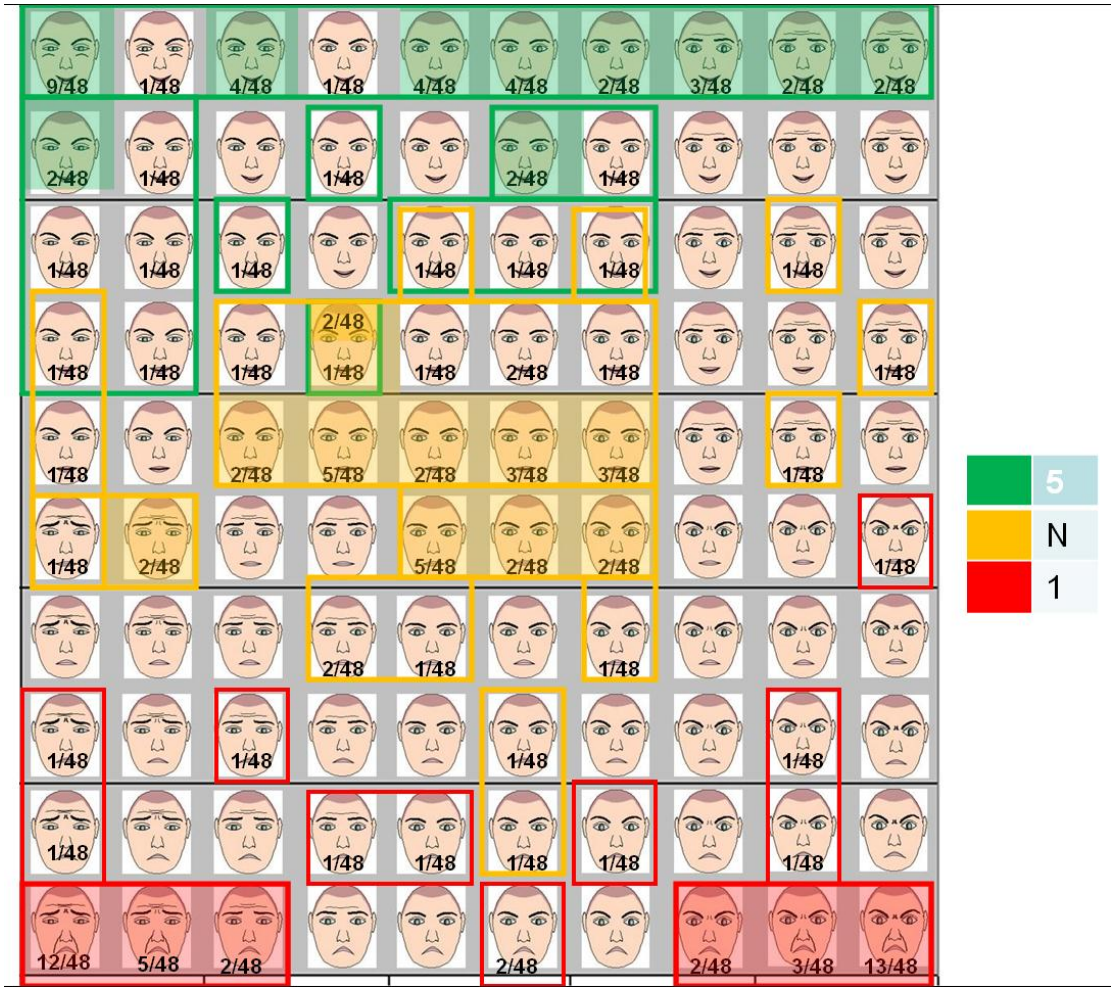

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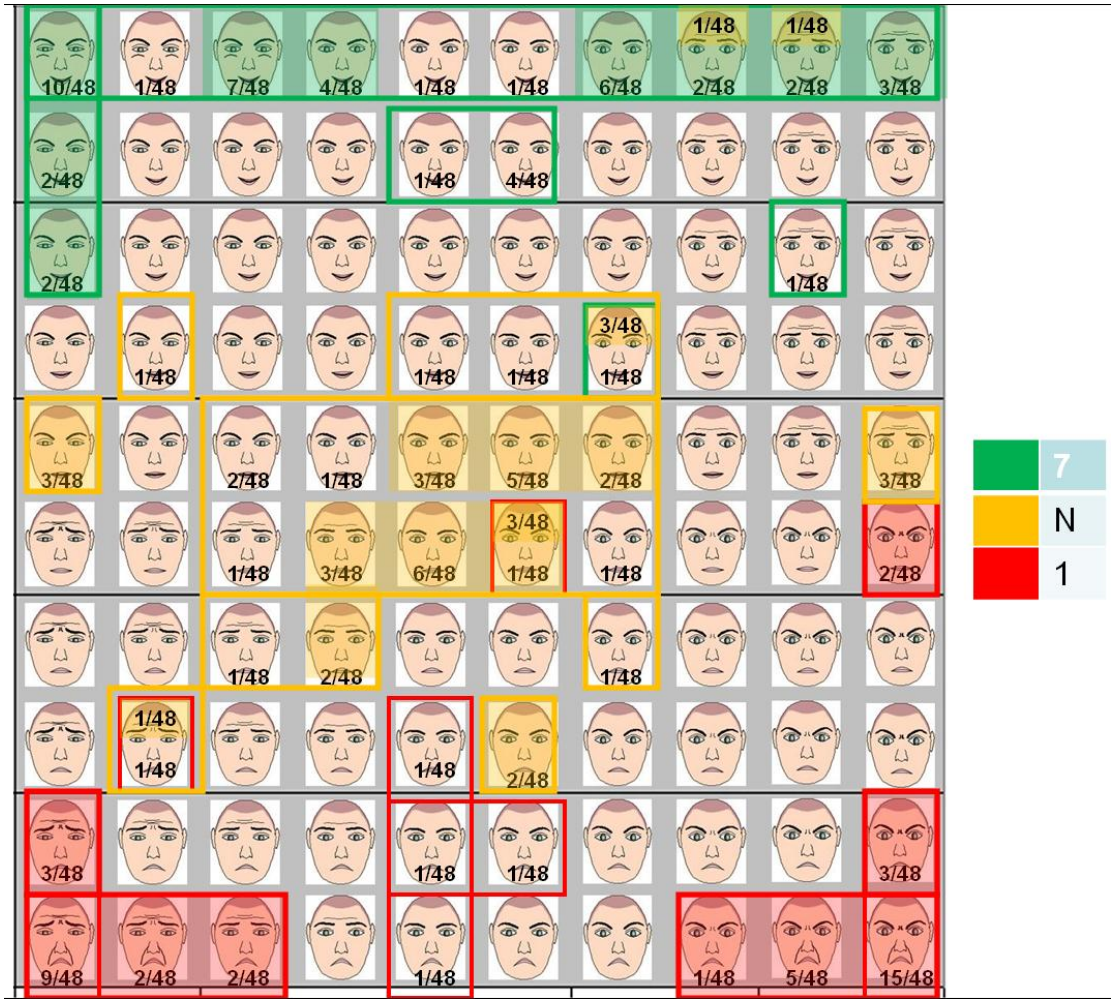
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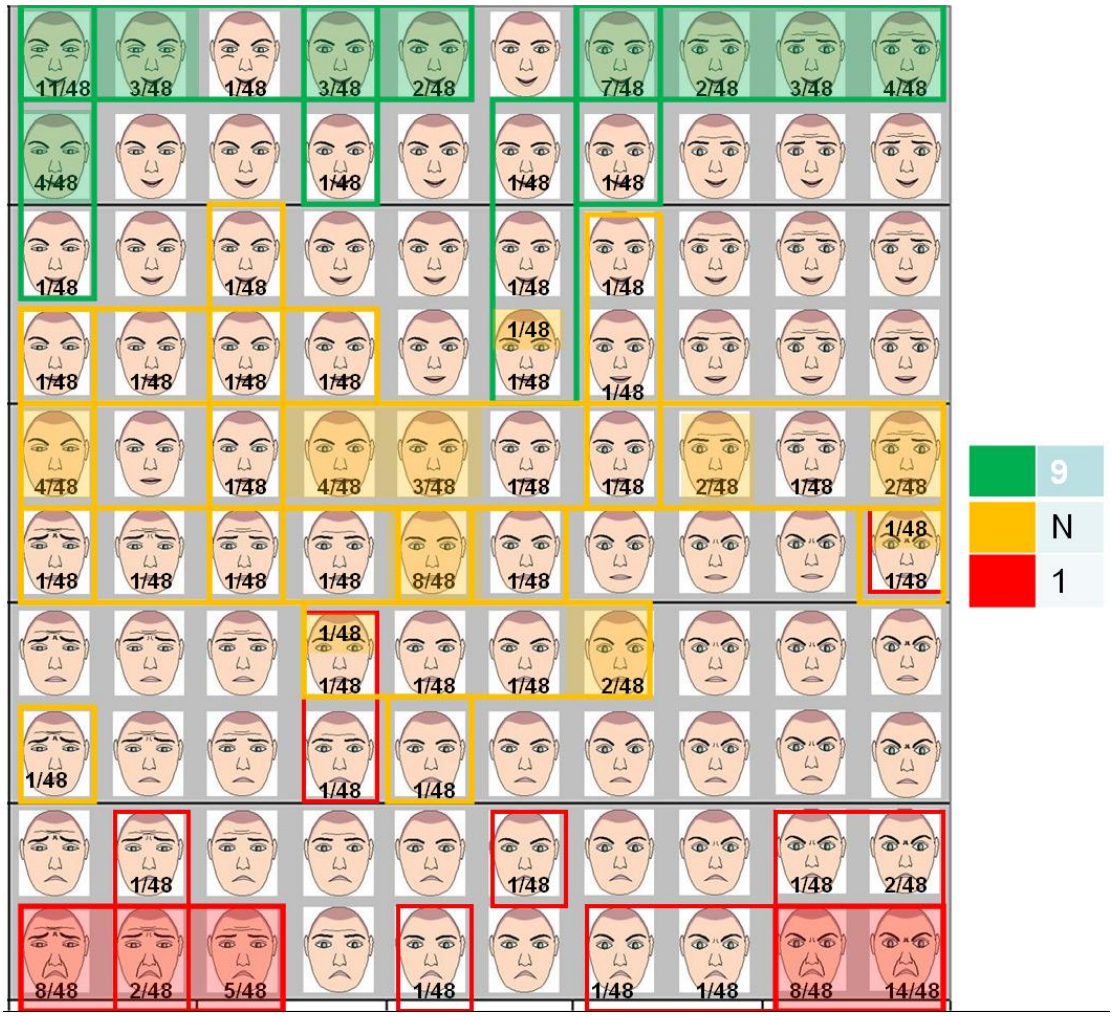
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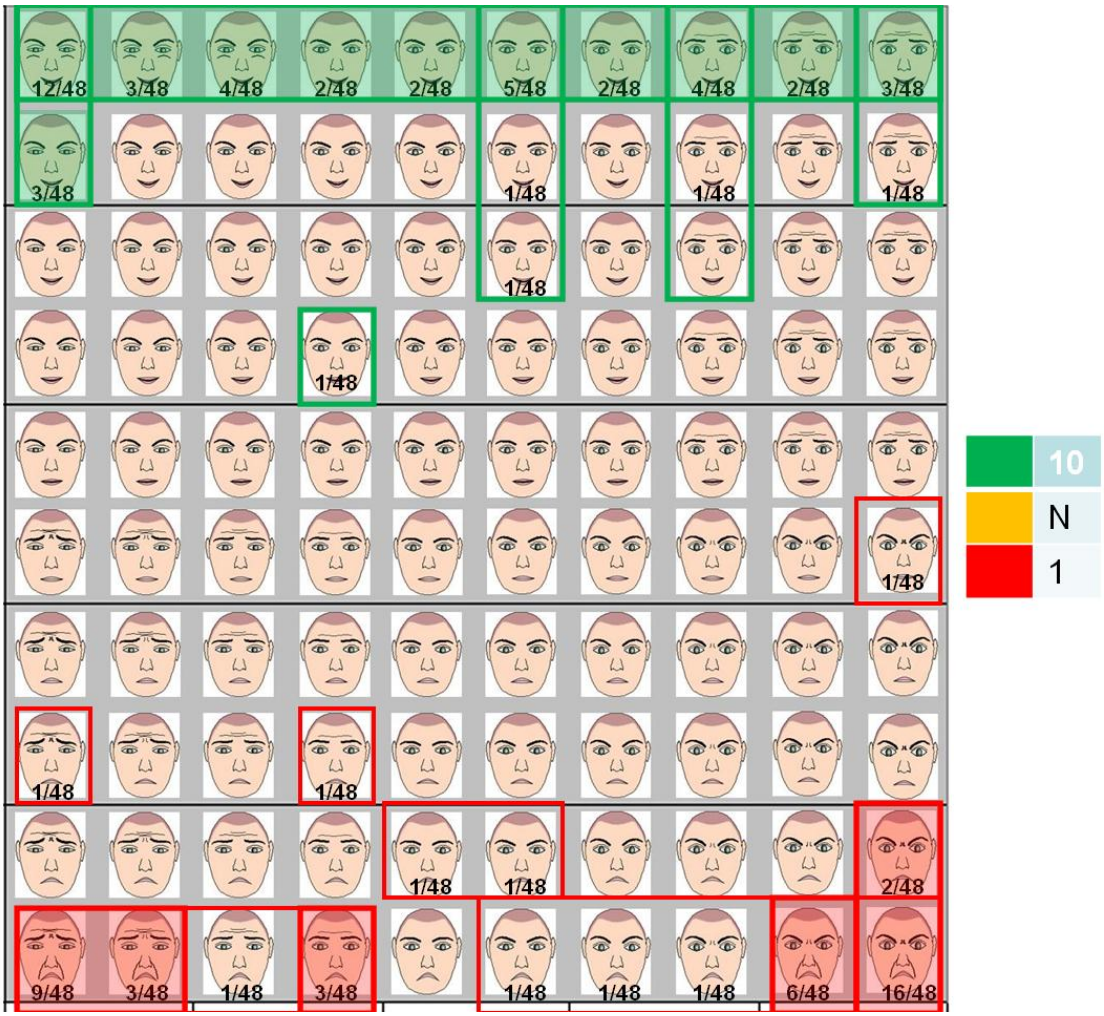
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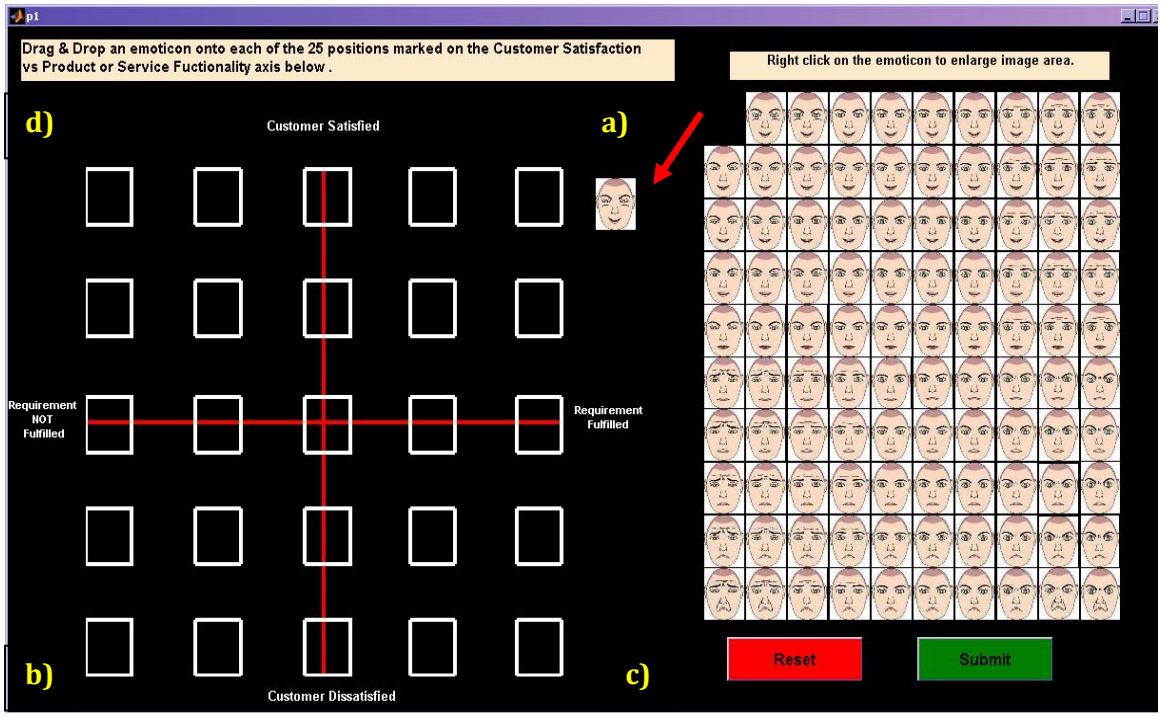
Appendix 4

