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ANALYSING QUALITATIVE DATA USING FACIAL EXPRESSIONS IN AN EDUCATIONAL SCENARIO

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ABSTRACT: *In communication, both verbal and non-verbal means ensure that a message is conveyed. Facial expressions are acknowledged as one of the most influential factors in non-verbal communication. Facial Analysis Coding System (FACS) is a tool to analyse data other than the spoken language to improve a researcher's reading of an interviewee's emotions, and proposes a methodology to support the annotation process of facial expressions in a piece of communication. This study investigates an applied framework for FACS in an educational scenario. The study combines both the computerised and manual entries in the applied method. The study addresses the challenges, findings, and recommendations of this applied method.*

KEYWORDS: Facial Expression, Emotions, Non-Verbal, Qualitative, Reliability, Software.

INTRODUCTION

According to Schmitz (2012), non-verbal communication is a process of generating meaning using behaviour other than words. For Dimmick (1995), non-verbal communication including body language such as body movements, gestures, posture, muscle tension, eye contact or skin colouring (flushing) constitutes up to 70% of the message of any face-to-face communication, while tone of voice contributes another 23%. Combining the two ratios (70% and 23%) means that non-verbal messages can form as much as 92% of any piece of face-to-face communication could be non-verbal, and transferred by a number of different means from tone of voice to speaking pauses, body posture and body gestures, and especially facial expressions. Besson *et al*. (2005) stress the importance of facial expressions as dynamic features which can communicate the speaker's attitude, emotions or intentions, and are therefore next in importance to the actual words in trying to determine an individual speaker's internal feelings conveyed in a piece of face-to-face communication. Sathik and Safia (2013) explain that facial expressions are the primary source of emotional messages in determining an individual's internal feelings. Through these messages, humans are able to express a wide range of emotions through facial expressions only. According to Besson *et al*. (2005), all of our non-verbal behaviors, the gestures we make, the way we sit, how fast or how loud we talk, how close we stand, how much eye contact we make send strong messages. For example, analysing facial expressions while delivering a lecture, lecturers could use student's expressions to determine whether or not to slow down, speed up, or in some other way they modify their presentations. Ekman (1992) points out another distinctive feature of facial expressions, namely that unlike some other forms of non-verbal communication which vary with age, gender, or cultural background, facial expressions are universal. A useful model for assessing non-verbal communication is the neuro-cultural model of facial expression (Ekman, 1992). These expressions represent norms guiding how emotion is expressed in various social contexts and which vary within and among cultures. In particular, facial expressions for states of happiness, sadness, anger, surprise, fear, and disgust are considered to be the same across cultures. Onwuegbuzie *et al*. (2011) suggest that mapping these particular six emotions can be used to

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support the reading of verbal-based emotions by interviewees in responding to individual interview questions.

The structure of this paper is as follows. First, it reviews the current situation of FACS. This review places more focus on FACS in education as it is the area of the researcher's expertise and on which the empirical data is collected. A highlight of FACS in qualitative research, is also addressed. This is then followed by the applied methodology and its detailed steps. The next section discusses the applied method, discoveries and challenges within this method. Final section is the conclusion and future research.

LITERATURE/THEORETICAL UNDERPINNING

Currency of FACS

Onwuegbuzie *et al*. (2011) concluded that research to date neither presents a clear model of how to interpret this non-verbal communication, nor gives guidelines for researchers on how to use it to help answer their research questions. This claim is confirmed by Valstar *et al*. (2015), explaining that despite efforts towards evaluation standards in facial expression analysis (FERA 2011, The First Facial Expression Recognition and Analysis Challenge', Conference, Santa Barbara, California, March 2011), there is a need for up-to-date standardised evaluation procedures, focusing in particular on current challenges in the field. One of the challenges states that there is a call to continue providing a standardisation platform and to help the field progress beyond its current limitations. The Facial Expressions Recognition Analysis (FERA) (Valstar *et al.* 2017) extended to focus on expression analysis under different camera views by generating an extensive set of videos comprising different views. They addressed that need to conduct more research to conclude to robust detection under non-frontal head poses and intensity estimation. From my view, it seems that a number of FACS steps are still completed manually to date, could easily become computer–based, such as an automatic calculation of the duration and frequency values inserted in the sheet by the researcher resulting in a digital form ready for analysis or printing. In this study, an investigation of this computed calculation is addressed.

