UNIVERSITY OF BIRMINGHAM

School of Computer Science
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BSc. Project

Investigating Conformity in Online Behaviour using an Asch Style Line Judgement Task

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Abstract

Although conformity to group pressure has been a well researched phenomenon in face-to-face (f-t-f) groups since Asch's seminal studies (Asch, 1951), it is unclear to what degree the extensive research into f-t-f conformity applies to online groups. As human interaction increasingly shifts to online environments such as social networking and virtual learning, it is critical that we understand how conformity manifests online, and its potential social implications. This study aims to investigate conformity in an online setting by deploying a Django quiz application with multiple choice questions (MCQs) of an objective nature (using an Asch-style line judgement task). The quiz was shared in multiple student Facebook groups with 93 users completing all eighty questions. In line with similar studies (Cinnirella and Green, 2007; Wijenayake et al., 2020), the results showed that conformity was significantly lower than f-t-f studies (Asch, 1956; Larsen, 1974), which typically found an error rate of one-third; the error rate obtained in this study was eight percent. However, there was still a conformity effect, and a significant relationship between an incorrect majority and the number of incorrect answers, $\chi^2(3, N = 93) = 17.88, p = .05$. We can reasonably conclude from this that conformity to group pressure does exist online, and further investigation is needed to determine the factors involved in creating online conformity.

Contents

Chapter 1

Introduction

Human-Computer Interaction (HCI) is the study of the design and use of computer technology, and it has long focused on the relationship between people (users) and the machine (computers). However, as our relationship with technology has become increasingly complex following inventions such as the internet, the World Wide Web (WWW), and smartphones, the need for research into our behaviour with respect to these systems has increased. One area of particular interest is the study of social behaviour online, i.e., user-user interaction, e.g., do the same influences which affect face-to-face (f-t-f) groups apply in an online context such as social networking sites? One of these social influences, of particular interest to online social groups, and which has yet to be thoroughly researched, is conformity.

Conformity is a powerful social phenomenon defined as "behaviour intended to fulfil normative group expectations as these expectations are perceived by the individual", i.e., behaviour deriving from a perceived standard or norm (Willis, 1965, [27]), or a "phenomenon that encourages individuals to change their personal opinions and behaviour to agree with an opposing majority" (Wijenayake et al., 2020, [26]). The phenomenon of conformity to group pressure—changing one's responses to be consistent with group members' responses [4]—has been well documented and researched since Asch's original experiments (Asch, 1956, [3]) in the 1950s, where participants would have to defy a majority group—by publicly declaring a different answer to the everybody else in the room—to give the correct answer to a simple question.

However, as noted by Wijenayake, et al. in 2020 [26], there has been little research on the effects of conformity in an online environment. E.g., it is unclear to what extent the decades of research into conformity in f-t-f groups (see 1.1.1) applies to online contexts where there is a high level of user-user interaction such as social networks, especially since these platforms offer partial or complete anonymity. It is therefore critical that we investigate conformity in online behaviour, especially since human interaction has increasingly shifted to online social networks that have been consistently blamed in popular news discourse for acting as echo chambers that create political polarisation (Nguyen and Vu, 2019 [18]). In recent years, we have seen how social media can create polarised populations, even over harmless things such as the viral dress phenomenon [24] where one group of people were convinced an image showed a blue dress, and another group were convinced the dress was gold. In a similar case, one group heard the word "Yanny", and another heard "Laurel" after listening to a viral audio recording [28]. Furthermore, recent research has shown that most people polarise their social attitudes by conforming to the perceived demands of the authority (Panizza, Vostroknutov, and Coricelli, [20]), further emphasising the need for research into this area.

The present study aims to investigate conformity in online groups by developing and deploying a web-based online quiz with low-difficulty multiple-choice questions (MCQs) of an objective nature. The participants were exposed to some kind of group judgement on each question before they gave their answer, in order to introduce some element of group pressure. The study aims to answer the following research question: are users of an online quiz persuaded to change their answer in order agree with a perceived majority opinion, even if that contradicts their own judgement?

1.1 Related Work

1.1.1 Conformity in Face-to-face Groups

Conformity to group pressure was first explored in Asch's conformity experiments (Asch, 1951, [2]; Asch, 1956, [3]) which investigated whether or not individuals would yield to or defy a majority group, when faced with a simple and clear matter of *fact* judgement task matching the length of a reference line to one of three comparison lines. Analysis of all twelve critical trials—in which a majority group were instructed to give unanimous and incorrect judgements—revealed that 76.5% of the participants conformed with an incorrect majority *at least once* (n=50). Furthermore, *one-third* of all critical trial responses were incorrect. This was significant because it showed that individuals were willing to disregard their own judgement—literally what they were seeing *in front of their own eyes*—in favour of a clearly incorrect majority. A subsequent interview with a conforming participant revealed that although they were suspicious of the crowd, they were not sufficiently confident to contradict their judgement. Asch later commented "that intelligent, well-meaning, young people are willing to call white black is a matter of concern."