Set-up of the Experiment 2



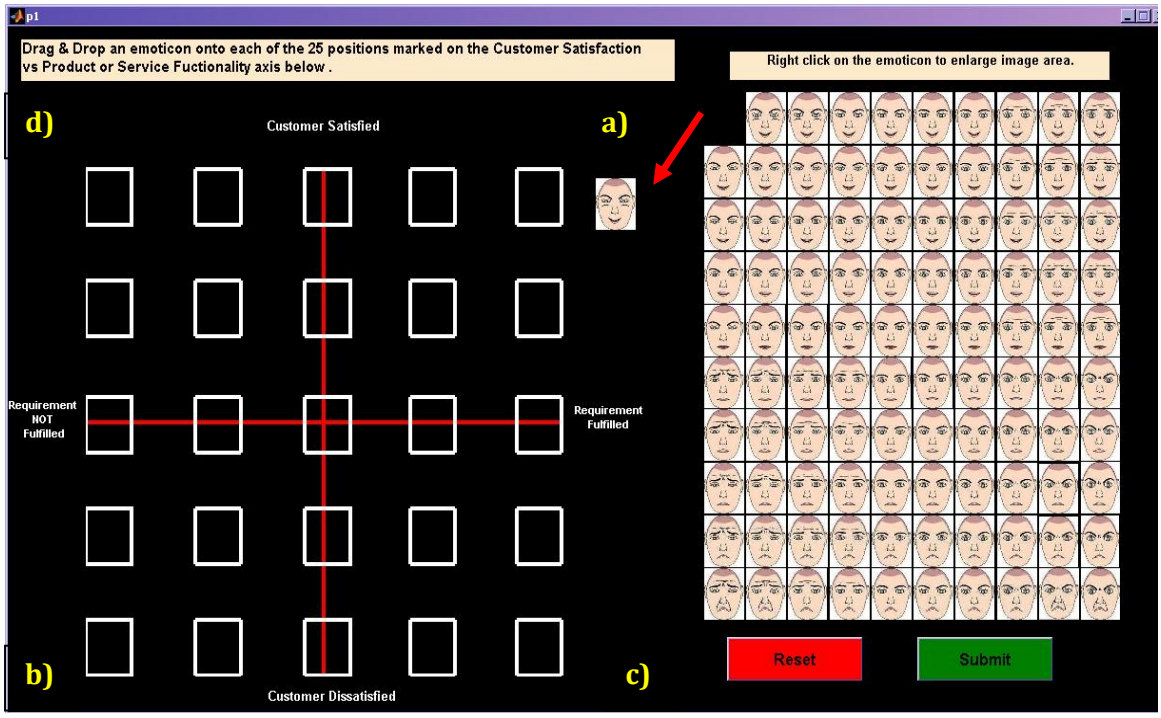
Appendix 5

EXPERIMENT 2: INSTRUCTIONS

What facial expressions can serve as YOUR emotional labels / along the two dimensions: customer satisfaction vs. dissatisfaction and functionality vs. dysfunctionality of a product / service?

To help you answer the above question, we provide you with a pool of 10 x10 emoticons with varying facial expressions, on the one hand, and the two-dimensional layout (Customer satisfaction ↕, Product or service functionality ↔).

You are requested to select 25 faces from the pool and drag and drop these onto predefined locations in the layout while capturing both the Satisfaction–Dissatisfaction dimension and the Functionality dimension.



The following examples should allow you to think about what each predefined location might mean.

Meanings of Functionality

- Requirement fulfilled
    - Product performs well

    - Product or service meets expectations
- Requirement NOT fulfilled
    - Process is interrupted , unfinished
    - Product fails to meet the expectations

a) Requirement Fulfilled (Functional) & Customer Satisfied

This is the case where a customer finds that the product or service and he or she is satisfied.

Eg: Good gas mileage in a car

Booking appointments online for a health centre, booking train or flight tickets (fast and easy)

Good customer service

b) Requirement Not Fulfilled (Dysfunctional) & Customer Dissatisfied

This is the case when again customer finds that product or service functions badly and he or she is dissatisfied.

Eg: Not able to access booking information online

Airline delays

Loss of Internet or telephone connection for days

c) Requirement Fulfilled (Functional) & Customer Dissatisfied

This is the case when even though the product or service meets certain functional requirements, the customer might still feel dissatisfied. The reason for this could be that the customer assumes the product or service to have a certain feature anyway but might be expecting something more or might be taking the feature for granted.

Eg: Library available, however want newer books.

Standard employee benefits, however expecting more benefits.

d) Requirement Not Fulfilled (Dysfunctional) / Customer Satisfied

This is the case when a product or service does not have a certain functional feature but the customer is still satisfied. The reason for this could be that the customer is not aware of such a feature, therefore he or she cannot get dissatisfied with the product or service in question.

Eg: Renewal of prescriptions online (You might not be aware of this e-Health service)

Free postage & packaging

Ryanair return flights to France 1p.

Appendix 6

Rotter's Locus of Control Assessment questionnaire

1. a. Children get into trouble because their patents punish them too much.

1. b. The trouble with most children nowadays is that their parents are too easy with them.

2. a. Many of the unhappy things in people's lives are partly due to bad luck.

2. b. People's misfortunes result from the mistakes they make.

3. a. One of the major reasons why we have wars is because people don't take enough interest in politics.

3. b. There will always be wars, no matter how hard people try to prevent them.

4. a. In the long run people get the respect they deserve in this world.

4. b. Unfortunately, an individual's worth often passes unrecognized no matter how hard he tries.

5. a. The idea that teachers are unfair to students is nonsense.

5. b. Most students don't realize the extent to which their grades are influenced by accidental happenings.

6. a. Without the right breaks, one cannot be an effective leader.

6. b. Capable people who fail to become leaders have not taken advantage of their opportunities.

7. a. No matter how hard you try, some people just don't like you.

7. b. People who can't get others to like them don't understand how to get along with others.

8. a. Heredity plays the major role in determining one's personality.

8. b. It is one's experiences in life which determine what they're like.

9. a. I have often found that what is going to happen will happen.

9. b. Trusting fate has never turned out as well for me as making a decision to take a definite course of action.

10. a. In the case of the well prepared student there is rarely, if ever, such a thing as an unfair test.

10. b. Many times, exam questions tend to be so unrelated to course work that studying in really useless.

11. a. Becoming a success is a matter of hard work, luck has little or nothing to do with it.

11. b. Getting a good job depends mainly on being in the right place at the right time.

12. a. The average citizen can have an influence in government decisions.

12. b. This world is run by the few people in power, and there is not much the little guy can do about it.

13. a. When I make plans, I am almost certain that I can make them work.

13. b. It is not always wise to plan too far ahead because many things turn out to be a matter of good or bad fortune anyhow.

14. a. There are certain people who are just no good.

14. b. There is some good in everybody.

15. a. In my case getting what I want has little or nothing to do with luck.

15. b. Many times we might just as well decide what to do by flipping a coin.

16. a. Who gets to be the boss often depends on who was lucky enough to be in the right place first.

16. b. Getting people to do the right thing depends upon ability - luck has little or nothing to do with it.

17. a. As far as world affairs are concerned, most of us are the victims of forces we can neither understand, nor control.

17. b. By taking an active part in political and social affairs the people can control world events.

18. a. Most people don't realize the extent to which their lives are controlled by accidental happenings.

18. b. There really is no such thing as "luck."

19. a. One should always be willing to admit mistakes.

19. b. It is usually best to cover up one's mistakes.

20. a. It is hard to know whether or not a person really likes you.

20. b. How many friends you have depends upon how nice a person you are.

21. a. In the long run the bad things that happen to us are balanced by the good ones.

21. b. Most misfortunes are the result of lack of ability, ignorance, laziness, or all three.

22. a. With enough effort we can wipe out political corruption.

22. b. It is difficult for people to have much control over the things politicians do in office.

23. a. Sometimes I can't understand how teachers arrive at the grades they give.

23. b. There is a direct connection between how hard I study and the grades I get.

24. a. A good leader expects people to decide for themselves what they should do.

24. b. A good leader makes it clear to everybody what their jobs are.

25. a. Many times I feel that I have little influence over the things that happen to me.

25. b. It is impossible for me to believe that chance or luck plays an important role in my life.

26. a. People are lonely because they don't try to be friendly.

26. b. There's not much use in trying too hard to please people, if they like you, they like you.

27. a. There is too much emphasis on athletics in high school.

27. b. Team sports are an excellent way to build character.

28. a. What happens to me is my own doing.

28. b. Sometimes I feel that I don't have enough control over the direction my life is taking.

29. a. Most of the time I can't understand why politicians behave the way they do.

29. b. In the long run the people are responsible for bad government on a national as well as on a local level.

Score one point for each of the following:

2.a, 3.b, 4.b, 5.b, 6.a, 7.a, 9.a, 10.b, 11.b, 12.b, 13.b, 15.b, 16.a, 17.a, 18.a, 20.a,

21.a, 22.b, 23.a, 25.a, 26.b, 28.b, 29.a.

A high score = External Locus of Control

A low score = Internal Locus of Control

Appendix 7

National Student Survey Questionnaire

National Student Survey

Main Questions (Page 1 of 2)

	Definitely agree	Mostly agree	Neither agree nor disagree	Mostly disagree	Definitely disagree	Not applicable
The teaching on my course						
1. Staff are good at explaining things.	☐	☐	☐	☐	☐	☐
2. Staff have made the subject interesting.	☐	☐	☐	☐	☐	☐
3. Staff are enthusiastic about what they are teaching.	☐	☐	☐	☐	☐	☐
4. The course is intellectually stimulating.	☐	☐	☐	☐	☐	☐
Assessment and feedback						
5. The criteria used in marking have been clear in advance.	☐	☐	☐	☐	☐	☐
6. Assessment arrangements and marking have been fair.	☐	☐	☐	☐	☐	☐
7. Feedback on my work has been prompt.	☐	☐	☐	☐	☐	☐
8. I have received detailed comments on my work.	☐	☐	☐	☐	☐	☐
9. Feedback on my work has helped me clarify things I did not understand.	☐	☐	☐	☐	☐	☐
Academic support						
10. I have received sufficient advice and support with my studies.	☐	☐	☐	☐	☐	☐
11. I have been able to contact staff when I needed to.	☐	☐	☐	☐	☐	☐
12. Good advice was available when I needed to make study choices.	☐	☐	☐	☐	☐	☐
Organisation and management						
13. The timetable works efficiently as far as my activities are concerned.	☐	☐	☐	☐	☐	☐
14. Any changes in the course or teaching have been communicated effectively.	☐	☐	☐	☐	☐	☐
15. The course is well organised and is running smoothly.	☐	☐	☐	☐	☐	☐

National Student Survey

Main Questions (Page 2 of 2)

	Definitely agree	Mostly agree	Neither agree nor disagree	Mostly disagree	Definitely disagree	Not applicable
Learning resources						
16. The library resources and services are good enough for my needs.	☐	☐	☐	☐	☐	☐
17. I have been able to access general IT resources when I needed to.	☐	☐	☐	☐	☐	☐
18. I have been able to access specialised equipment, facilities, or rooms when I needed to.	☐	☐	☐	☐	☐	☐
Personal development						
19. The course has helped me to present myself with confidence.	☐	☐	☐	☐	☐	☐
20. My communication skills have improved.	☐	☐	☐	☐	☐	☐
21. As a result of the course, I feel confident in tackling unfamiliar problems.	☐	☐	☐	☐	☐	☐
22. Overall, I am satisfied with the quality of the course.	☐	☐	☐	☐	☐	☐

Looking back on the experience, are there any particularly positive or negative aspects you would like to highlight? (Please use the boxes below.)

Positive :

Negative :

Appendix 8

Kano Questionnaire

Teaching

1

How do you feel if the staff are good at explaining things?	□ I like it that way □ It must be that way □ I am neutral □ I can live with it that way □ I dislike it that way
How do you feel if the staff are not good at explaining things?	□ I like it that way □ It must be that way □ I am neutral □ I can live with it that way □ I dislike it that way

2

How do you feel if the staff make the subject interesting?	□ I like it that way □ It must be that way □ I am neutral □ I can live with it that way □ I dislike it that way
How do you feel if the staff do not make the subject interesting?	□ I like it that way □ It must be that way □ I am neutral □ I can live with it that way □ I dislike it that way

3

How do you feel if the staff are enthusiastic about what they are teaching?	□ I like it that way □ It must be that way □ I am neutral □ I can live with it that way □ I dislike it that way
How do you feel if the staff are not enthusiastic about what they are teaching?	□ I like it that way □ It must be that way □ I am neutral □ I can live with it that way □ I dislike it that way

4

How do you feel if the course is intellectually stimulating?	□ I like it that way □ It must be that way □ I am neutral □ I can live with it that way □ I dislike it that way
How do you feel if the course is not	□ I like it that way □ It must be that way

intellectually stimulating?	□ I am neutral □ I can live with it that way □ I dislike it that way

Assessment and Feedback

1

How do you feel if the criteria used in marking was clear in advance?	□ I like it that way □ It must be that way □ I am neutral □ I can live with it that way □ I dislike it that way
How do you feel if the criteria used in marking was not clear in advance ?	□ I like it that way □ It must be that way □ I am neutral □ I can live with it that way □ I dislike it that way

2

How do you feel if the assessment arrangements and marking were fair?	□ I like it that way □ It must be that way □ I am neutral □ I can live with it that way □ I dislike it that way
How do you feel if the assessment arrangements and marking were not fair?	□ I like it that way □ It must be that way □ I am neutral □ I can live with it that way □ I dislike it that way

3

How do you feel if the feedback on your work is prompt?	□ I like it that way □ It must be that way □ I am neutral □ I can live with it that way □ I dislike it that way
How do you feel if the feedback on your work is not prompt?	□ I like it that way □ It must be that way □ I am neutral □ I can live with it that way □ I dislike it that way

4

How do you feel if you receive detailed comments on your work?	□ I like it that way □ It must be that way □ I am neutral □ I can live with it that way □ I dislike it that way
How do you feel if you do not receive	□ I like it that way

detailed comments on your work ?	□ It must be that way □ I am neutral □ I can live with it that way □ I dislike it that way

5

How do you feel if feedback on your work helps you clarify things that you did not understand?	□ I like it that way □ It must be that way □ I am neutral □ I can live with it that way □ I dislike it that way
How do you feel if feedback on you r work does not help you clarify things that you don't understand ?	□ I like it that way □ It must be that way □ I am neutral □ I can live with it that way □ I dislike it that way

Academic Support

1

How do you feel if you receive sufficient advice and support with your studies?	□ I like it that way □ It must be that way □ I am neutral □ I can live with it that way □ I dislike it that way
How do you feel if you do not receive sufficient advice and support with your studies?	□ I like it that way □ It must be that way □ I am neutral □ I can live with it that way □ I dislike it that way

2

How do you feel if you are able to contact staff when you need to?	□ I like it that way □ It must be that way □ I am neutral □ I can live with it that way □ I dislike it that way
How do you feel if you are unable to contact staff when you need to ?	□ I like it that way □ It must be that way □ I am neutral □ I can live with it that way □ I dislike it that way

3

How do you feel if good advice was available when you need to make study choices?	☐ I like it that way ☐ It must be that way ☐ I am neutral ☐ I can live with it that way ☐ I dislike it that way
How do you feel if good advice was not available when you need to make study choices?	☐ I like it that way ☐ It must be that way ☐ I am neutral ☐ I can live with it that way ☐ I dislike it that way

Organisation and Management

1

How do you feel if the timetable works efficiently as far as your activities are concerned?	☐ I like it that way ☐ It must be that way ☐ I am neutral ☐ I can live with it that way ☐ I dislike it that way
How do you feel if the timetable does not work efficiently as far as your activities are concerned?	☐ I like it that way ☐ It must be that way ☐ I am neutral ☐ I can live with it that way ☐ I dislike it that way

2

How do you feel if any changes in the course or teaching have been communicated effectively?	☐ I like it that way ☐ It must be that way ☐ I am neutral ☐ I can live with it that way ☐ I dislike it that way
How do you feel if any changes in the course or teaching have not been communicated effectively?	☐ I like it that way ☐ It must be that way ☐ I am neutral ☐ I can live with it that way ☐ I dislike it that way

3

How do you feel if the course is well organised and running smoothly?	☐ I like it that way ☐ It must be that way ☐ I am neutral ☐ I can live with it that way

	☐ I dislike it that way
How do you feel if the course is not well organised and not running smoothly?	☐ I like it that way ☐ It must be that way ☐ I am neutral ☐ I can live with it that way ☐ I dislike it that way

Learning Resources

1

How do you feel if the library resources and services were good enough for your needs?	☐ I like it that way ☐ It must be that way ☐ I am neutral ☐ I can live with it that way ☐ I dislike it that way
How do you feel if the library resources and services were not good enough for your needs?	☐ I like it that way ☐ It must be that way ☐ I am neutral ☐ I can live with it that way ☐ I dislike it that way

2

How do you feel if you are able to access general IT resources when you need to?	☐ I like it that way ☐ It must be that way ☐ I am neutral ☐ I can live with it that way ☐ I dislike it that way
How do you feel if you are unable to access general IT resources when you need to?	☐ I like it that way ☐ It must be that way ☐ I am neutral ☐ I can live with it that way ☐ I dislike it that way

3

How do you feel if you are able to access specialised equipment, facilities or rooms when you need to?	☐ I like it that way ☐ It must be that way ☐ I am neutral ☐ I can live with it that way ☐ I dislike it that way
How do you feel if you are unable to access specialised equipment, facilities or rooms when you need to?	☐ I like it that way ☐ It must be that way ☐ I am neutral ☐ I can live with it that way ☐ I dislike it that way

Personal Development

1

How do you feel if the course helps you to present yourself with confidence?	☐ I like it that way ☐ It must be that way ☐ I am neutral ☐ I can live with it that way ☐ I dislike it that way
How do you feel if the course does not help you present yourself with confidence?	☐ I like it that way ☐ It must be that way ☐ I am neutral ☐ I can live with it that way ☐ I dislike it that way

2

How do you feel if your communication skills have improved?	☐ I like it that way ☐ It must be that way ☐ I am neutral ☐ I can live with it that way ☐ I dislike it that way
How do you feel if your communication skills have not improved?	☐ I like it that way ☐ It must be that way ☐ I am neutral ☐ I can live with it that way ☐ I dislike it that way

3

How do you feel if as a result of the course you feel confident in tackling unfamiliar problems ?	☐ I like it that way ☐ It must be that way ☐ I am neutral ☐ I can live with it that way ☐ I dislike it that way
How do you feel if as a result of the course you do not feel confident in tackling unfamiliar problems?	☐ I like it that way ☐ It must be that way ☐ I am neutral ☐ I can live with it that way ☐ I dislike it that way

Appendix 9

System accuracy evaluation

The following questionnaire is part of a study carried out to identify student perceptions of different aspects of the university learning experience.