FACS in education

In education, FACS can help to obtain a database of emotional data in an educational context. The following section explains different studies where FACS could guide in forming impression about students' understanding of lectures and keeping the students motivated and interested during lectures. FACS can also help in identifying changes in the learners' states when dealing with Mathematics problems. A study by Sathik and Sofia (2013) concentrates on the use of facial expressions in communication in the context of education. The goal of their study is to identify physical behaviours of the face that are linked to emotional states, and then to identify how these emotional states are linked to student's comprehension, particularly on the way teachers and students use facial expressions to form impressions of each other. The study statistically proved that facial expressions of the students are the most used non-verbal communication mode in the classroom and student's expressions are significantly correlated to their emotions which can help to recognise their comprehension towards the lecture. Similarly, Bosson *et al.* (2004) stress how understanding facial expressions can help teachers to keep the students motivated and interested during lectures for example, so that a teacher's understanding of the students' facial expressions and thus their emotions can be used as a source of feedback by the teacher to analyse the impact of their lecture and identify areas of improvement. Saneiro

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et al. (2014) use FACS to detect emotions in students' interactions while solving mathematics problems, and analyse how the participants' emotional reactions in this learning scenario are influenced by the duration of the task and its difficulty level, and how the valence and arousal levels influence emotions reported by the students themselves. Their analysis makes clear how all these factors have an impact on the students' emotions which can be observed through the facial expressions and body movements during learning tasks that involve cognitive processes, such as mathematics and physics. The significance of using FACS in this study that it could identify changes in the learners' affective states when dealing with cognitive tasks which help to provide emotional personalised support by tutor. In summary, using FACS in the previous studies can inform teachers to change their applied teaching tactics or strategies for a better students' understanding or class engagement. These studies also produce some contributions to support the analysis of facial expressions that considers information about the cognitive process which is relevant in an educational scenario.

FACS as a research methodology in qualitative data analysis

Onwuegbuzie *et al*. (2009) emphasise that in the analysis of participants' responses in any interview context, interpreting only the text can be problematic, since the words alone may not provide in-depth information for example about the degree of agreement or disagreement between participants in a focus group discussion. Driscoll *et al*. (2007) similarly stress that researchers need to think of the social processes that keep research honest and enhance its fairness. Norris (1997) identifies the problem of qualitative research as the difficulty of constructing rules for judging the validity of particular studies, and of specifying procedures which if followed will systematically eliminate bias and error. These observations highlight the need to minimise bias in qualitative research by using analytical methods that are able to quantify qualitative data to separate data analysis from the researcher themselves, and to move towards an increased use of technology.
Mehrabina (1971) argues that only 7% of the expression of the individual's thought is made with words and the remaining 93% is made with gestures, body movements, voice intonation, speed of pronunciation etc. According to Hoque *et al*. (2017) FACS has proven its benefit in both confirming the qualitative findings and identifying emotional reactions, both positive and negative. In detail, linking between verbal data (i.e. interviews) and non-verbal data (i.e. facial expressions) help in assembling the meaning and relevance of what has been said. Consequentially, according to Sadalla and Larocca (2004), the video recording is suitable to capture aspects that may go unnoticed when other resources are used, such as: body, facial and verbal language. For them, "video recording allows recording momentary and non-repeatable events, which are very likely to escape from direct observation" (p. 423). In combination with video recordings, a computer-based FACS analysis can separate facial expressions into distinctively measurable units, providing a tangible approach to investigating the causes and effects of facial expressions (Ekman, 2006).

METHODOLOGY

Video recordings, computer-based FACS anaylsis software and extraction sheets are the methods used sequentially in this study. Firstly, the qualitative data used in this paper was collected during research on teachers' perceptions of student-centred learning in the online environment. It consists of a video recording of a piece of verbal communication with a respondent in a one-to-one interview, in which an online tutor speaks about a situation where his students ask him a question to which he does not know the answer. Secondly, this video