In subsequent studies, Asch explored several variations on his original experiment, with the following key findings:

- **The presence of a "true partner":** in studies which added a second 'true' participant, i.e., naive non-actors, the participants were more encouraged to retain their independence and oppose the majority, i.e., the levels of conformity decreased [1]. However, withdrawal of a true partner restored conformity to levels consistent with the absence of a true partner; Asch called this a "desertion effect" [1].
- **The size of the majority:** these trials found that high levels of independence were retained when paired with a single individual, but increasing the opposing group to three persons significantly increased conformity [1]. Increasing the opposing group to more than three persons did not further increase conformity.
- **Written responses:** in trials where the true participant was allowed to write their responses—whilst the rest of the group continued to answer verbally—the levels of conformity substantially decreased [3].

Other related studies have focused on the influence of contextual and individual factors on conformity. Contextual factors are concerned with cultural or social conditions which can influence the level of conformity found in particular population, e.g., a repetition of the Asch experiment (Larsen, 1974 [14]), noted that the relatively high levels of conformity found in the original experiments could be partly due to them taking place during the era of McCarthyism, known for its emphasis on a collective American identity in the U.S. In this study, 62.5% of the participants—once again, college students—conformed at least once (n=24), a reduction of 14%. It is important to note that this study took place during a period of student activism where challenging the authority was encouraged, therefore, this reduction was expected. Furthermore, a meta-analysis of 113 conformity studies using the Asch-style line judgement task (Culture and Conformity [5]) also discovered that conformity had declined in the U.S. since the original experiments in the 1950s. Analysis of these studies across 17 different countries also showed that conformity was significantly related to the country's *individualism-collectivism*; i.e., collectivist (emphasising the needs and goals of the group) countries showed a greater conformity effect than individualist (emphasising the needs and goals of the individual) countries.

As well as these contextual factors, studies have discovered that individual factors such as the gender of the participant can influence levels of conformity. E.g., as pointed out by Eagly in 1983, several studies have suggested that social influence may have a greater effect on women than on men (Eagly, 1983, [11]). Another study investigated the effect of prior reinforcement (positive and negative) on the tendency to be influenced by a partner (Mausner, 1954, [15]). After completing an "alone session", half of the participants in this study were told that they were correct on 82% of the questions (positive reinforcement), the other half were told that they were wrong on 82% of the questions (negative reinforcement). In the second session, the participants made their judgements in pairs; the group that had been given negative reinforcement were much more likely to be influenced by their partner.

Despite the extensive research into conformity in f-t-f groups, it is unclear to what extent their findings apply to online groups; since online social interaction has become ubiquitous [26], it is of interest to multiple research communities, e.g., those involved in social psychology and HCI, that the existence (or lack thereof) of conformity in virtual groups be investigated and explored. The next section discusses related work on conformity in online groups, and identifies gaps in the literature which can be explored in the present study.

1.1.2 Conformity in Online Groups

Over the past two decades, human interaction has rapidly moved to a diverse set of online 'virtual' platforms, e.g., virtual learning environments, instant messaging applications, social networking applications, and forums; individuals use these platforms to get their needs for friendship, connection, and belonging met instantly—especially adolescents (Kraut et al., 2006, [13]). Online interaction is very dissimilar to f-t-f interaction for the following reasons:

- **Removal of nonverbal communication (in text-based online communication):** studies have suggested that up to 70% of all f-t-f communication is nonverbal [12], and therefore one can expect that the removal of body language and age, gender, ethnicity, and status (e.g., clothing) clues will have a significant impact on online behaviour.
- **Possibility of asynchronous communication:** communication online can be asynchronous, e.g., email, because two users don't have to be communicating at the same time, whereas most f-t-f communication is synchronous by nature (Cinnirella and Green, 2007, [7]).
- **Reduced social presence:** one of the key factors encouraging participants to agree with a majority in Asch's original studies was having to announce a judgement publicly in front of an opposing group. In online groups, a user can choose to share as much, or as little, of their "true" identity with the rest of the group (Mckenna, Green, Gleason, 2002, [16]), offering an inherent anonymity in an online context.