Please fill in the following details:

Initials				
Age				
Gender	Male	☐	Female	☐
Ethnicity	UK/EU	☐	Overseas	☐
Course				
Year				

Instructions

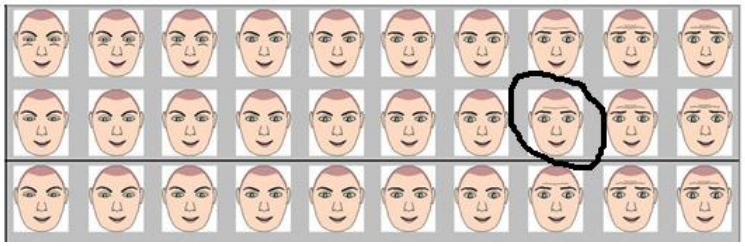
This questionnaire consists of 2 sections:

Section A

For each statement, show the extent of your agreement or disagreement by putting a cross in the one box ☒ that best reflects your current view of the course as a whole. If you need to change your answer obliterate your cross by completely shading the box ■ then place a cross in the correct box.

Section B

For each statement, show the extent of your agreement or disagreement by circling one Facial Expression that best reflects your current view of the course as a whole.



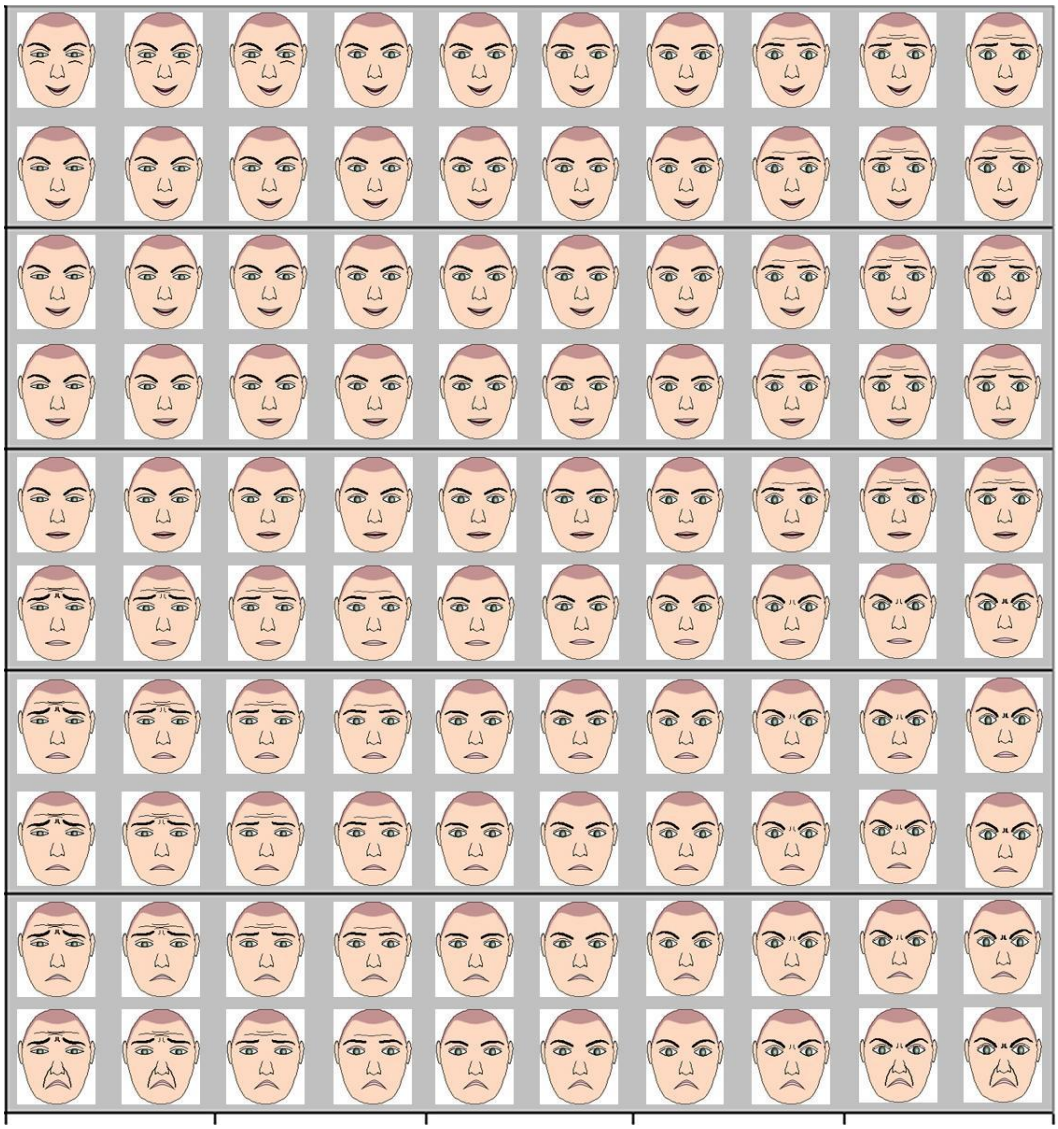
SECTION A

	Definitely agree	Mostly agree	Neither agree nor disagree	Mostly disagree	Definitely disagree	Not Applicable
The teaching on my course						
1. Staff are good at explaining things	☐	☐	☐	☐	☐	☐
2. Staff have made the subject interesting	☐	☐	☐	☐	☐	☐
3. Staff are enthusiastic about what they are teaching	☐	☐	☐	☐	☐	☐
4. The course is intellectually stimulating	☐	☐	☐	☐	☐	☐
Assessment and feedback						
5. The criteria used in marking have been clear in advance	☐	☐	☐	☐	☐	☐
6. Assessment arrangements and marking have been fair	☐	☐	☐	☐	☐	☐
7. Feedback on my work has been prompt	☐	☐	☐	☐	☐	☐
8. I have received detailed comments on my work	☐	☐	☐	☐	☐	☐
9. Feedback on my work has helped me clarify things I did not understand	☐	☐	☐	☐	☐	☐
Academic support						
10. I have received sufficient advice and support with my studies	☐	☐	☐	☐	☐	☐
11. I have been able to contact staff when I needed to	☐	☐	☐	☐	☐	☐
12. Good advice was available when I needed to make study choices	☐	☐	☐	☐	☐	☐
Organisation and management						
13. The timetable works efficiently as far as my activities are concerned	☐	☐	☐	☐	☐	☐
14. Any changes in the course or teaching have been communicated effectively	☐	☐	☐	☐	☐	☐
15. The course is well organised and is running smoothly	☐	☐	☐	☐	☐	☐

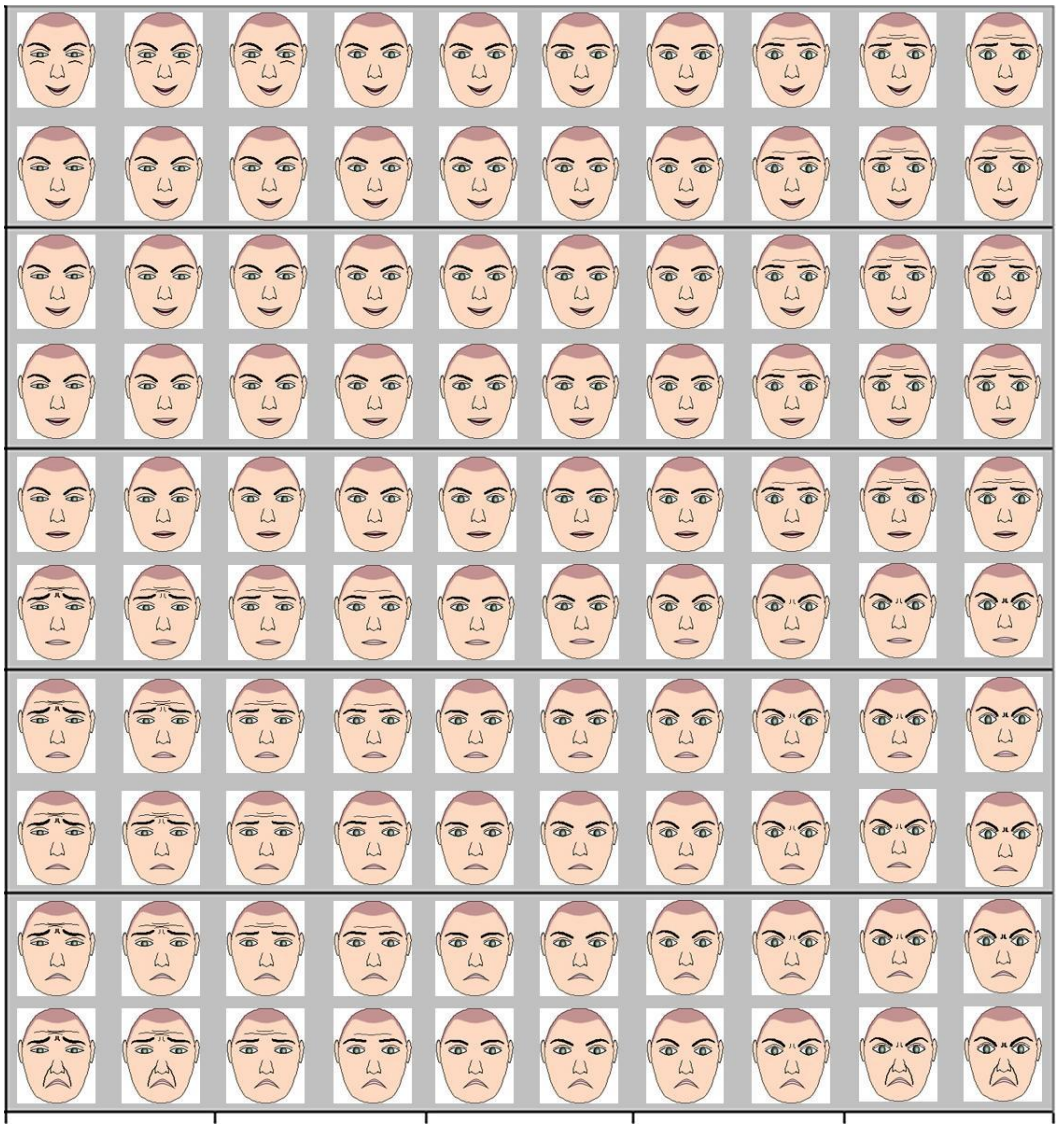
Learning resources						
16. The library resources and services are good enough for my needs	☐	☐	☐	☐	☐	☐
17. I have been able to access general IT resources when I needed to	☐	☐	☐	☐	☐	☐
18. I have been able to access specialised equipment, facilities or rooms when I needed to	☐	☐	☐	☐	☐	☐
Personal development						
19. The course has helped me to present myself with confidence	☐	☐	☐	☐	☐	☐
20. My communication skills have improved	☐	☐	☐	☐	☐	☐
21. As a result of the course, I feel confident in tackling unfamiliar problems	☐	☐	☐	☐	☐	☐
Overall satisfaction						
22. Overall, I am satisfied with the quality of the course	☐	☐	☐	☐	☐	☐

SECTION B

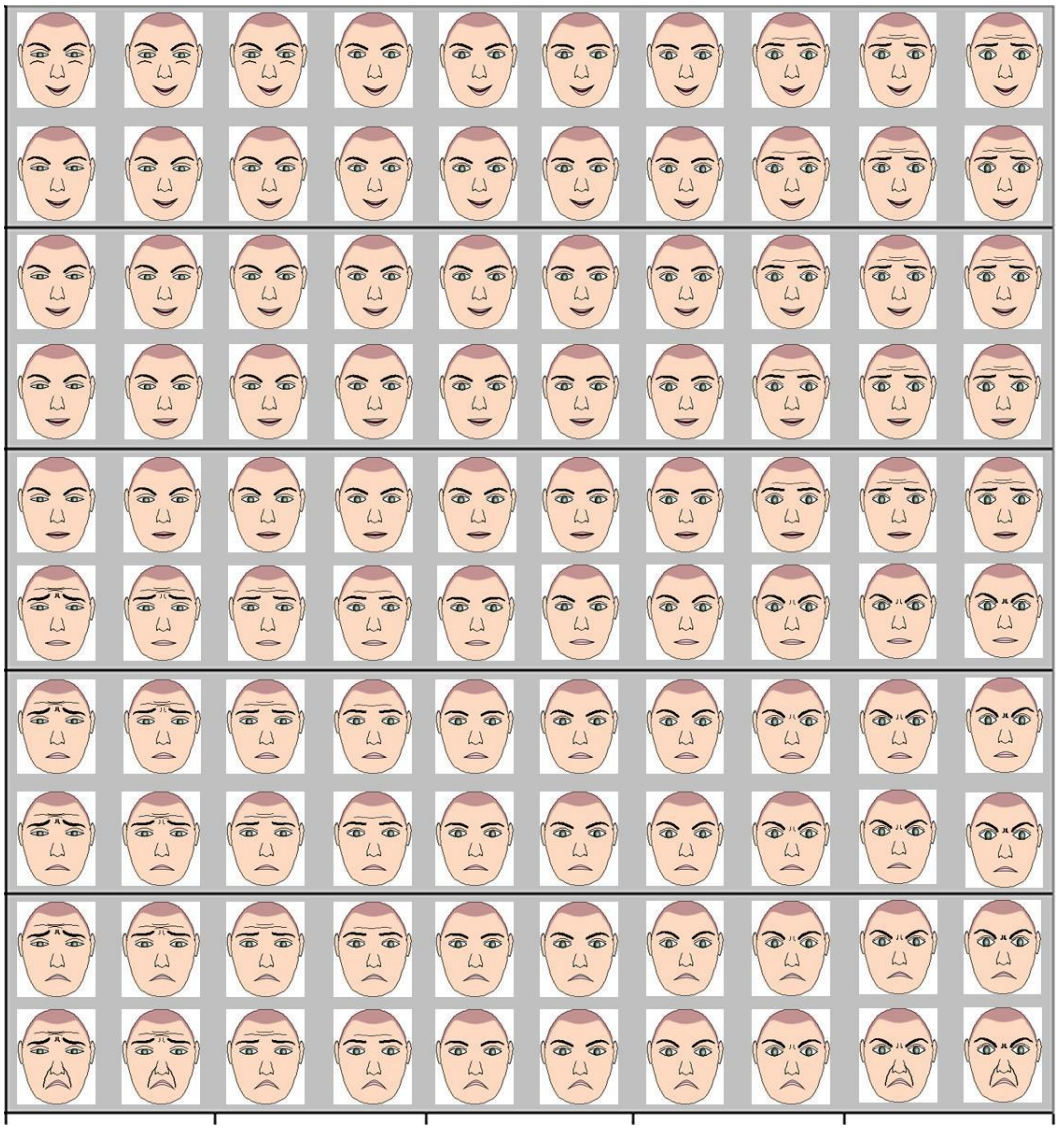
1. Staff are good at explaining things.