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recording of the tutor was captured into facial expression analysis computer programme. An example of such programmes are: Noldus (Noldus, 2017). The used software in this study is: Sightcorp (Sightcorp, 2017). These programmes capture, interpret emotions as they occur and make direct measurement of emotional response. Within this phase using Sightcorp, FACS involves three stages: (1) face acquisition (finding the face region for the input images), (2) facial data extraction (representing the facial changes caused by facial expressions, representation), and (3) facial expression recognition (identifying facial changes as emotional expressions) (Tan *et al*. 2011). For (1) and (2), Software (Sightcorp) analysed human emotions from facial expression was used for acquisition as well as data extraction and representation. For (3), according to FERA (2015), most FACS proposed in the literature focus on the binary occurrence of expressions, often either basic emotions or FACS Action Units (AUs) which are the observable component of facial movement. In reality, expressions can vary greatly in intensity, and this intensity is often a strong cue for the interpretation of the meaning of expressions. Therefore, step (3) will start by using the software where facial expressions are recognized and will be continued by Kring and Sloan's (2007) Face Coding Sheets (FCS), which record four factors: (1) Expression (the result of (1) face acquisition and (2) facial data extraction), (2) Frequency, (3) Valence (positive or negative feeling), and (4) Intensity (low - medium - high - very high rating). Also, frequency and duration of expressions were totaled and recorded.

The objective of integrating FACS results between the program and the extracting sheets is to increase the reliability of the program's results by focusing on variables (i.e. frequency, valence and intensity). This integration ends up with the overall feeling of the confronted situation (full details of these variables are explained later in this study).

The use of FACS in this study focuses on the analysis of only six facial expressions which correspond to six distinct emotions, and are generally accepted to be culturally independent and universal for all humans: disgust, sadness, happiness, fear, anger, and surprise. As suggested by Ekman (2006), the aforementioned six expressions are "macro" facial expressions which last between half a second and four seconds. According to Ekman (2007), there are also "micro" facial expressions lasting less than half a second and are not culturally universal. Summary of the applied methodology is in the following diagram.

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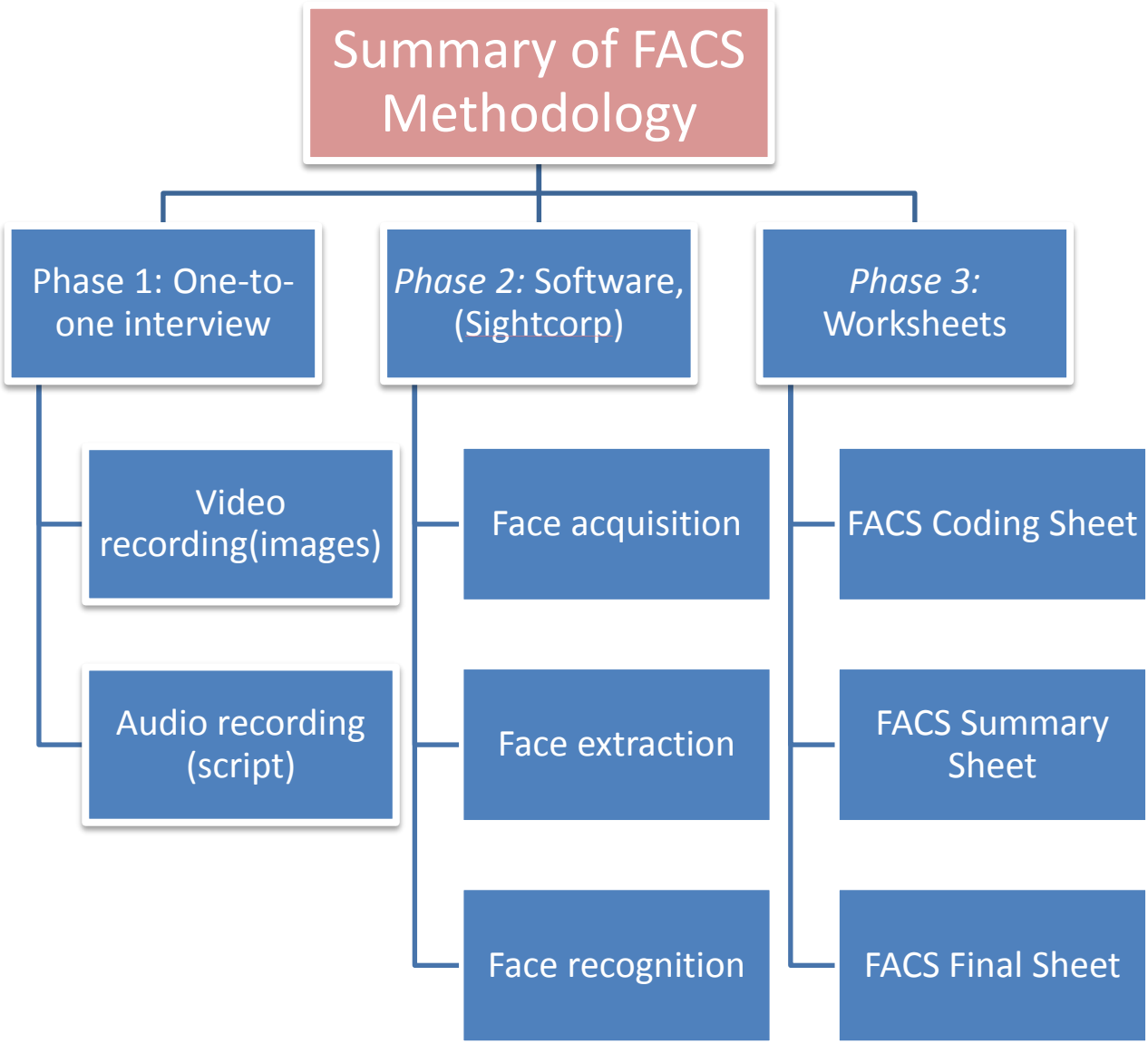