Due to the reasons above, one can expect conformity in online groups to be lower compared to f-t-f studies. An investigation of 'normative influence' (Cinnirella and Green, 2007, [7])—conforming to a majority in order to be 'liked'—used an Asch style line judgement task, but some participants selected their answers using computer-based communication. The results of this experiment were compared against a f-t-f group, and found that conformity was significantly reduced; however, even though the participants in the online group were able to remain anonymous users, there was still a conformity effect. However, this research doesn't explore exactly what abstract representations of a majority group create the most conformity in computer applications; e.g., does a live poll produce greater levels of conformity than presenting group judgements as text? An interesting (unanswered) question is how far can you abstract away from f-t-f communication and still get a conformity effect; this will be explored in the present study.

A similar study (Wijenayake, Berkel, 2020, [26]), investigated the influence of contextual factors such as self-confidence, personality, and gender on online conformity using an online quiz with subjective and objective multiple choice questions. For each question, participants gave their answer and reported their level of confidence in this answer. After answering, they were shown a fake bar chart placing them either in the majority or minority of answers; they were then given the opportunity to change their answer and rate their confidence again. This study found that 78% of the participants conformed to the majority's answers at least once during the quiz, and conformity was higher for objective questions, suggesting an 'informational influence' (accepting the majority to be more accurate than one's own judgement).

Lots of research focuses on the negative influence of conformity, however a 2011 study explored the positive effect that conformity could have among users of an online website (Sukumaran et al., 2011, [21]). This study took place on an online news website where participants were invited to post a comment about a news article. Before commenting, one group of participants saw 'high-thoughtful' comments posted previously by other users whereas another group saw 'low-thoughtful' comments. An analysis of the participant's comments—measured by the length of the comment, the time taken to write them, and the number of issue-relevant thoughts they contained—showed that participants in the first group exposed to 'high-thoughful' comments were influenced to write similarly thoughtful and issue-relevant comments. However, the second group, exposed to 'low-thoughful' comments ended up making similarly low-effort comments themselves.

The most common way that individuals interact online is through social media where there has been a recent rise in so-called 'fake news'. A study about sharing and commenting on disinformation on social media (Colliander, 2019, [8]) showed that prior exposure to critical comments decreased the likelihood that users would positively engage with a piece of fake news, e.g., by commenting or sharing. Furthermore, this study also showed that critical comments had a much greater impact than labelling posts with an official disclaimer, i.e., users are more influenced by each other than messages from so-called *'trusted'* sources.

(Beran et al., 2015, [4]) investigated whether graduate students would conform to an incorrect majority in an online virtual classroom. Some of the participants could see the names and responses of three other students whilst responding to curriculum-based multiple choice questions. However, these other students were in fact actors, and had been instructed to give incorrect answers on some of the questions. The participants who had exposure to these incorrect answers obtained fewer correct responses than those who saw no responses demonstrating that individuals are likely to trust incorrect information presented by their peers.

Chapter 2

Method

2.1 Experiment Design

Asch's original experiment [3] was conducted as follows: A group of eight participants gathered in what appeared to be a simple experiment in visual discrimination. The participants were instructed to match the length of a given line—the standard—with one of three other lines. One of the three comparison lines was equal to the standard; the other two lengths differed from the standard by considerable amounts. The participants announced their judgements *publicly*. All but one of the participants had met with the experimenter beforehand and were instructed to respond on certain trials with *unanimous* and *incorrect* judgements. The 'true' participant—referred to as the 'critical subject'—was therefore placed in the position of a *minority of one* against a *wrong* and *unanimous* majority.

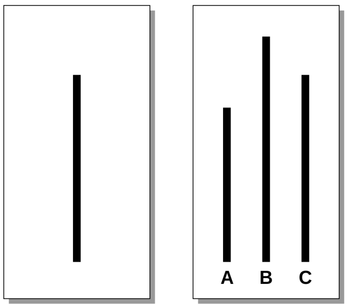

Figure 2.1: *A Line Matching Task from Asch's Original Experiments* [19]

The present experiment follows Asch's paradigm by using a similar line judgement task and placing the participant in a situation where they believe they are a minority of one. This means that the results of this study can be compared directly with the extensive existing literature. In order to follow Asch's convention, the present experiment had the following procedure:

- Participants were invited to take part in an online quiz with the appearance of being an experiment about visual perception in Human-Computer Interaction.
- The questions each presented four lines and asked the participant *"Which is the tallest line?"*.
- In order to familiarise participants with the user interface, they completed a set of three practice questions before moving on to the main sets of questions—of which there were eighty—all presented in a *random* order.
- On each question page, the participants were exposed to some fake data—titled *"How others answered"*—which aimed to represent a group judgement by leading the participant to be-

lieve that they had access to data showing how previous participants had answered the same questions.

- There was always a majority group in this data, in favour of a particular line; however, this majority differed in size.

NB: from now on, the terms *"crowd"* and *"group judgement"* shall be used to refer to the fake "How others answered" data.