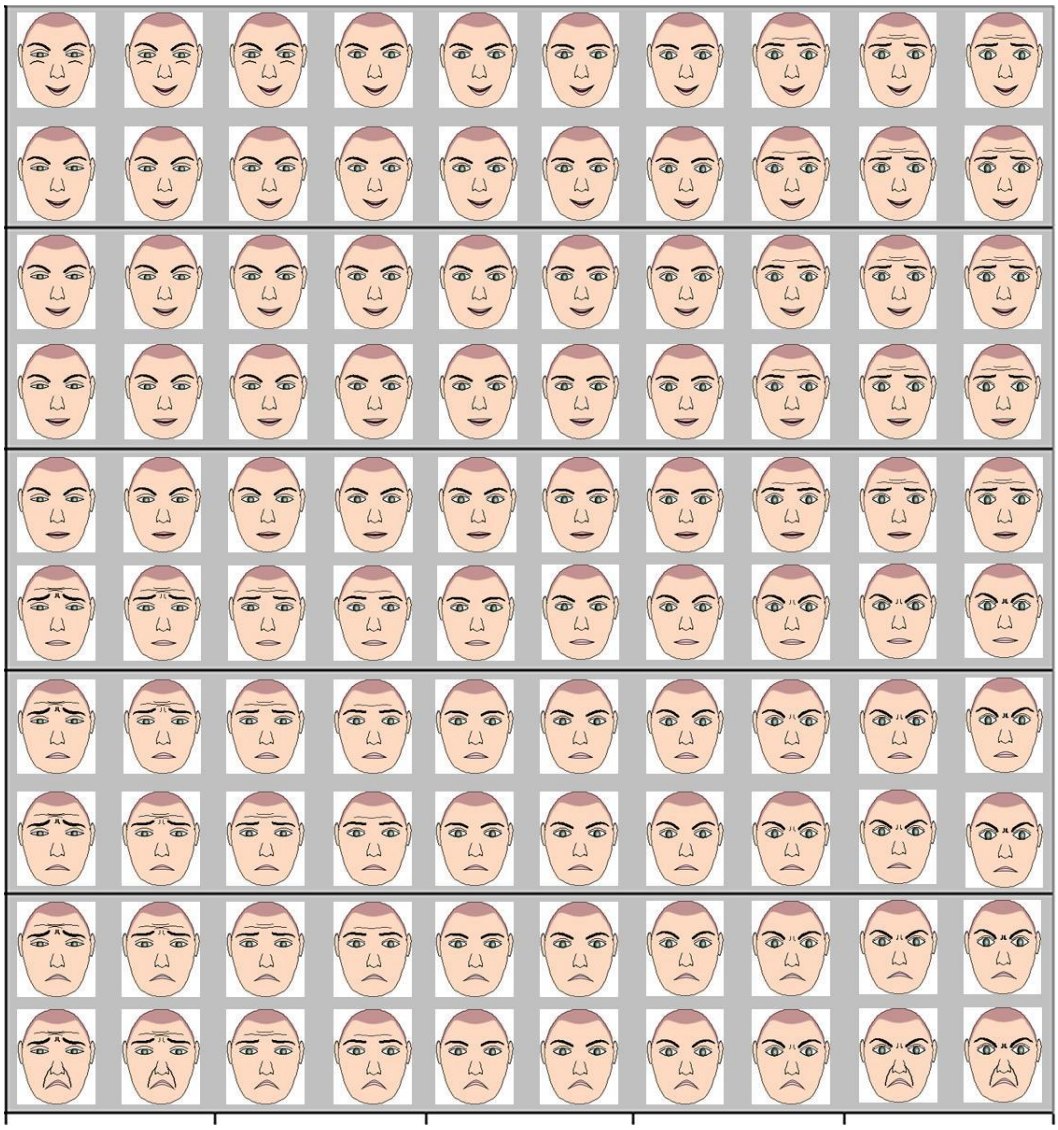
2. Staff have made the subject interesting.



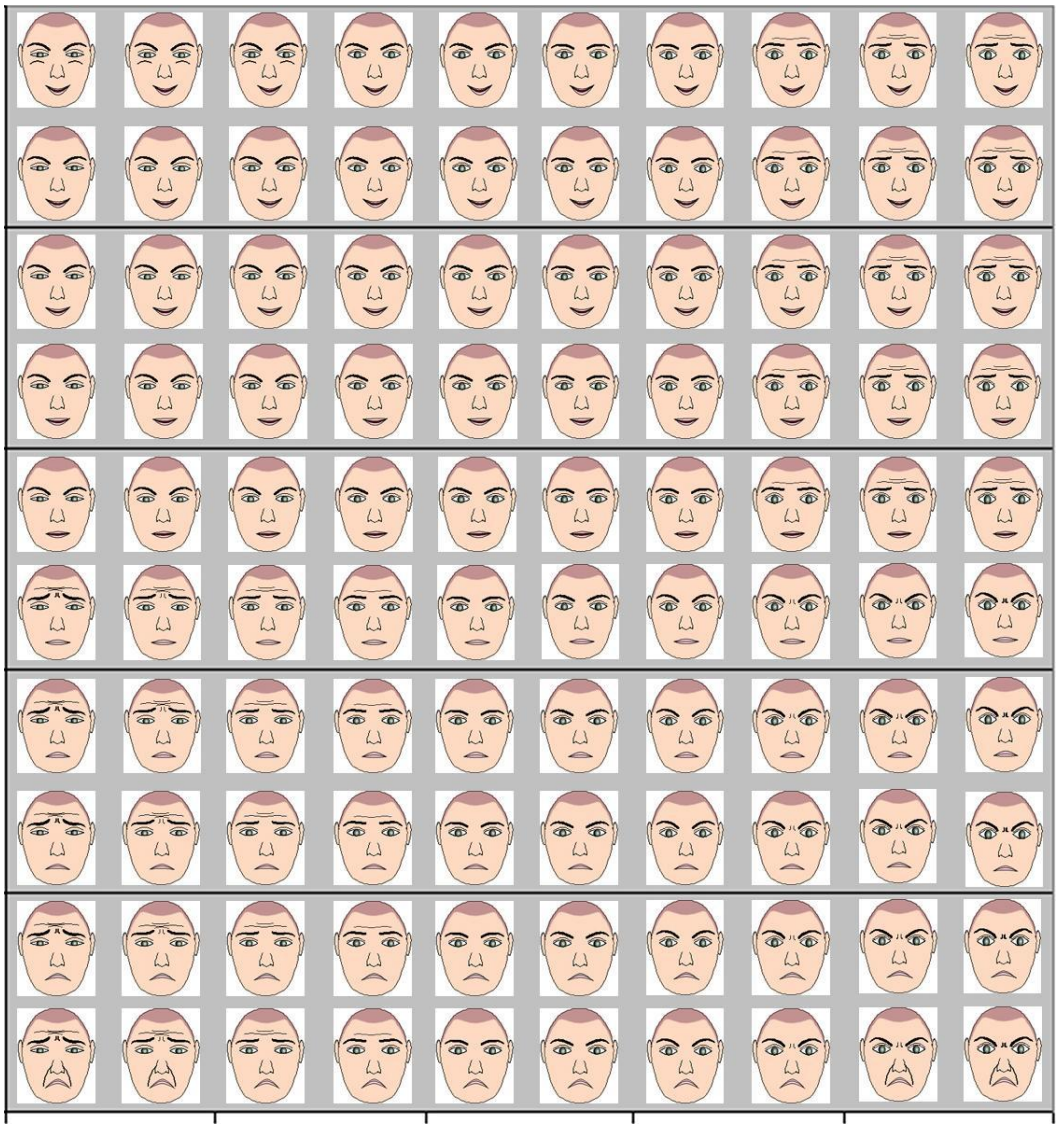
3. Staff are enthusiastic about what they are teaching.



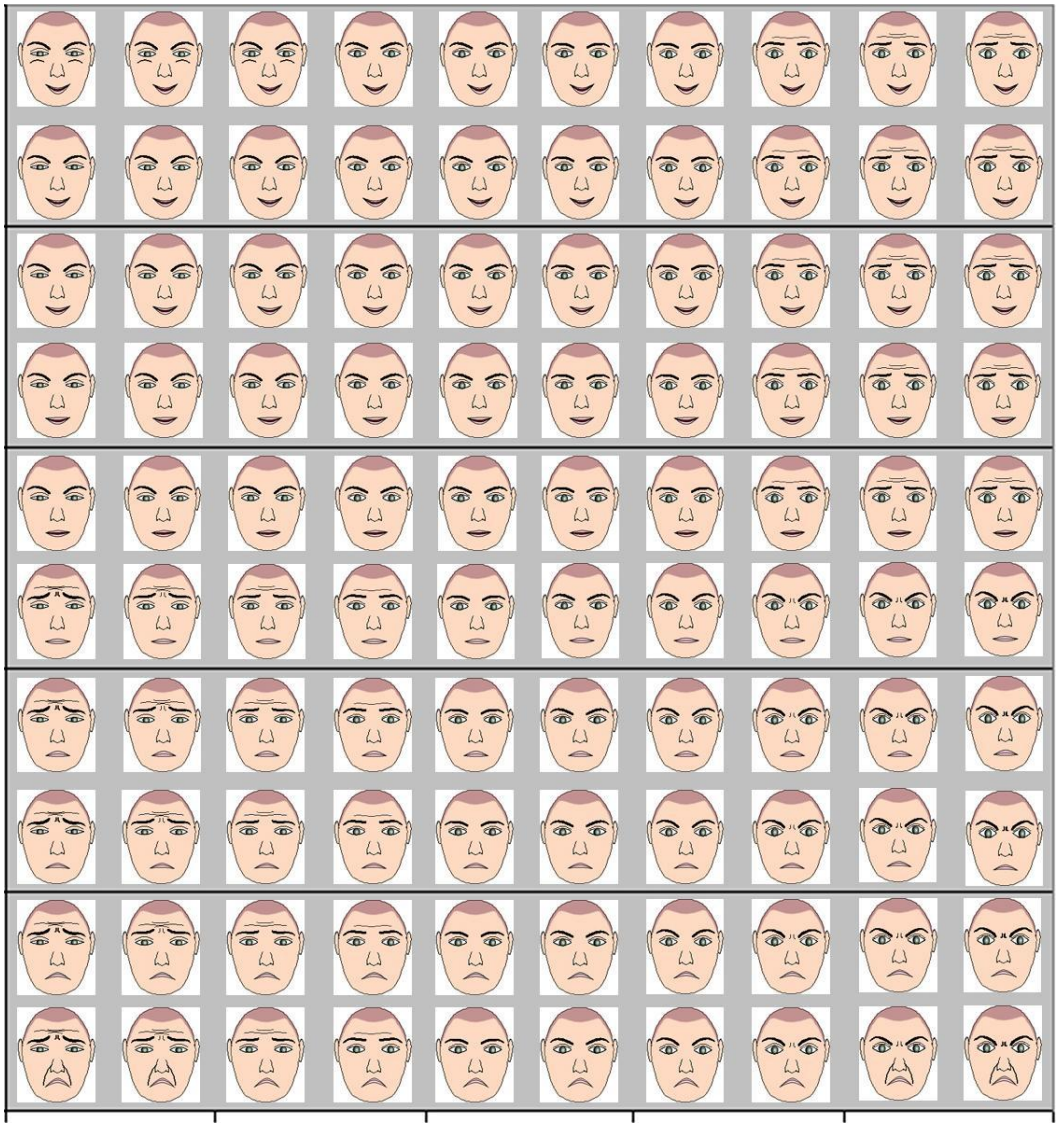
4. The course is intellectually stimulating.



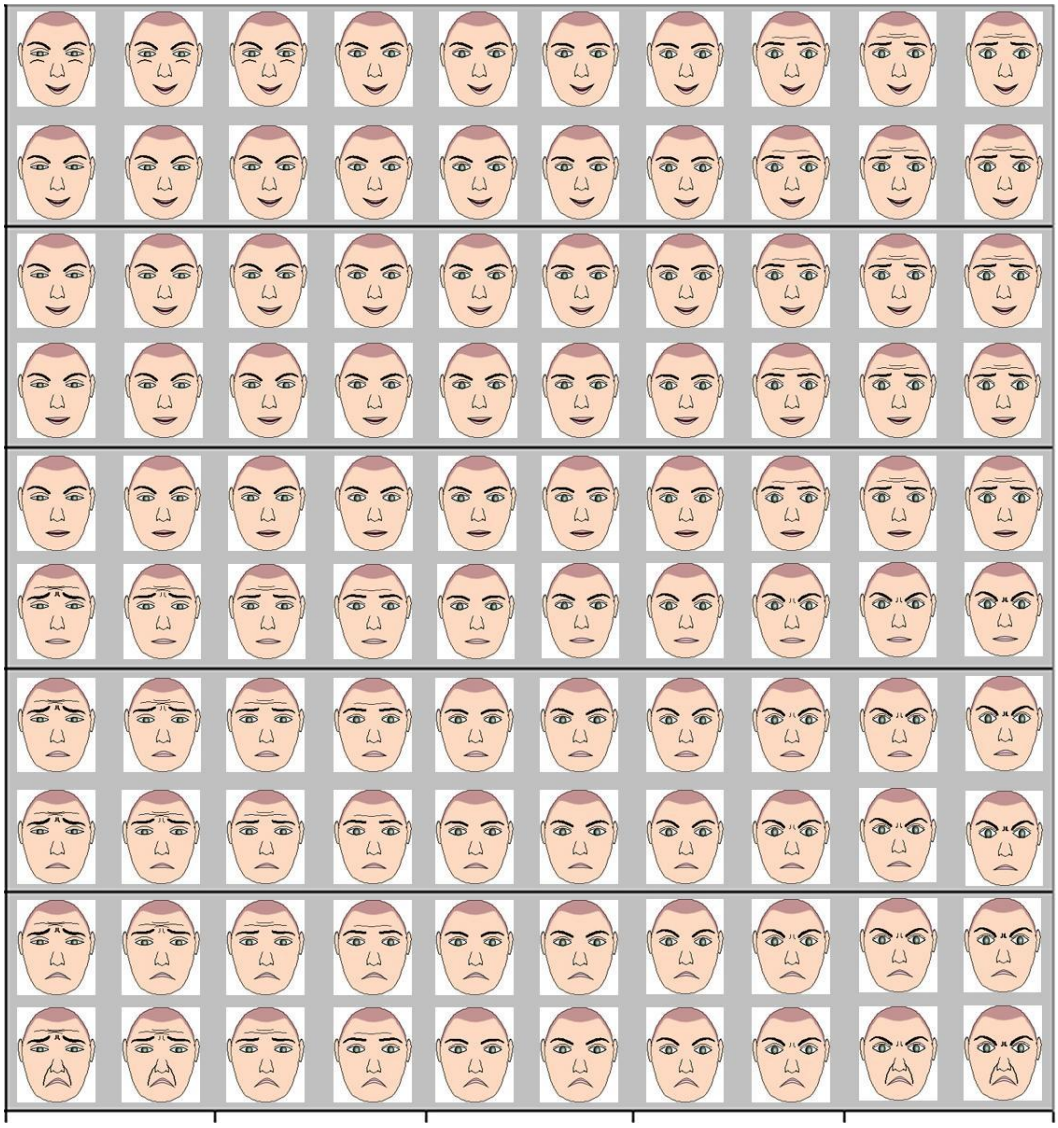
5. The criteria used in marking have been clear in advance.