Figure 1: Framework of the applied methodology

RESULTS AND FINDINGS

Phase 1: Interview transcript (Script of interview extracted to be analysed by FACS)

Interviewer: What are your concerns as an online tutor?

Interviewee (online tutor): " I'm always worried about the student's question, how to answer this question and what shall I do if I don't know the answer. I would simply say "Guys, I don't know the answer of this question, but tomorrow morning by 6 am, the answer will be emailed to you". I won't sleep all night till I find the answer, and email it to them."

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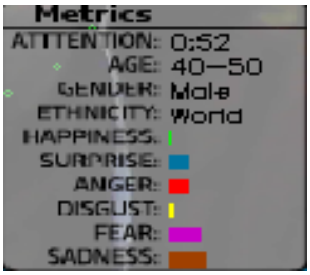
Phase 2: Using Sightcorp software for facial expression analysis

The used software "Sightcorp" constructs a model of the face from the video and automatically evaluate several elementary facial movements (action units). Based on these movements it calculates the likeliness that each of six basic emotions (happiness, anger, sadness, surprise, fear and disgust) is felt at any given time. Facial expression analysis using Sightcorp consists of three distinct steps: face acqustion, face extraction and face recognition, as explained earlier.

An embedded laptop camera is used in this study where the software that analyses the FACS is installed on the same laptop. The interviewee (tutor) was asked a question and started to answer the question. As soon as the tutor looked at the embedded video camera, face, facial landmarks such as eyes and eye corners, brows, mouth corners, the nose tip etc. are detected. After this, an internal face model is adjusted in position, size, and scale in order to match the respondent's actual face. Once the simplified face model is available, position and orientation information of all the key features is fed as input into classification algorithms which translate the features into Action Unit (AU) codes and emotional states (i.e. anger, happiness). The following table explains how the program extracted and presented the tutor's emotions through analyzing his facial expressions. The table below has three columns, the first is the translated transcript, and the second column illustrates print screen of the sex universal emotions. While the interviewee is narrating his experience, the bar (graphical element to visualise the progression of the emotion), progresses. The third column is the dominant emotion that the bar illustrated as the most progressing emotion.

Transcript	Extracted emotion(s)	Dominant emtion(s)
Clip1: I'm always worried about the student's question		Sadness Fear
Clip 2:how to answer this question		Fear

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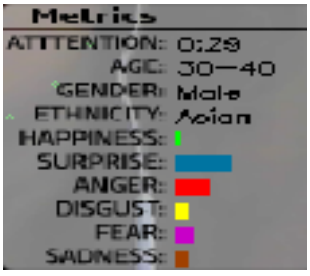
Clip3:what shall I do if I don't know the answer		Fear Sadness
Clip 4:I would simply say		Surprise
Clip 5 :Guys, I do not know the answer		Disgust
Clip 6:but tomorrow morning by 6 am		Fear
Clip7:The answer will be emailed to you		Surprise

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Clip 8:I won't sleep all night till I find the answer, and email it to them		Surprise
Clip 9:and email it to them in due time		Happiness

Table 1: summary results of FACS in action using Sightcorp software

Note: Attention: is the duration that the emotion lasted (part of second till the facial expression returns back to the neutral state)

Phase 3: FACS using Faces Coding Sheets

After the facial expression analysis by Sightcorp, the Faces Coding Sheets (FCS) created by Kring and Sloan (2007) is used to record the data acquired to manually calculate frequency, intensity, valence, and duration of facial expressions.