We will now consider some of the decisions made in the creation of this experiment design, and make comparisons to other experiments discussed in the related literature. Similar experiments (Sukumaren et al., 2011, [21] and Colliander, 2019, [8]) have used comments to represent group judgements. Other online conformity studies have also used real other respondents (Beran et al., 2015 [4]). However, in order to satisfy ethical requirements, and to present the group judgements in a simpler and more abstract fashion, the present study represents the judgements *graphically*, using fictitious data as described above. Overall, this study attempted to abstract away from f-t-f groups as much as possible, by removing any social presence. It was predicted that this would have no impact on conformity.

In another comparable study (Wijenayake, Berkel, 2020, [26]), the group judgements were presented *after* the participant answered a question, giving an opportunity to explicitly change answer. The advantage of this approach is that it is clear that the participant is changing their answer in order to agree with a majority group. However, in this study, group judgements are presented before the participant answers to reduce completion time; it was hoped that having lots of questions that could be answered quickly would tire the participant, increasing the likelihood that they would rely on the crowd.

2.1.1 Independent Variables

The experiment had three key independent variables:

1. The category of difference between the lengths of the lines: low or high.
2. The strength of the crowd response: weak or strong.
3. The type of crowd response: correct or incorrect.

Which from now on will be referred to using (1), (2), and (3) respectively.

These variables were combined to create the following sets of questions, of which there were ten each:

Set	Category of Difference (1)	Strength of Response (2)	Type of Response (3)
1	High	Strong	Correct
2	High	Strong	Incorrect
3	High	Weak	Correct
4	High	Weak	Incorrect
5	Low	Strong	Correct
6	Low	Strong	Incorrect
7	Low	Weak	Correct
8	Low	Weak	Incorrect

resulting in a total of eighty questions (see appendix A). It is worth noting that on some of the questions—twelve in total—there was no difference between some, or all, of the lines; these were included under the low category of difference between the lines (1).

The experiment was conducted using a *within-subjects design*, i.e., each participant experienced every combination of these independent variables by completing all eighty questions. The combination of high category of difference (1), strong strength of response (2), and the correct type of crowd response (3) was the control condition. It can also be said that in this design, every participant is a critical subject. The advantage of using a within-subjects design over a between-subjects design is that it is not necessary to have multiple groups of participants, e.g., a control group, and an experimental group. In addition to that, the validity of a within-subjects design does not depend on random assignment and it is easier to statistically analyse the results (Charness, Gneezy, Kuhn, 2012 [6]).

2.1.2 Hypothesis Generation

In line with previous Asch-style studies, we are particularly interested in the relationship between the the type of crowd response (3) and the number of incorrect answers. We will hypothesise that there will be a significant relationship between these variables; therefore, we take the following hypothesis H: *the number of incorrect answers increases when the type of crowd response (3) is incorrect.*

2.2 Software Review

In this section, we will review other software that has been created as a means to investigate online conformity.

The first application shown in Figure 2.2 displays a table containing the names of the participants and their answers. The participant selects their answer (either A, B, or C) underneath this table and submits it using a button. There is a chat window to facilitate communication between the participants and the moderator (Beran, 2015 [4]).

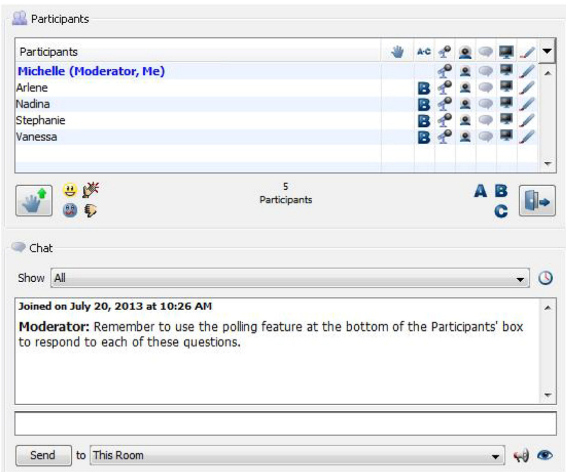

Figure 2.2: *Screenshot of an Application Developed to Investigate Conformity Among Graduate Students* [4]

The second application shown in Figure 2.3 displays a multiple choice question and a slider for the user to rate their confidence, followed by a fictitious bar chart designed to convince the user that they are either in the majority or minority of answers. The third view in the user journey re-displays the same question, giving the user the chance to change their answer and re-rate their confidence (Wijenayake et al., 2020, [26]).