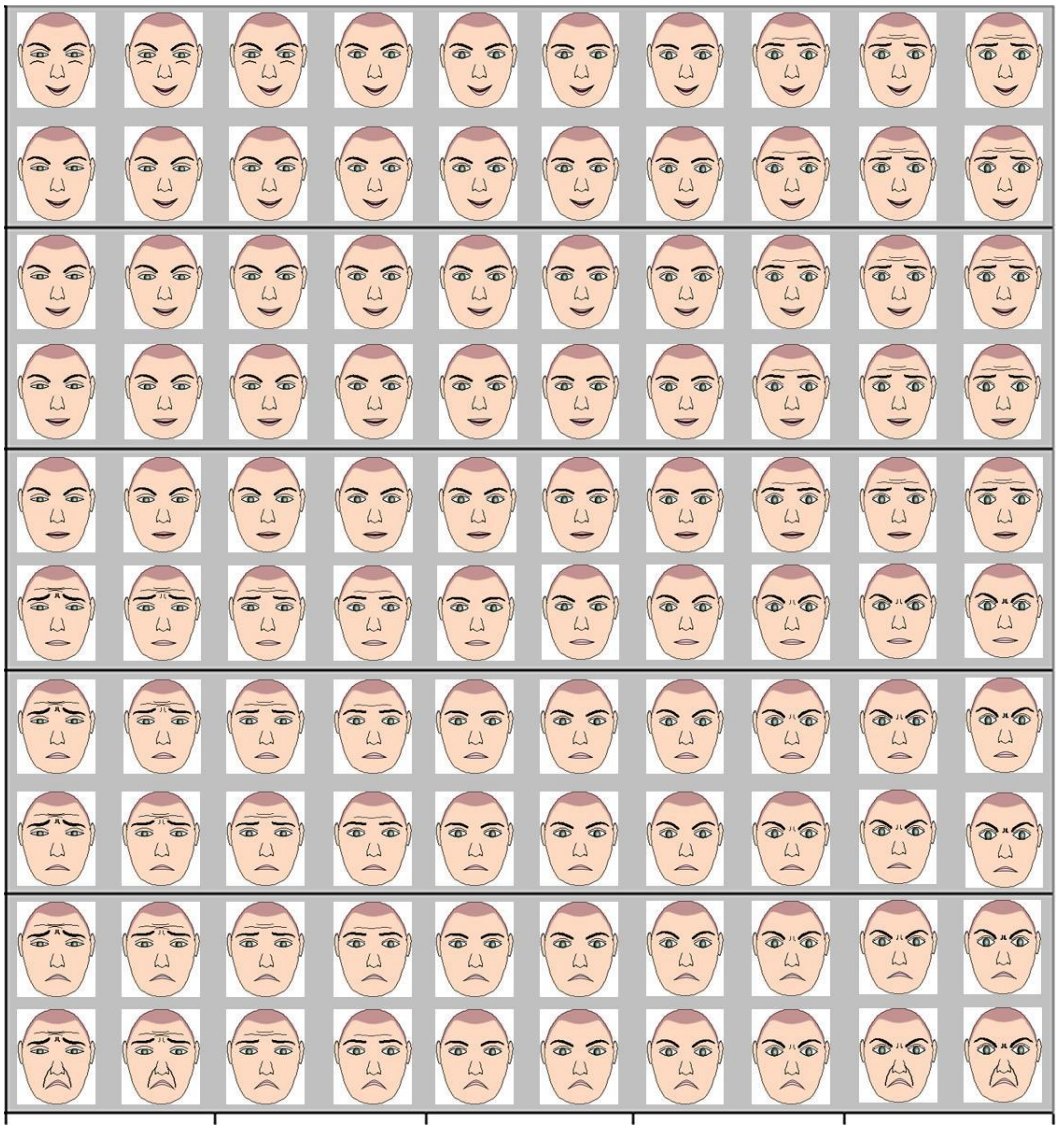
6. Assessment arrangements and marking have been fair.



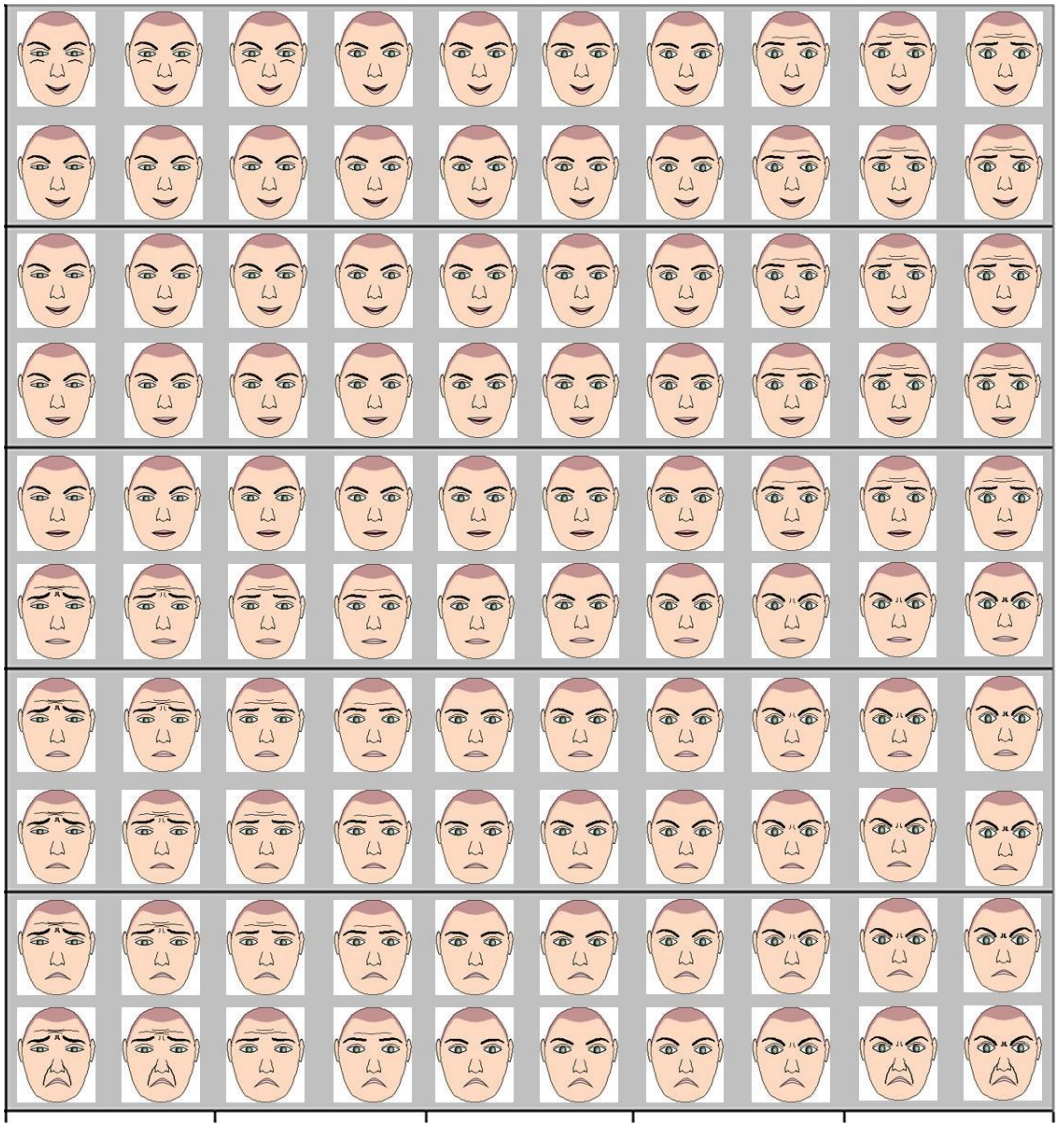
7. Feedback on my course has been prompt.



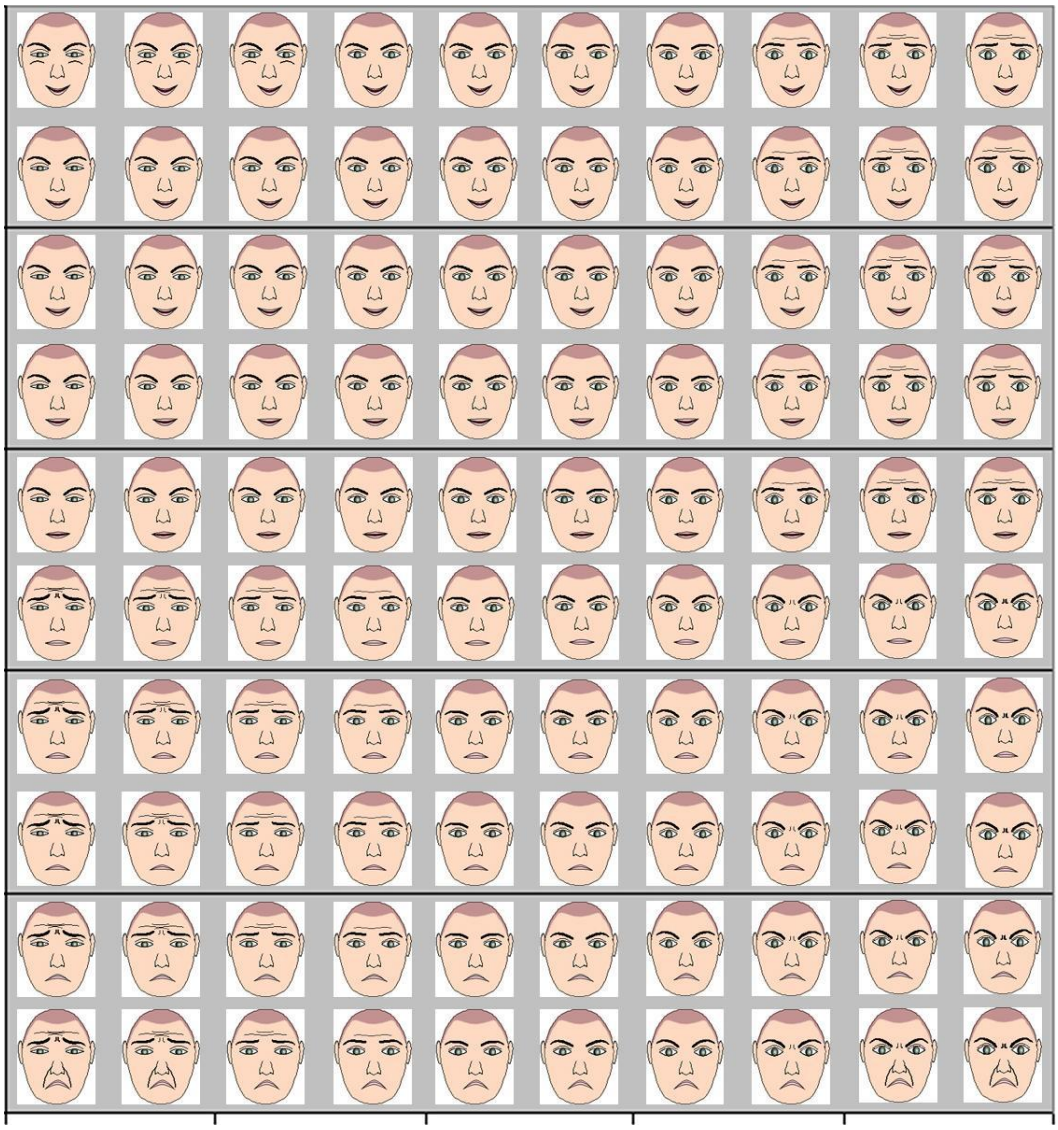
8. I have received detailed comments on my work.



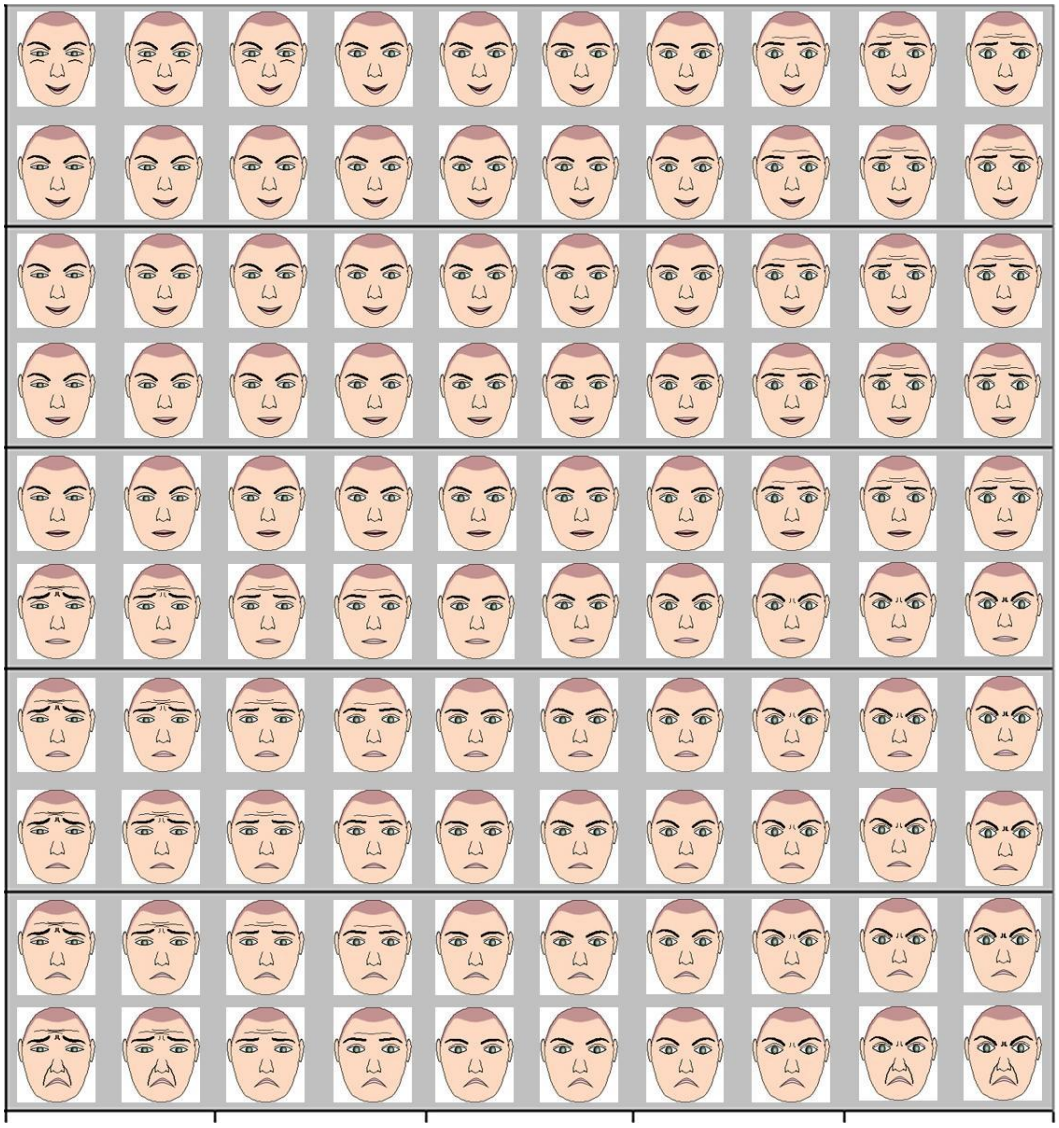
9. Feedback on my work has been prompt.



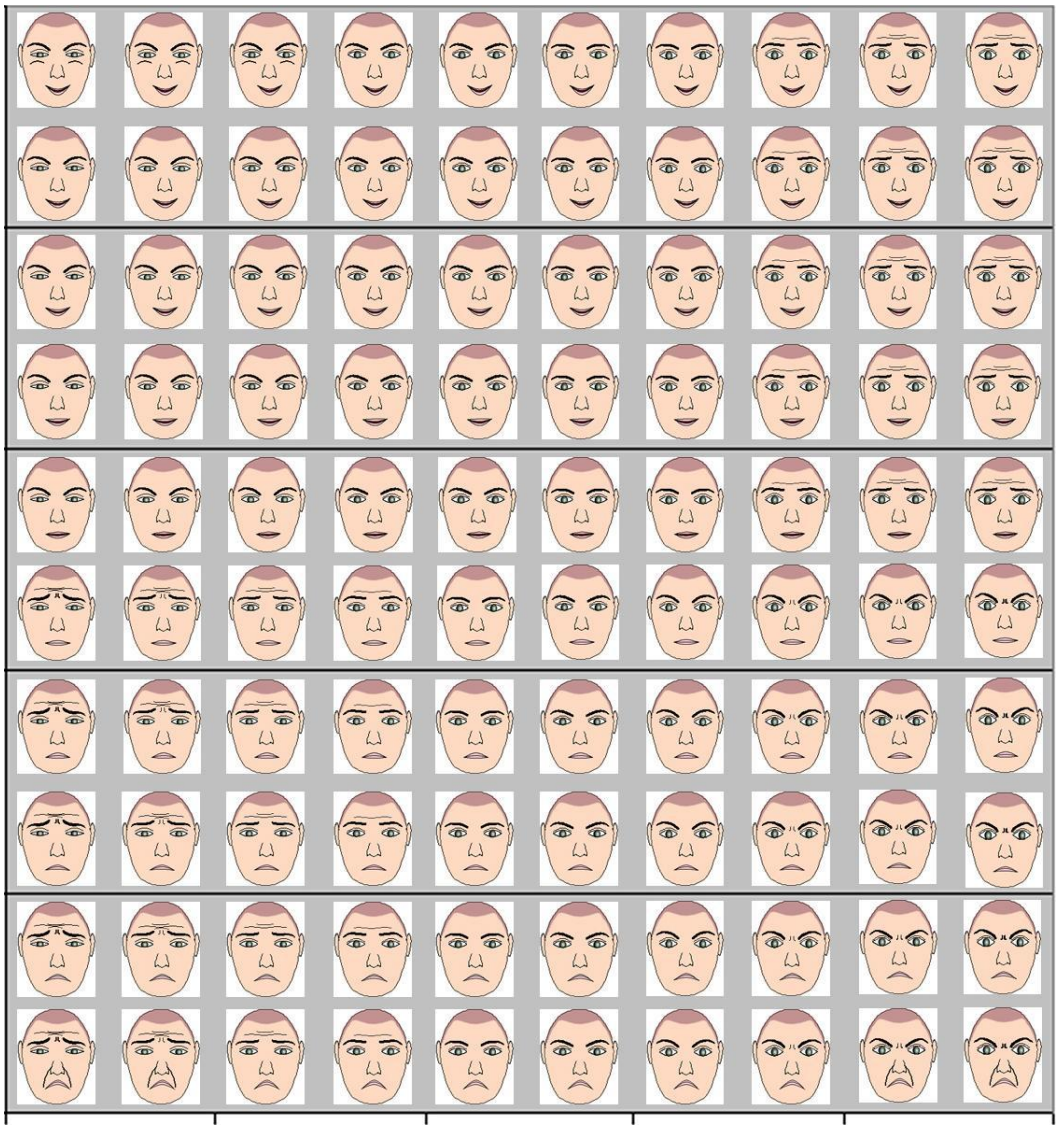
10. I have received sufficient advice and support with my studies.