Sheet 1: FACS Coding Sheet

(Example of Clip1: I'm always worried about the student's question)

Clip start time 10:05:58

Clip end time 10:06:07

Duration **9** seconds

Clip 1

Valence

Positive happiness, surprise

Negative disgust, **sadness**, anger, **fear**, surprise

Intensity

- Low=1
- Medium=2

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- **High=3**
- Very High=4

Summary of Sheet 1 of this clip Duration=9 seconds, Valence=negative, Emotion(s): Disgust, Intensity= very high

Notes:

- Clip is any unnatural state (the bar is increasing, till it gets back again to the neutral state)
- Surprise as an emotion can be a positive or negative emotion, it depends on the context
- Intensity grade (1-4) is divided on the bar length based on (%100) (i.e. if it is in the middle (%50=2))

Sheet 2: FACS Final Sheet

For each clip:

Please rate the degree to which the participant expressed each of the following emotions using the scale below:

Not at all = 1 slightly = 2 somewhat = 3 moderately = 4 quite a bit = 5 very much = 6

Sadness

Happiness

Anger

Fear

Disgust

Surprise

What is the overall level of expressiveness for this person for this film?

Fairly low	low	medium	fairly high	high
1	2	3	4	5

Number of positive expressions

Number of negative expressions

Mean positive intensity

Mean negative intensity

Duration of positive expressions

Duration of negative expressions

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Note: this form has to be filled for each emotion in the clip. According to table1, it has to be filled for each statement listed above (9 emotions)

Sheet 3: FACS Summary Sheet

Facial Expression Summary Sheet

Participant-(x) Clip-1
What was the predominant emotion being expressed throughout the clip?
1.Neutral. 2. Anger 3. Sadness 4. Disgust 5. Fear 6. Surprise 7. Happiness
What is the overall level of expressiveness for this person for this clip?
1.Low 2. Fairly Low 3. Medium 4.Fairly High 5.High
● Number of positive expressions
2 _(surprise, happiness)
Number of negative expressions
4_ (sadness, disgust, anger, fear)
● Duration of positive expressions __15__(in seconds)
● Duration of negative expressions __45__ (in seconds)
● Mean intensity--positive __7.5___
● Mean intensity--negative __11.25__

Figure 2: Facial Expression Summary Sheet

This sheet is an average of the 9 different clips (1minute duration in total) that have been filled in the previous sheet, FACS Final Sheet. The Facial Expression Summary Sheet (Figure 2) shows that the dominant emotion is negative, a feeling of sadness, but the positive emotion of surprise is recorded with high frequency but in short duration (<50% of bar length). The feeling of happiness is present once, in short duration (nearly 50% of bar length), when the tutor narrated emailing the answer to students in due time.

DISCUSSION

This section highlights discoveries and challenges within this method. This study could explain the detailed steps of using FACS starting with videotaping and ending with the emotions behind the transcript. Analysis of facial expression could give other dimensions for the data collected that helped me while coding. For example, when the tutor was asked about his concerns in online teaching and he expressed that the concern is to be asked a question by students that he does not know an answer. Based on FACS results in this example, if the tutor's dominant recorded emotion is "fear", coding will be different from tutor's dominant recorded emotion is "anger" or "sad". According to psychologists, fear, sadness and happiness are human emotional feelings but each one is different in the aspect of how to react and respond (krummerl, 2013). Therefore, in my coding and discussion, for "Fear" if it is a concern as the tutor lacks or needs professional development, this is annotated coding. While, if it is personal trait as a concern of losing control of the lesson, this is another annotated coding. The challenge for me in this case is that I needed to have real time full analysis of these emotions to allow me to ask further questions that are based on this analysis, this suggestion is highlighted in the conclusion and recommendations section. Alternatively, I may need to have another interview with the same

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interviewee, at a later date, to investigate in-depth the reasons behind these feelings. This point highlights the concern of losing the interviews' interest to repeat the experience again in two interviews and may have different reflection or explanation from the first instance occurrence. This losing of interest is explained in a phenomenon known as ―semantic satiation. This psychological phenomenon investigates the temporary influence that may be caused by the repetition of a word or phrase or repeating the narration of same experience. According to Jakobovits and Lambert (1962) this repetition may lead to loss of meaning and interest for the listener. Another use of FACS as a methodology that it can be used for methodological triangulating for the collected data to increase the credibility and validity of the results. For example, if the data is coded after face- to-face interview, followed by another running analysis with FACS. Finally, both coding can verify each other, as according Cohen and Manion (2000) methodological triangulating is the cross verification from two or more sources of data collection.