2.3 Software Design

In order to implement the experiment, a web-based quiz application was created with two types of user in mind: a **participant** who would complete the questions and an **experimenter** who would

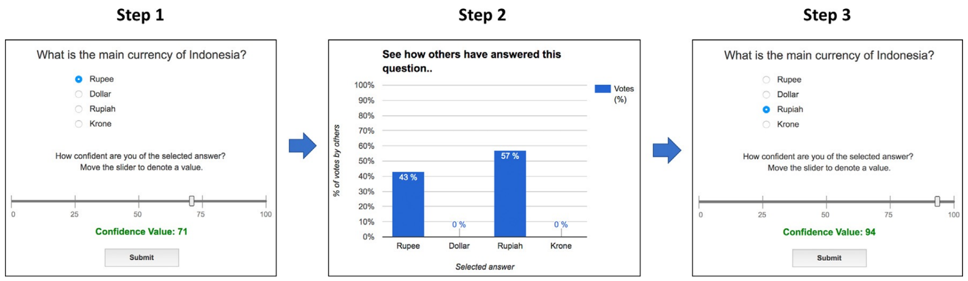

Figure 2.3: *Screenshot of a Website Developed to Investigate Conformity Online* [26]

create, manage, and collect results from the quiz. This software had the following functional and non-functional requirements:

2.3.1 Functional Requirements

Participant

As a participant, I want to...

1. ...be registered as a user after I visit the quiz website and start the questions
2. ...view and answer the quiz questions
3. ...view data for *"How others answered"* before I answer a question
4. ...be updated on my progress as I complete the quiz, and when I finish the quiz

Experimenter

As an experimenter, I want to...

1. ...create, edit, and delete questions
2. ...create, edit, and delete choices corresponding to a given question
3. ...create and edit data for *"How others answered"*
4. ...view and collect answers

2.3.2 Non-Functional Requirements

The application should...

1. ...load as quickly as possible. This means that the files, e.g., images for the line judgement task, loaded on each page should each have a small file size.
2. ...involve as few interactions with the user interface as possible. This means that the user interface should be simple.
3. ...work intuitively on as many devices as possible. This means that the application should be responsive by adjusting to different screen sizes, e.g., devices with smaller screens like smartphones.
4. ...store each user's answers. After the participant user has completed the quiz, the experimenter user will need to able to access their answers for analysis.

5. ...present the questions in a random order. According to the experiment design, the questions should be presented in a random order, and therefore the application needs to be designed as such.

2.3.3 User Interface (UI)

In order to satisfy the experiment design and the function and non-functional requirements, the question page user interface (UI) had the following elements:

- **A line judgement task** using images. The experiment design requires a set of four lines (line judgement task) to be presented on each question.
- **A representation of the crowd** using progress bars. The experiment design requires that the questions expose the participants to fake data for how many of the previous participants went for each choice. This will be achieved using four progress bars.
- **A question label** using a header. The experiment design states that each question will ask the user "Which is the tallest line?".
- **A method of answering** using radio buttons. The user will need a way of selecting their answer for each question, but they must only be able to select one answer.

With these in mind, and following on from the functional, and non-functional requirements, low-fidelity (lo-fi) prototypes were created using Balsamiq: a web-based rapid prototyping software which enables the creation of wireframes (simple illustrations of a user interface). See Figures 2.4 and 2.5.

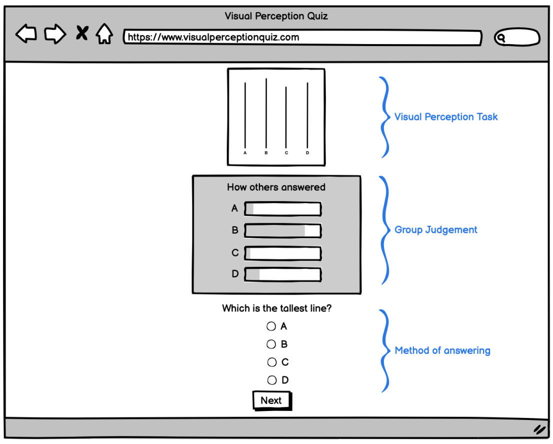

Figure 2.4: *Question Page Wireframe*

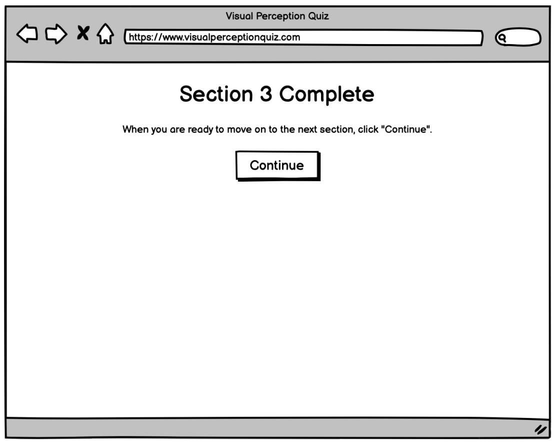

Figure 2.5: *Section Complete Page Wireframe*

The actual user interface was created using Bootstrap: an open source front-end CSS framework designed to build responsive mobile-first websites. Based on the wireframes above, the screenshots in Figures 2.6 and 2.7 show the application's user interface.