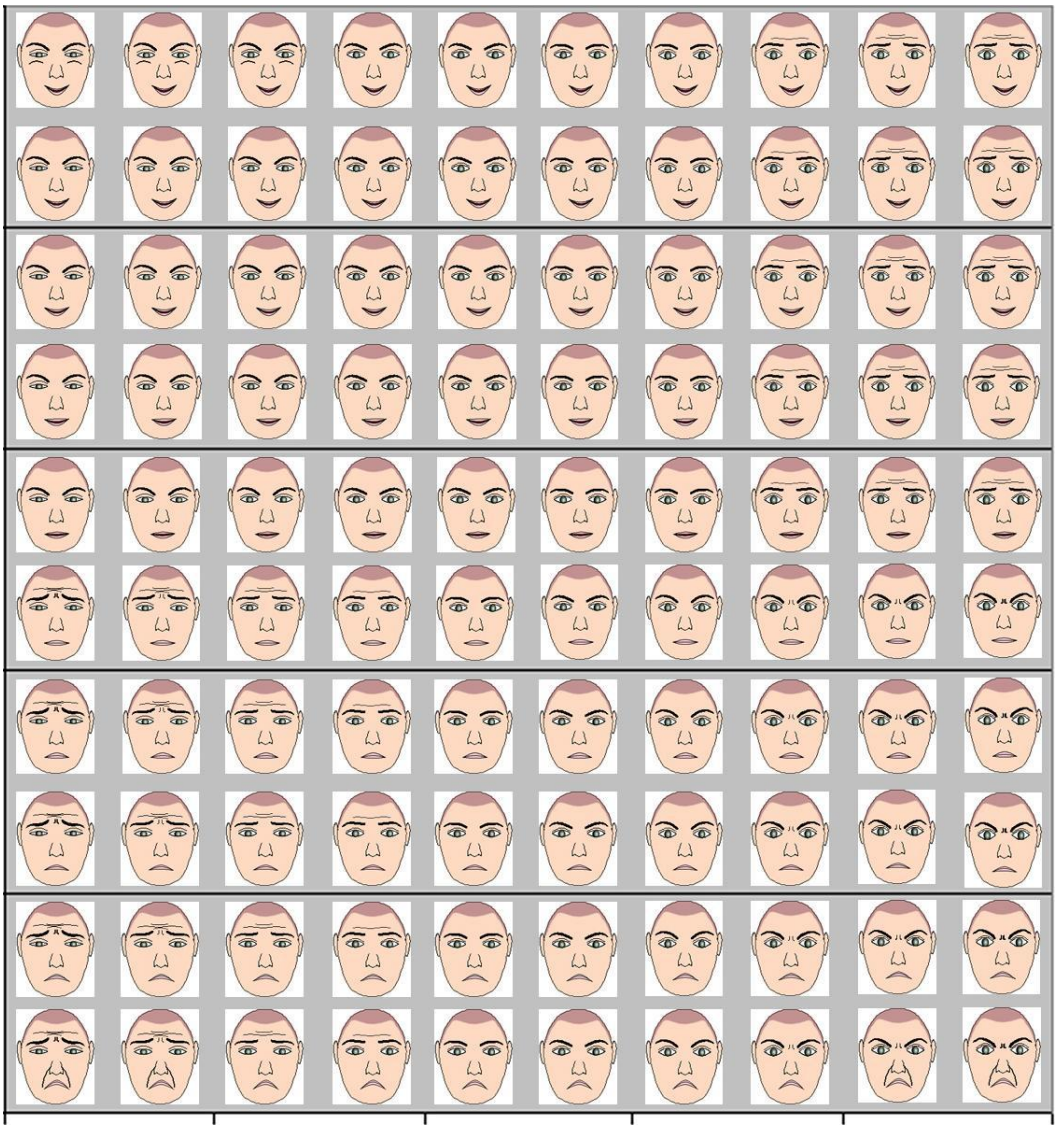
11. I have been able to contact staff when I needed to.



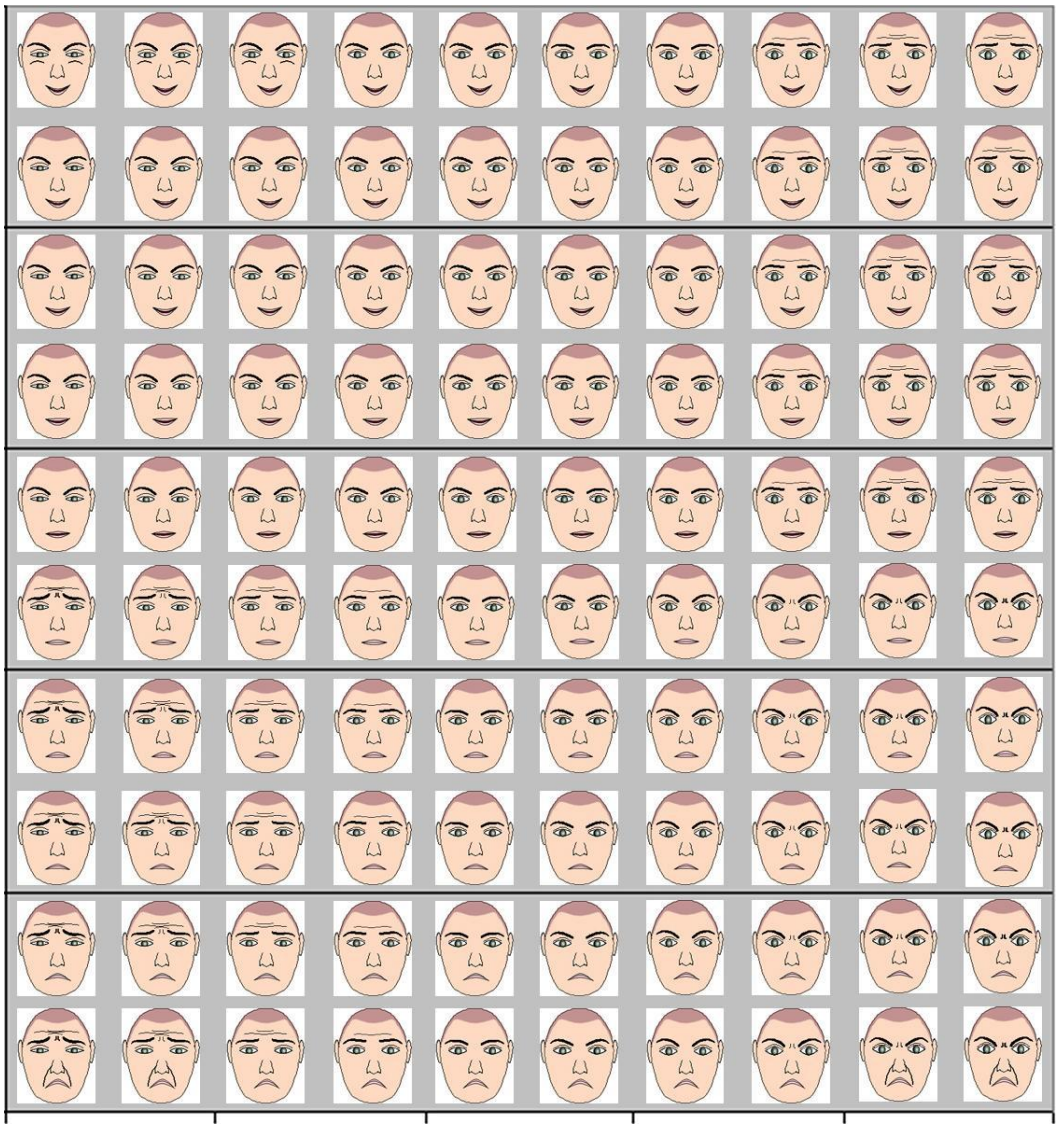
12. Good advice was available when I needed to make study choices.



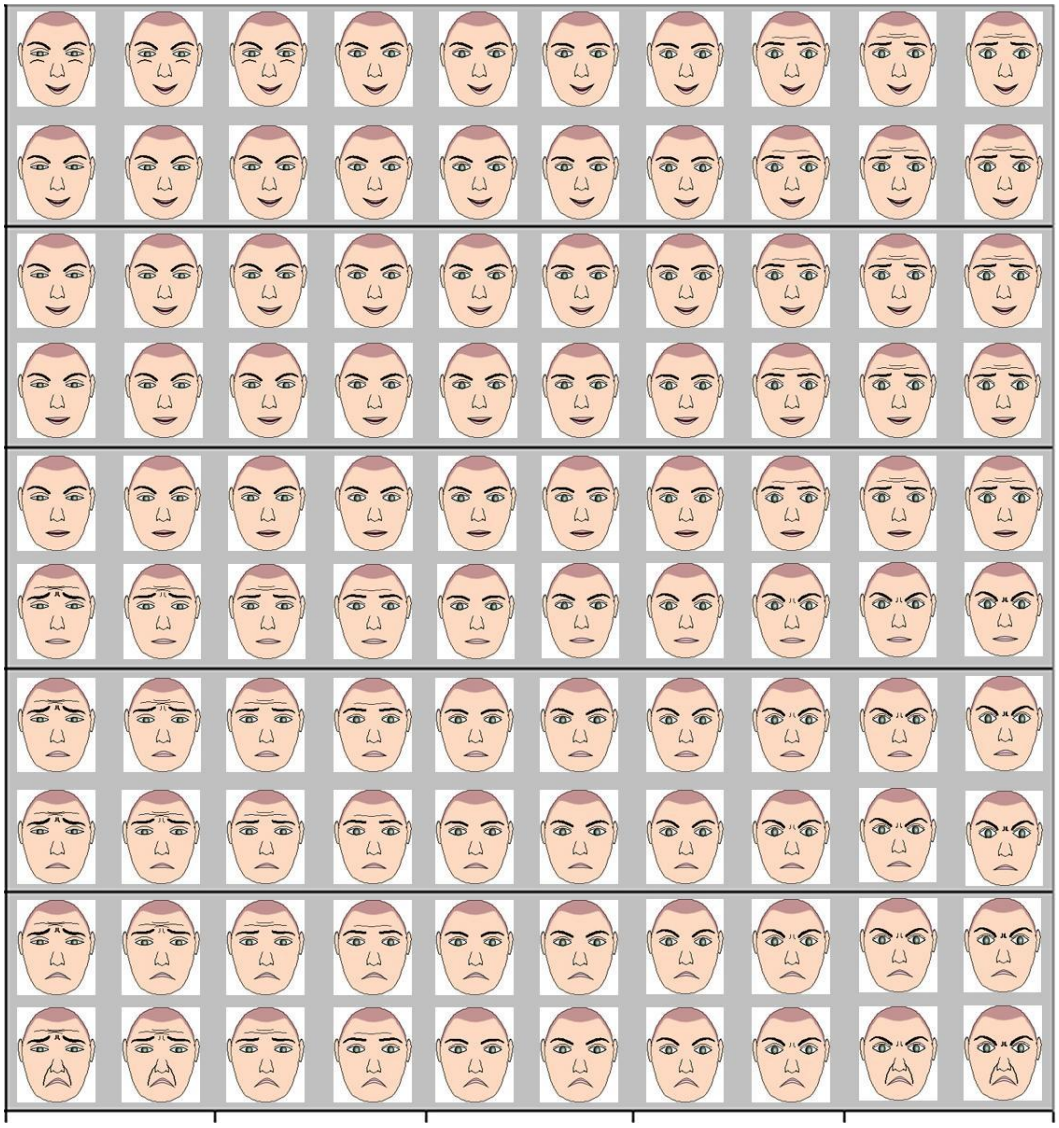
13. The timetable works efficiently as far as my activities are concerned.



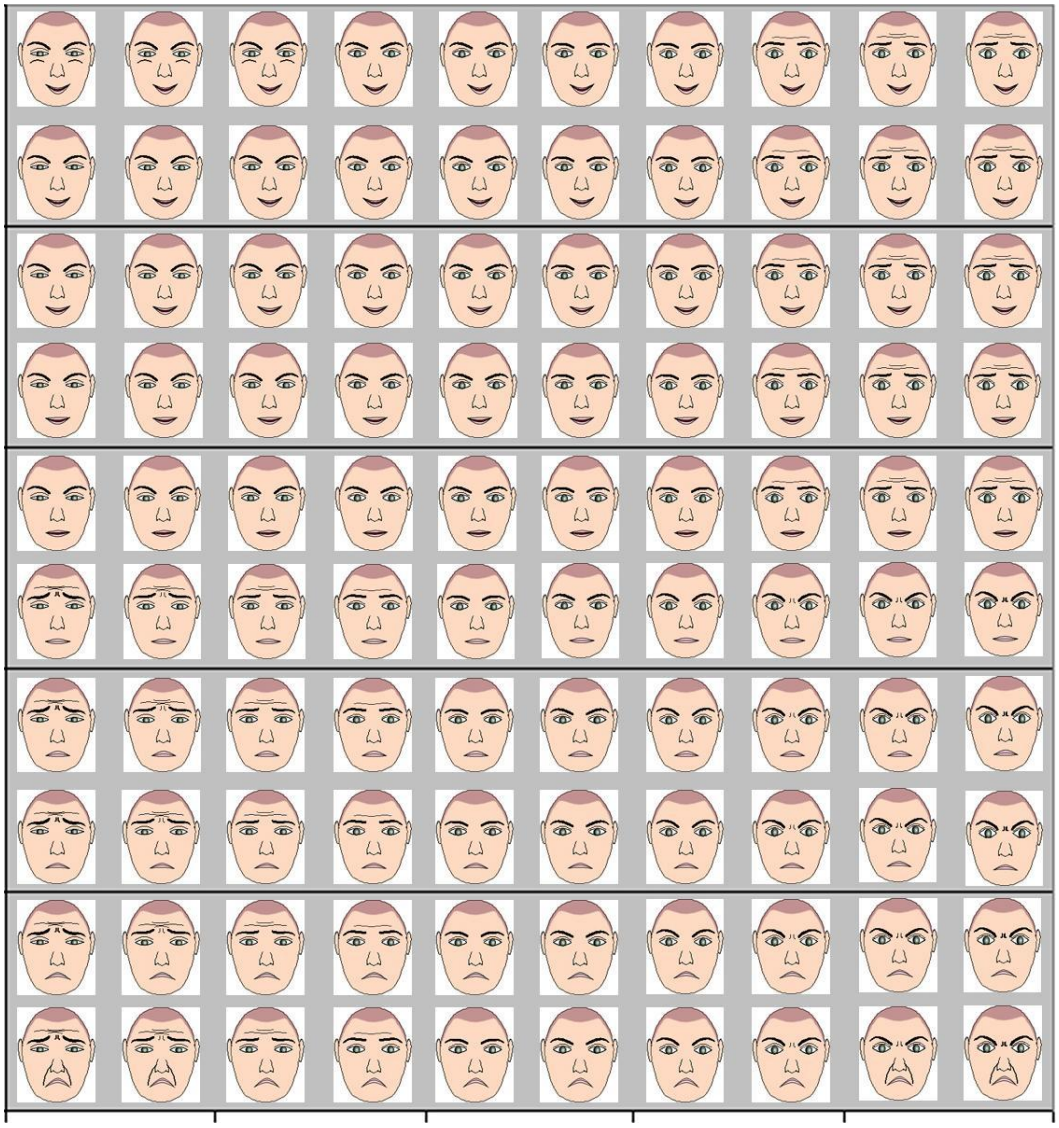
14. Any changes in the course or teaching have been communicated effectively.