Another point to be addressed here is about methods of FACS, human and/or software coding. Software for FACS coding is not the only used method where human coding can be used as well. Human coding has the advantage of reliability and results of validation ca be easily checked. Worth noting that according to Sayette *et al*. (2001), FACS is susceptible to problems of inter-coder reliability and limits in the usage of data. In detail, reliability of FACS relies on different laboratories should using FACS in the same way. For example, if the experiment is tested in different laboratories and videotapes using a single video camera and recorder that provides a frontal view of the subject's chest and face, this method has to be applied for the rest of laboratories. Therefore, according to Sayette *et al.* (2001), accredited certification as a FACS coder is essential in this case. Moreover, in the case of human FACS coders, inter-observer reliability for the occurrence of specific AU has to be tested to maximise reliability of this method, this check test requires coders to score videotapes of spontaneous expression with a high level of agreement with a group of reference coders.

In terms of using software for FACS coding, according to Cohen *et al*. (2013), there is still yet considerable work to be done before computerised facial analysis is ready for wholesale use in research. For example, factors like reliability (theoretical work that proprietary analytical techniques derive from such as Ekman (1992)) is a matter of concern to check the software reliability. Another issue that is addressed in this study that when using FACS and in the phase of videotaping, there is a need to develop a task or ask a question that maximises facial expressions. In my study, some questions were expressing neutral or no emotions for the majority of the interaction task. It would then be important to design a task that promotes a variety of facial expressions from subjects. This concern is confirmed by Cohen' *et al*'s. (2003) study where in some given tasks for their study, neutral expressions were given for all participants.

Last point to be highlighted in this section is the third step involving extracting sheets. I found that with real time digital calculation can be less time consuming if these sheets can be calculated by a spreadsheet program. In this study, data was manually entered in the FSC, if a package can combine between the two entries: FACS program and FCS, that can reduce the spent time for researcher to insert, calculate and minimise the chance for any occurring error. Therefore, I recommend for future work to append these calculation as plug-in (added module) to the used software in FACS, so the results can be produced in real time with the recording.

In summary, the lack of a method to digitally calculate results means that despite the use of the available software the entire process of facial expression analysis is time-consuming. Interview

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duration lasted about an hour and it took about an hour for every 5 minutes of recorded communication, though the use of computer-based calculations would speed up this process slightly.

CONCLUSION AND RECOMMENDATIONS

Facial expression analysis research has changed drastically in recent years due to advances in the application of computational techniques in areas such as face detection, tracking and recognition. These advances have led to the establishment of the Facial Analysis Coding System (FACS) as a computed automated system which has helped to eliminate issues such as subjectivity and time-consuming. This study uses the FACS which breaks down facial expressions into distinctively measurable units, providing a tangible approach to investigate the emotions behind these facial expressions. The study aims to support a framework for FACS. The example was used to analysis qualitative data is in an educational scenario. In this sense, this paper reports a methodology to detect facial expressions for an educator narrating his experience in teaching and FACS could analyse the tutors' emotion to answer a specific question. The methodology for FACS depends on software (Sightcorp) followed by manual extracting sheets. Hence, this paper concluded that FACS can assist to improve the reliability and trustworthiness of collected qualitative data by providing information from facial expressions that supplements the verbal message. It can also be suggested to use this methodology in other scenarios that deal with qualitative interviews (i.e. market study). Finally, a need to digitalise the extracted outcomes of the used software for a real time full analysis of these emotions, is suggested to accelerate and increase the accuracy of the results.

Future Research

Finally, due to the constantly increasing interest in applications for human behaviour analysis, and technologies for human-machine communication and multimedia retrieval, FACS is a rapidly growing field of research to which this study seeks to make a contribution. However, for a fully automatic FACS intensity estimation, more research is to be conducted in this area.

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