2.4 Software Architecture

The web application was created using the Python-based web framework Django, which is designed to build database-driven web applications [9].

Database-driven web applications typically wait for HTTP requests from the web browser; when that request is received, the application works out what is needed based on the URL and possibly the `GET` or `POST` data (contained in the request). The application will then return a response to the web browser, often dynamically creating an HTML web page by inserting data retrieved from the database into placeholders in an HTML template (Django Introduction, Mozilla, [10]).

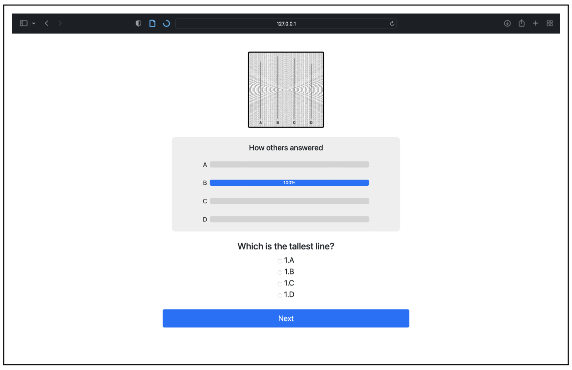

Figure 2.6: *Question Page Screenshot*

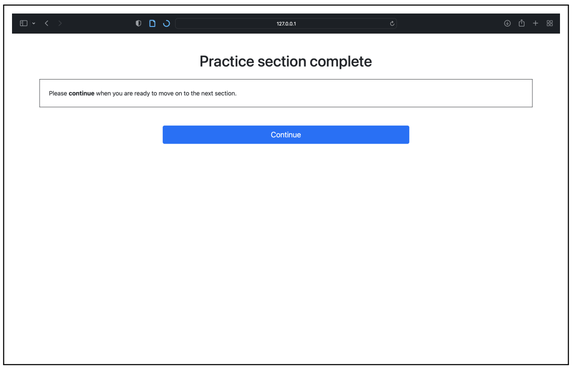

Figure 2.7: *Section Complete Page Screenshot*

To handle this process, Django applications have the following core components:

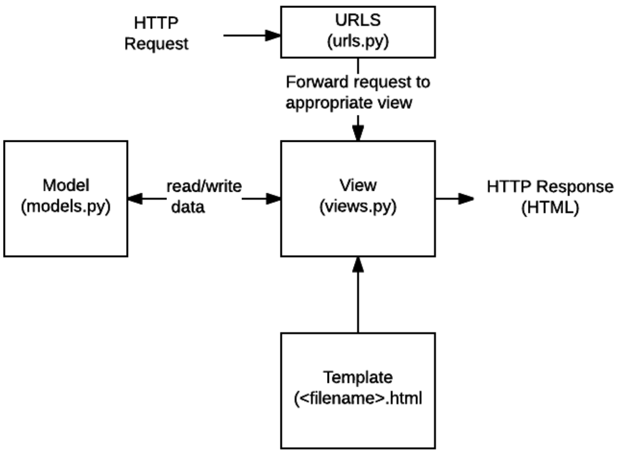

Figure 2.8: *Django Introduction, Mozilla,* [10]

- **Models:** the single definitive source of data for Django applications. Each model is a Python class that subclasses `django.db.models.Model`. Each model typically maps to a single database table. Each attribute of the model represents a database field (Models, Django Documentation, [17]).
- **Views:** can either be function-based, or class-based. Either way, the basic premise is the same: a view is a callable which takes web request and returns a web response, e.g., an HTML web page. They are roughly equivalent to Controllers in the Model, View, Controller (MVC) architecture.
- **URLs:** maps URLs to views, and forwards HTTP requests to the appropriate view.
- **Templates:** a mixture of static HTML content and custom syntax describing how dynamic content should be populated by data sent from the view. Each view typically has its own template (Templates, Django Documentation, [23]).