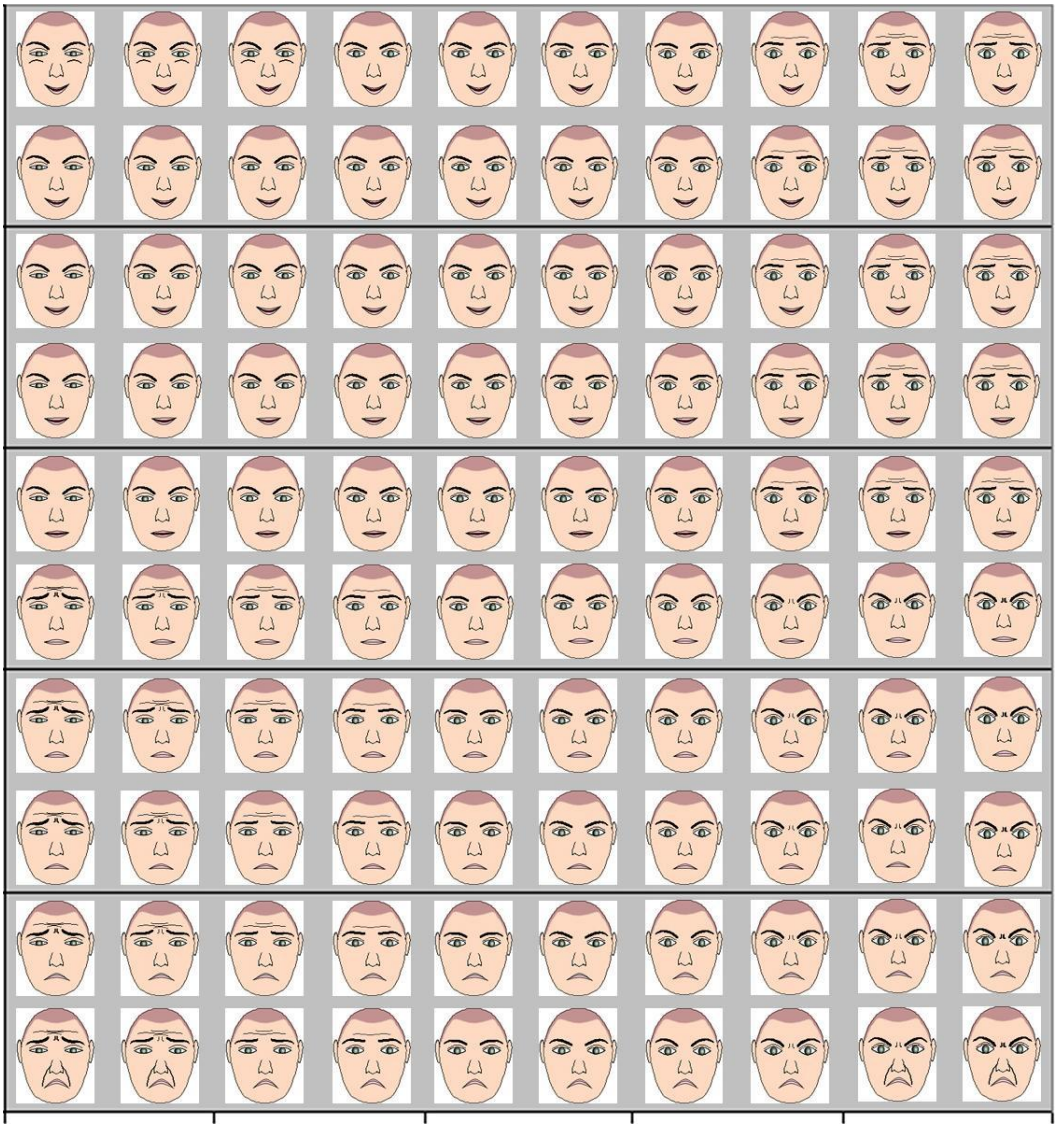
15. The course is well organised and is running smoothly.



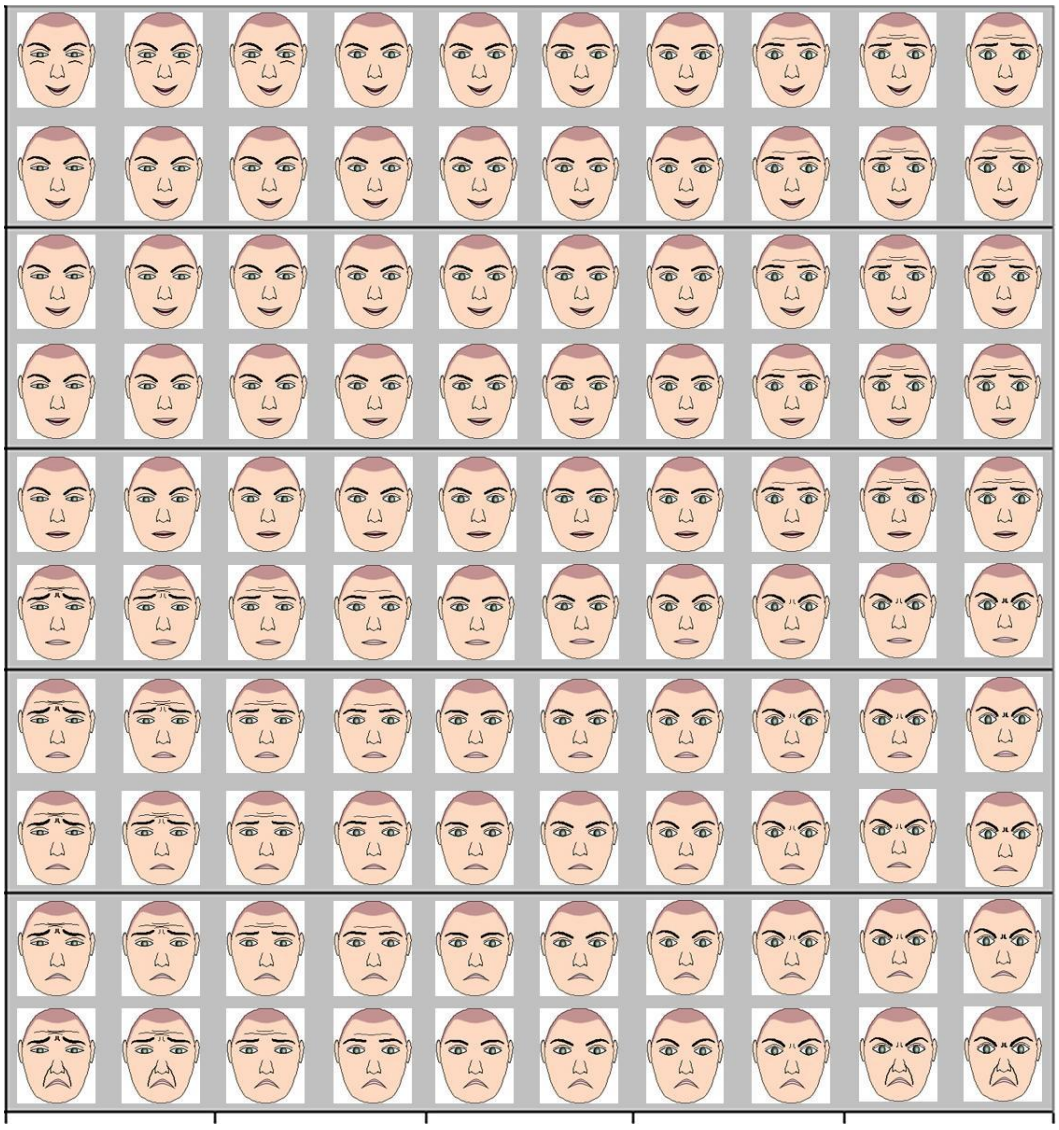
16. The library resources and services are good enough for my needs.



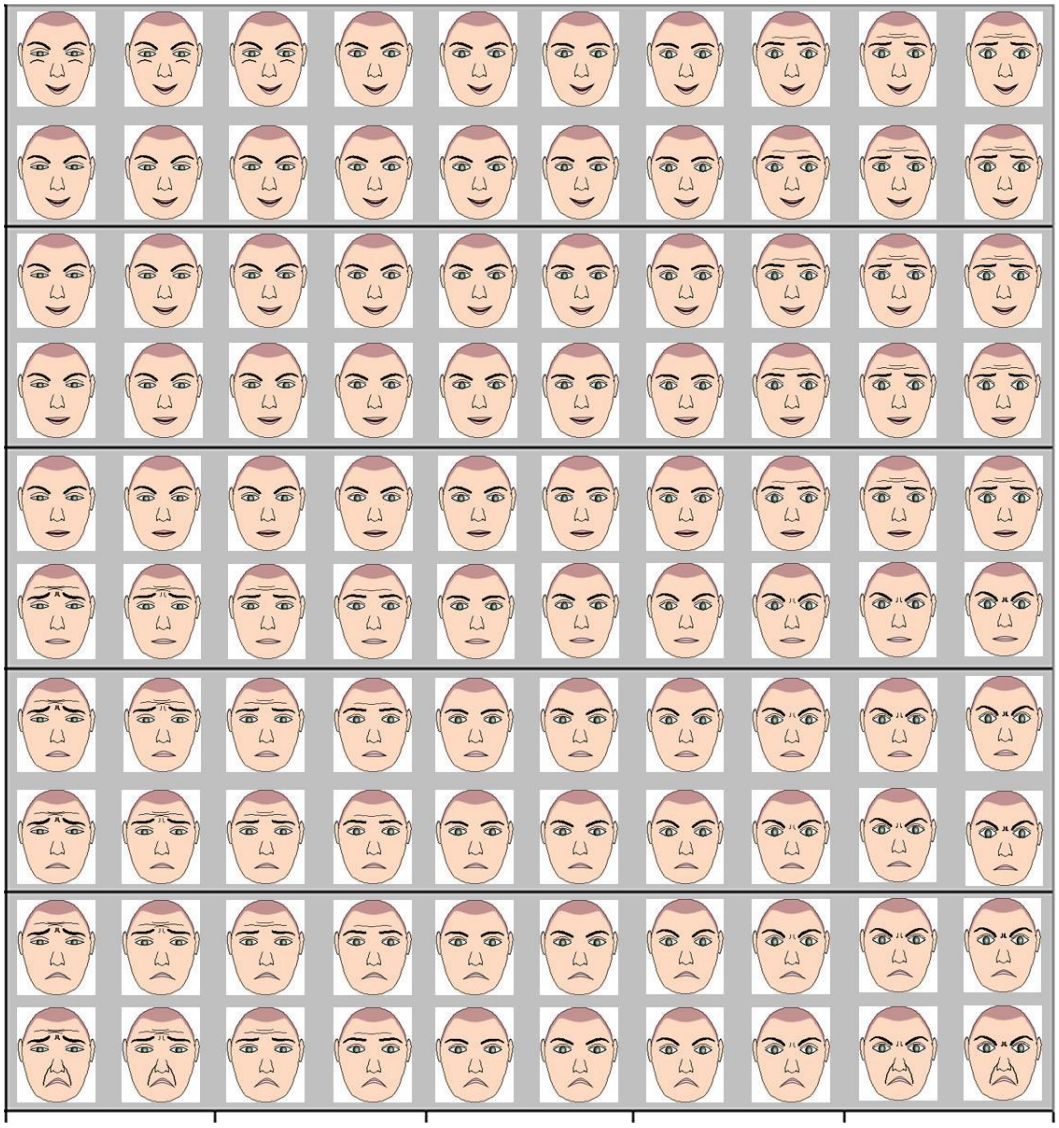
17. I have been able to access general IT resources when I needed to.



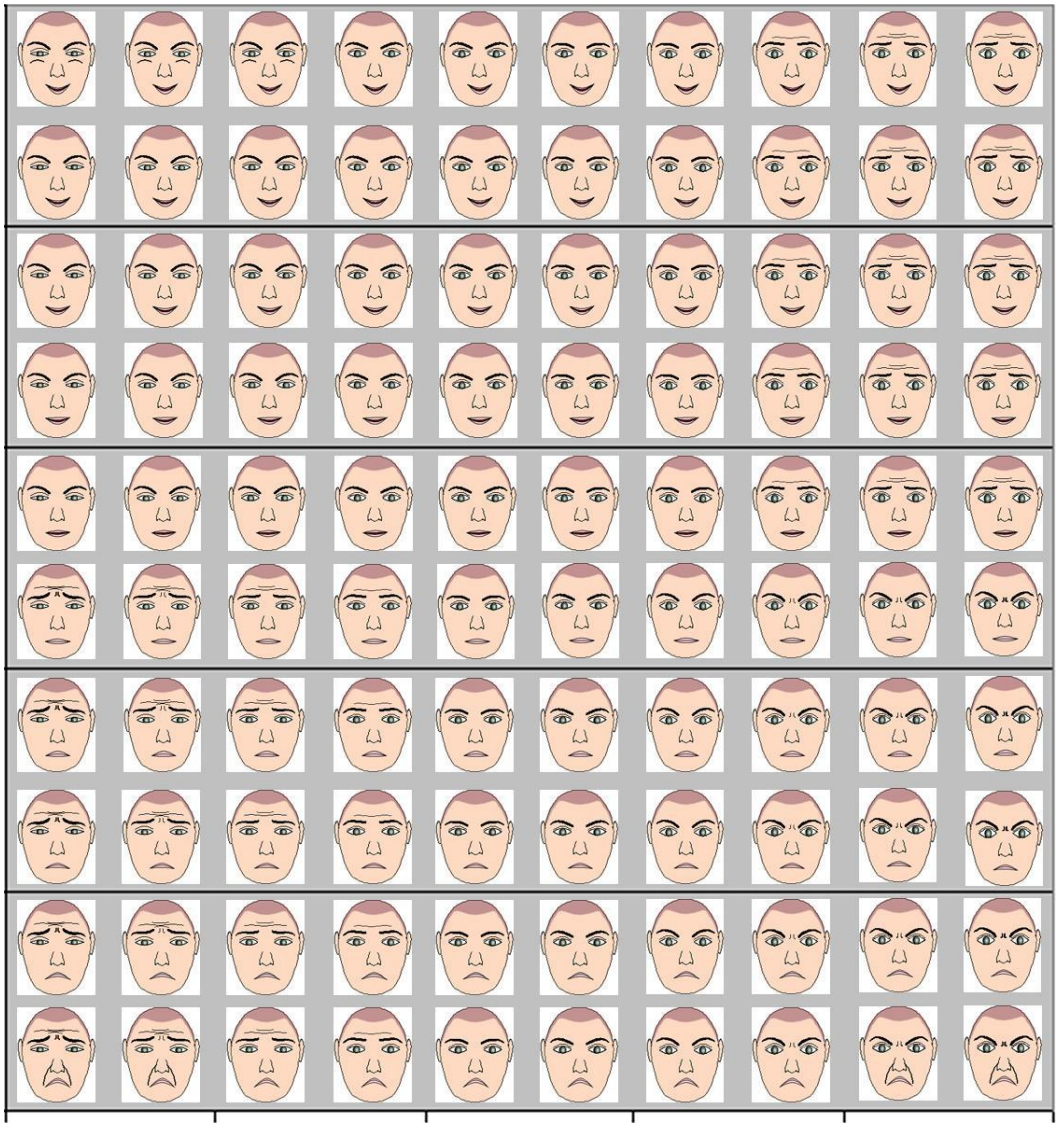
18. I have been able to access specialised equipment, facilities or rooms when I needed to.



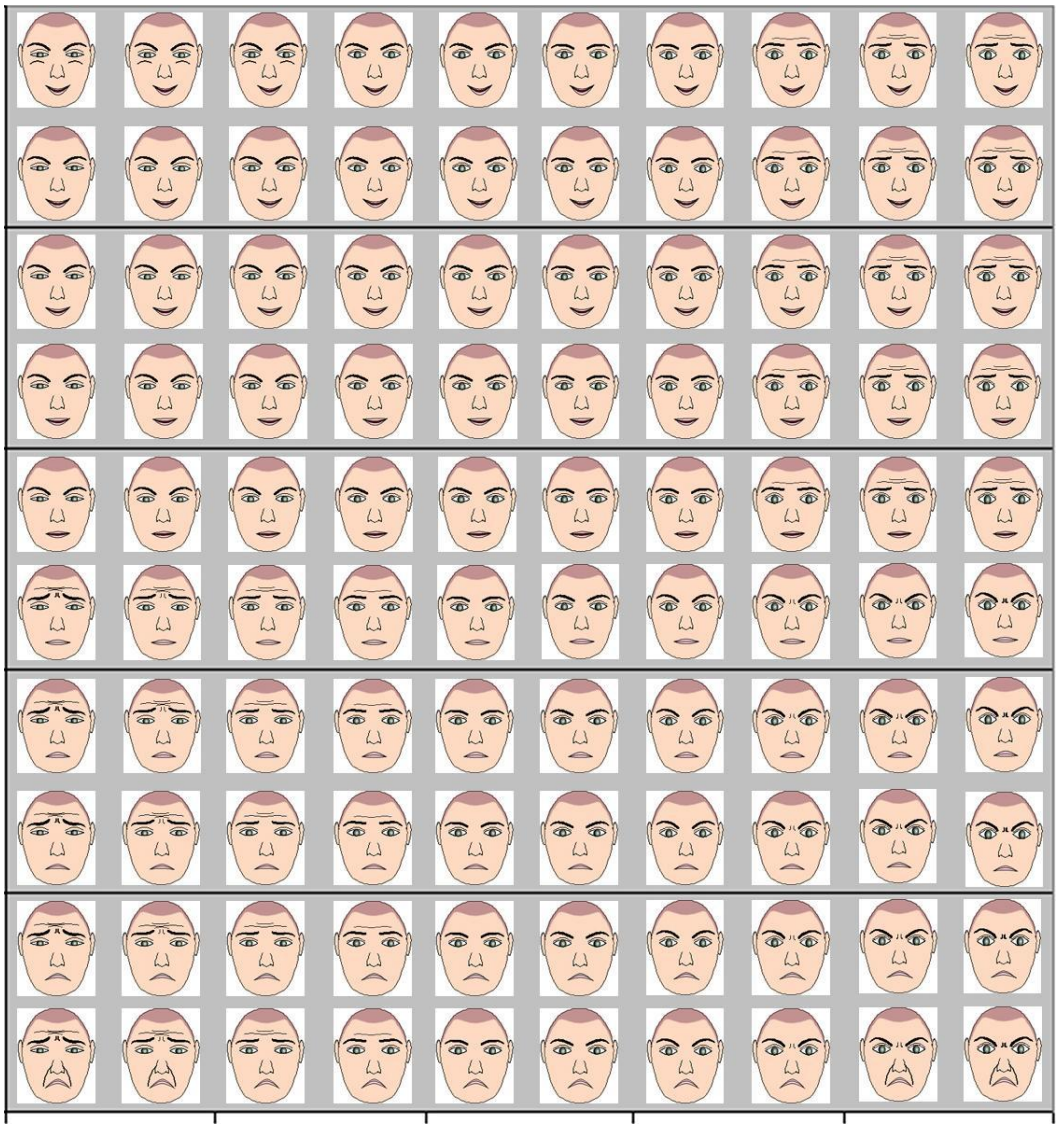
19. The course has helped me to present myself with confidence.



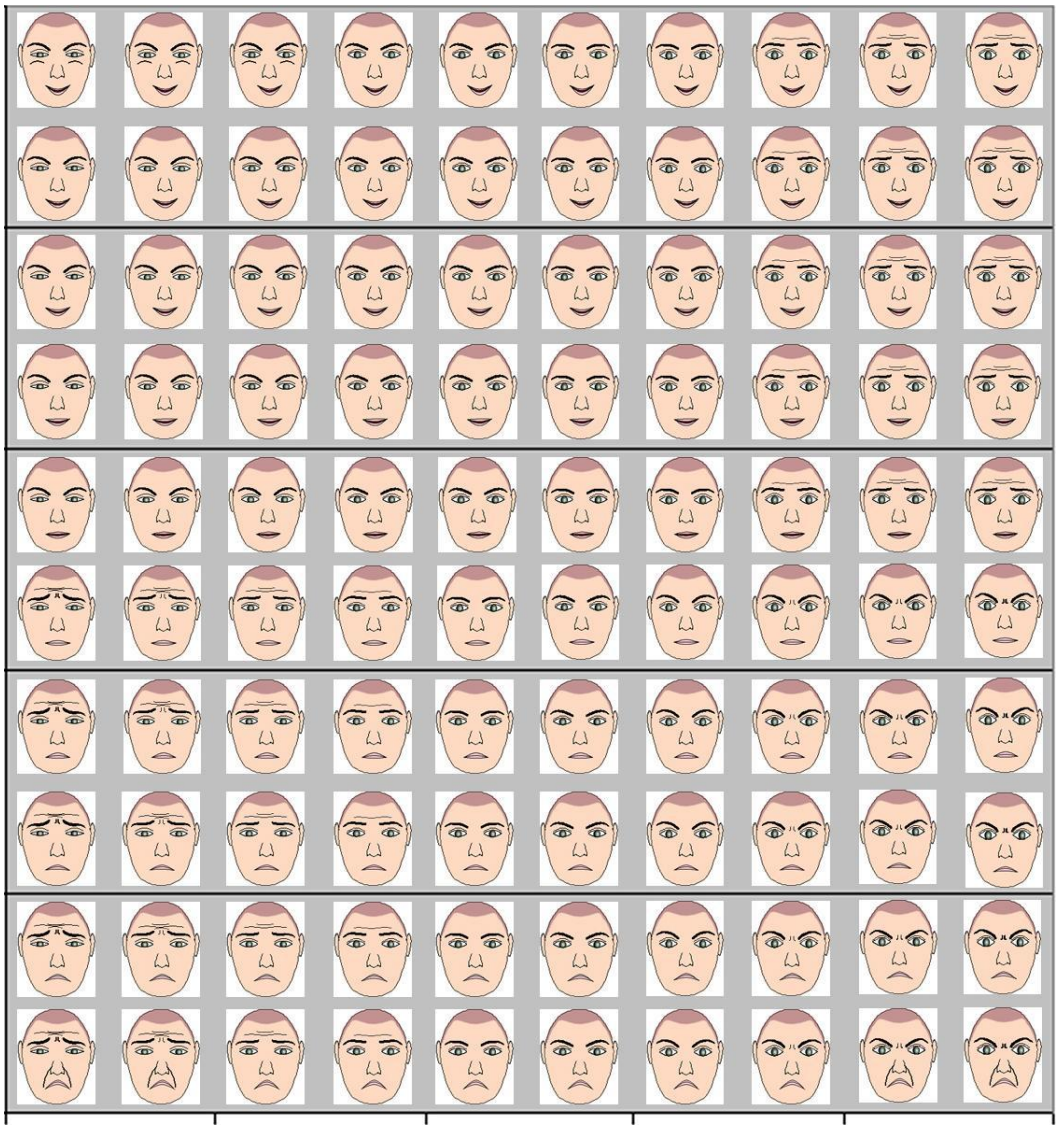
20. My communication skills have improved.



21. As a result of the course, I feel confident in tackling unfamiliar problems.



22. Overall, I am satisfied with the quality of the course.



Appendix 10

System evaluation (User group 1)

Affective Interface Feedback System

For Visualising Student Feedback

System Evaluation Questionnaire

User Type **:** Specialist / Non-specialist

Computer experience: Expert / Some experience / Novice

Job Title :

Discipline :

Faculty :

What mode/s do you most often use to visualise student feedback data?

- ☐ Mean rating
- ☐ Percentage of students satisfied / dissatisfied
- ☐ Bar charts
- ☐ Pie charts
- ☐ Other (Please Specify): ……..
- ☐ None

What software/s have you used to visualise student feedback data?

☐ SPSS

☐ Microsoft Excel

☐ Microsoft Word

☐ Microsoft PowerPoint

☐ Other (Please Specify): ……..

☐ None

Please answer the following questions regarding the Affective Interface Feedback System you have just used.

Interface

1. It is clear what different parts of the interface does
   Disagree 1 2 3 4 5 Agree

2. The interface is flexible in allowing the user to choose options
   Disagree 1 2 3 4 5 Agree

3. The organization of information in the system was not confusing
   Disagree 1 2 3 4 5 Agree

4. The sequence of screens in the interface was not confusing
   Disagree 1 2 3 4 5 Agree

5. Overall, the interface was pleasing and easy to use
   Disagree 1 2 3 4 5 Agree

Data Visualisation

1. The level of student satisfaction conveyed by the interface was clear and understandable
   Disagree 1 2 3 4 5 Agree

2. The use of facial expressions for visualising student satisfaction data was adequate
   Disagree 1 2 3 4 5 Agree

3. The use of facial expressions for visualising student satisfaction data was efficient
   Disagree 1 2 3 4 5 Agree

4. The numerical overall mean display was useful
   Disagree 1 2 3 4 5 Agree

5. The bar chart showing the frequency distribution was useful
   Disagree 1 2 3 4 5 Agree

6. The pie chart showing the percentages was useful
   Disagree 1 2 3 4 5 Agree

7. The use of a facial expression to display the OVERALL level of student satisfaction was useful
   Disagree 1 2 3 4 5 Agree

8. The use of a facial expression to display the OVERALL level of student satisfaction was informative
   Disagree 1 2 3 4 5 Agree

9. The use of a facial expression to display the level of satisfaction with each evaluation criteria was useful
   Disagree 1 2 3 4 5 Agree

10. The use of a facial expression to display the level of satisfaction with each evaluation criteria was informative
    Disagree 1 2 3 4 5 Agree

11. The use of a facial expression to display the level of satisfaction with each survey question was useful
    Disagree 1 2 3 4 5 Agree

12. The use of a facial expression to display the level of satisfaction with each survey question was informative
    Disagree 1 2 3 4 5 Agree

13. The option to weight criteria and different questions helped identify the influence of different criteria and questions on the overall level of satisfaction
    Disagree 1 2 3 4 5 Agree

14. Overall, the interface provided adequate functions for visualizing and understanding the student feedback data
    Disagree 1 2 3 4 5 Agree

Usefulness

1. The option to weight criteria was useful
   Disagree 1 2 3 4 5 Agree

2. The option to weight questions was useful
   Disagree 1 2 3 4 5 Agree

3. The interface helps me be more effective in my role
   Disagree 1 2 3 4 5 Agree

4. The interface helps me be more productive in my role
   Disagree 1 2 3 4 5 Agree

5. The interface is useful for me
   Disagree 1 2 3 4 5 Agree

6. The interface saves me time when I use it
   Disagree 1 2 3 4 5 Agree

7. The interface provides everything I would expect from a feedback system
   Disagree 1 2 3 4 5 Agree

Satisfaction

1. I am satisfied with the Affective Interface Feedback System
   Disagree 1 2 3 4 5 Agree

2. I would recommend it to other members of staff for visualising student feedback data
   Disagree 1 2 3 4 5 Agree

3. The interface works the way I expect it to work
   Disagree 1 2 3 4 5 Agree

4. The interface provides me all the information I need from the student survey data
   Disagree 1 2 3 4 5 Agree

5. The interface is pleasant to use
   Disagree 1 2 3 4 5 Agree

Interview Questions

Which information type in the interface did you pay most attention to ?

Which information type/types in the interface was the most informative?

What did the visualized result tell you about your data?

What did the data display as a facial expression make you feel about students' perception of the quality of their learning experience at Liverpool Hope University?

Do you feel that the use of facial expressions to convey levels of student satisfaction added meaning to the data?

Suggestions for improvement

Appendix 11

System evaluation (User group 2)

Affective Interface Feedback System
For Visualising Student Feedback
System Evaluation Questionnaire

User Type **:** Student

Computer experience: Expert / Some experience / Novice

Age:

Gender:

Course:

When selecting a university for your higher education did you look at student feedback about that institute?

- □ Yes
- □ No

If Yes

What type of feedback data did you look at?

- □ Mean satisfaction ratings
- □ Percentage of students satisfied / dissatisfied
- □ Bar charts of student satisfaction ratings
- □ Pie charts of student satisfaction ratings
- □ Other (Please Specify): ……..
- □ None

Section 1: Affective Interface feedback System Usability Study

The Affective Interface Feedback System (AIFS) has been developed as a means of instantly visualising student feedback data obtained using the National Student Survey (NSS).

This study is aimed at understanding the system efficiency in accomplishing the above. To achieve this you are required to complete the following timed tasks.

Task: All about getting information

- Imagine you have not entered University yet.
- Your task is to use the Affective Interface Feedback System to find some information about Liverpool Hope University.
- The study consists of 5 tasks. On completion of each task prompt the experimenter and answer the questions before starting the next task.

Task 1:

Use the system to find out the level of student satisfaction with the teaching at Liverpool Hope University.

Q1. The time taken to complete this task was:

Slow	Fairly slow	Fairly fast	Fast

Q2. Did you feel the system was error prone when carrying out this task?

Yes/No

Q3. If the answer to Q2 was **Yes**, why?

Task 2:

Use the system to find out the overall level of student satisfaction with the course Psychology.

Q1. The time taken to complete this task was:

Slow	Fairly slow	Fairly fast	Fast

Q2. Did you feel the system was error prone when carrying out this task?

Yes/No

Q3. If the answer to Q2 was **Yes**, why?

Task 3:

Use the system to find out the level of student satisfaction with the support and guidance they received for the course Computing.

Q1. The time taken to complete this task was:

Slow	Fairly slow	Fairly fast	Fast

Q2. Did you feel the system was error prone when carrying out this task?

Yes/No

Q3. If the answer to Q2 was **Yes**, why?

Task 4:

Use the system to find out the level of student satisfaction with their feedback on assessments in the course Geography.

Q1. The time taken to complete this task was:

Slow	Fairly slow	Fairly fast	Fast

Q2. Did you feel the system was error prone when carrying out this task?

Yes/No

Q3. If the answer to Q2 was **Yes**, why?

Task 5:

Use the system to find out the level of student satisfaction with the library facilities at Liverpool Hope University.

Q1. The time taken to complete this task was:

Slow	Fairly slow	Fairly fast	Fast

Q2. Did you feel the system was error prone when carrying out this task?

Yes/No

Q3. If the answer to Q2 was **Yes**, why?

Section 2: System Evaluation Questionnaire

Please answer the following questions regarding the Affective Interface Feedback System you have just used.

Interface

6. It is clear what different parts of the interface does
   Disagree 1 2 3 4 5 Agree

7. The interface is flexible in allowing me to choose options
   Disagree 1 2 3 4 5 Agree

8. The organization of information in the system was not confusing
   Disagree 1 2 3 4 5 Agree

9. The sequence of screens in the interface was not confusing
   Disagree 1 2 3 4 5 Agree

10. Overall, the interface was pleasing and easy to use
    Disagree 1 2 3 4 5 Agree

Data Visualisation

15. The level of student satisfaction conveyed by the interface was clear and understandable
    Disagree 1 2 3 4 5 Agree

16. The use of facial expressions for visualising student satisfaction data was adequate
    Disagree 1 2 3 4 5 Agree

17. The use of facial expressions for understanding student satisfaction data was efficient
    Disagree 1 2 3 4 5 Agree

18. The numerical overall mean display was useful
    Disagree 1 2 3 4 5 Agree

19. The bar chart showing the frequency distribution was useful
    Disagree 1 2 3 4 5 Agree

20. The pie chart showing the percentages was useful
    Disagree 1 2 3 4 5 Agree

21. The use of a facial expression to display the OVERALL level of student satisfaction was useful
    Disagree 1 2 3 4 5 Agree

22. The use of a facial expression to display the OVERALL level of student satisfaction was informative
    Disagree 1 2 3 4 5 Agree

23. The use of a facial expression to display the level of satisfaction with each evaluation criteria was useful
    Disagree 1 2 3 4 5 Agree

24. The use of a facial expression to display the level of satisfaction with each evaluation criteria was informative
    Disagree 1 2 3 4 5 Agree

25. The use of a facial expression to display the level of satisfaction with each survey question was useful
    Disagree 1 2 3 4 5 Agree

26. The use of a facial expression to display the level of satisfaction with each survey question was informative
    Disagree 1 2 3 4 5 Agree

27. The option to weight criteria and different questions helped identify the influence of different criteria and questions on the overall level of satisfaction
    Disagree 1 2 3 4 5 Agree

28. Overall, the interface provided adequate functions for visualizing and understanding the student feedback data
    Disagree 1 2 3 4 5 Agree

Usefulness

8. The option to weight criteria was useful
    Disagree 1 2 3 4 5 Agree

9. The option to weight questions was useful
    Disagree 1 2 3 4 5 Agree

10. The facial expression feedback helped me understand the data
    Disagree 1 2 3 4 5 Agree

11. The interface provides everything I would expect from a feedback system
    Disagree 1 2 3 4 5 Agree

12. I would have benefited from using such a system when making academic choices.
    Disagree 1 2 3 4 5 Agree

Satisfaction

6. I am satisfied with the Affective Interface Feedback System
   Disagree 1 2 3 4 5 Agree

7. I would recommend it to future students for understanding student feedback
   Disagree 1 2 3 4 5 Agree

8. The interface works the way I expect it to work
   Disagree 1 2 3 4 5 Agree

9. The interface provides me all the information I need from the student survey data
   Disagree 1 2 3 4 5 Agree

10. The interface is pleasant to use
    Disagree 1 2 3 4 5 Agree

Section 3: Interview Questions

Which information type in the interface did you pay most attention to?

Which information type/types in the interface was the most informative?

What did the visualised result tell you about the data?

What did the data display as a facial expression make you feel about students' perception of the quality of their learning experience at Liverpool Hope University?

Do you feel that the use of facial expressions to convey levels of student satisfaction added more meaning to the data?

Suggestions for improvement