2.4.1 Models

The following core models were created for the quiz application: `Question`, `Choice`, and `User`. Each `Question` model had a one-to-many relationship with `Choice` models, representing the fact that each question had four choices. The structure of each model is shown in the Unified Modelling Language (UML) class diagrams in Figure 2.9 below:

Each model maps to a single database table, e.g., here is the class definition for the `Question` model:

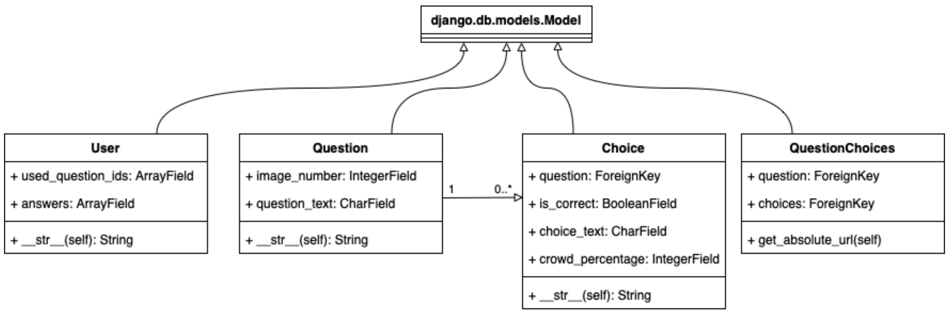

Figure 2.9: *Models UML Class Diagrams*

```
class Question(models.Model):
    image_number = models.IntegerField(default=0)
    question_text = models.CharField(max_length=200)

    def __str__(self):
        return str(self.id) + '. ' + self.question_text
```

And here is the table that Django created based on the above model definition:

```
table_name   |  column_name  |     data_type
---------------+----------------+-------------------
 quiz_question | id            | integer
 quiz_question | image_number  | integer
 quiz_question | question_text | character varying
```

Note how each attribute in the Question class maps to a database column in the quiz_question table.

2.4.2 Forms

In order to implement the "method of answering" part of the user interface, a form was created for each question with radio buttons for the choices. Radio buttons were used because they only allow the user to select one of a predefined set of mutually exclusive items. In a database-driven application such as this, the forms often closely map to the models, and therefore Django provides a helper class called ModelForm to create a form based on a model. A composite model QuestionChoices was created for this form, combining a question and its set of choices into one model (see Figure 2.9). QuestionChoiceForm was defined as follows:

```
1  class QuestionChoiceForm(ModelForm):
2      class Meta:
3          model = QuestionChoices
4          fields = ['choices']
5
6      def __init__(self, *args, **kwargs):
7          super(QuestionChoiceForm, self).__init__(*args, **kwargs)
8          question = self.initial['question']
9          choices_set = question.choice_set.order_by('choice_text')
10         self.fields['choices'] = forms.ModelChoiceField(queryset=choices_set,
11                                                         widget=forms.RadioSelect,
12                                                         label="", )
```

Django's ModelChoiceField was used with the RadioSelect widget (lines 10-12) in order to create a set of radio buttons that the user could use to select their answer, thereby meeting the first functional requirement for the participant user (see 2.3.1).

2.4.3 Views

The following views were created for the quiz application:

- `IndexView` for displaying information about the quiz before the participants start
- `QuestionFormView` for displaying the questions
- `InfoView` for displaying section complete updates as the user completes the quiz
- `CompleteView` for displaying information at the end of the quiz

The structure of each view is shown in the UML class diagrams in Figure 2.10.

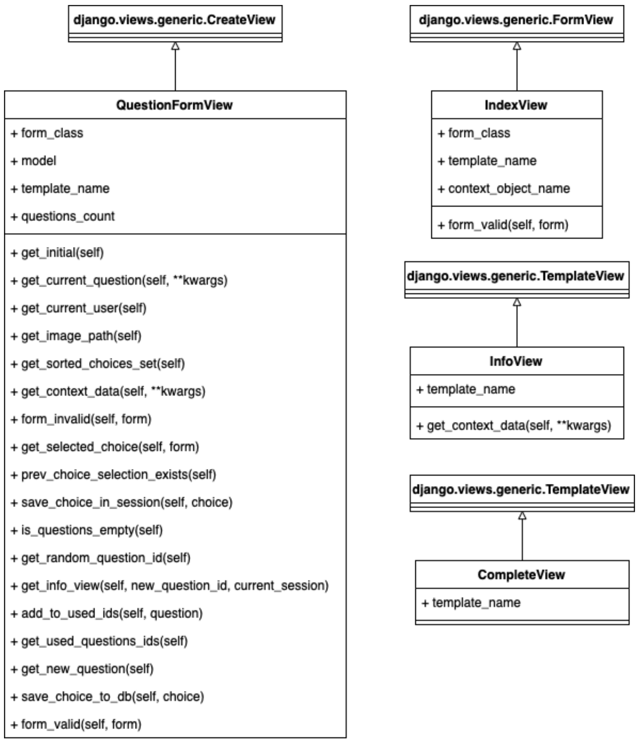

Figure 2.10: *Views UML Class Diagrams*

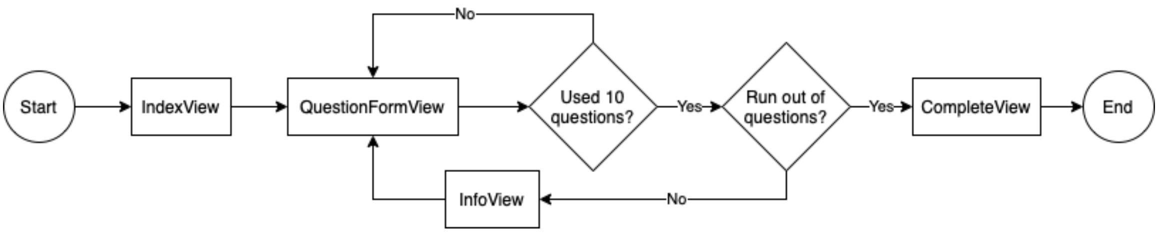

Figure 2.11: *Activity Diagram Showing Sequence of Views Used in the Participant User Journey*

Each view contains whatever arbitrary logic is necessary in order to return an HTTP response. In this quiz application, the most important piece of view-based logic was the retrieval of a new question after the user clicked the 'Next' button. The activity diagram shown in Figure 2.12 shows the simple algorithm used in the `get_new_question` method of `QuestionFormView`.

2.4.4 Templates

Django uses its own template language which is a mixture of HTML and custom template tags, e.g., here is the template used for the question pages:

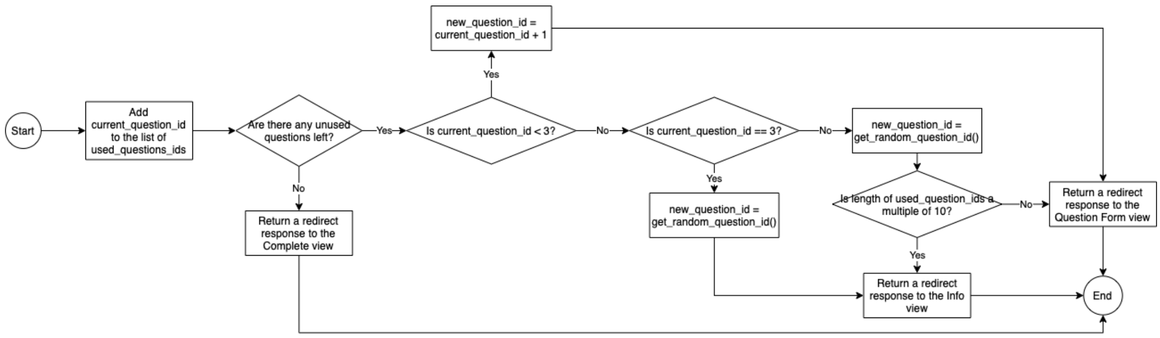

Figure 2.12: *Activity Diagram Showing Retrieval of a New Question*

```
{% extends 'quiz/base.html' %}

{% block content %}
    <div class="text-center">
        {% load static %} <img src="{% static image_path %}" class="img-fluid rounded"
             alt="Lines" id="lines-image">
        <div id="percentages-box" class="m-auto mt-4 p-3">
            <h5>How others answered</h5>
            {% for choice in sorted_choices_set %}
                <div class="d-flex justify-content-center align-items-center mt-3">
                    <p class="m-0 p-1">{{ choice.choice_text }}</p>
                    <div class="w-75 p-1">
                        <div class="progress">
                            <div class="progress-bar" role="progressbar" style="width: {{
                                 choice.crowd_percentage }}%;"
                                 aria-valuenow="{{ choice.crowd_percentage }}"
                                      aria-valuemin="0" aria-valuemax="100">
                                {{ choice.crowd_percentage }}%
                            </div>
                        </div>
                    </div>
                </div>
            {% endfor %}
        </div>
        <h4 class="mt-4">{{ current_question.question_text }}</h4>
        <form method="post">
            {% csrf_token %}
            {{ form.non_field_errors }}

            {% for hidden_field in form.hidden_fields %}
                {{ hidden_field.errors }}
                {{ hidden_field }}
            {% endfor %}

            <ul class="list-unstyled">
                {% for choice in form.choices %}
                    <li class="fs-5"> {{ choice.tag }} {{ choice.choice_label }}</li>
                {% endfor %}
            </ul>

            <div class="d-grid gap-2 col-6 mx-auto">
                <input type="submit" name="next" value="Next" class="btn btn-primary btn-lg
                     mt-2">
            </div>
        </form>
    </div>
{% endblock %}
```

In order to pass dynamic content to the template, e.g., `sorted_choices_set`, Django provides a method called `get_context_data` which is defined in the view:

```
def get_context_data(self, **kwargs):
    context = super().get_context_data(**kwargs)
    context['current_question'] = self.get_current_question()
    context['image_path'] = self.get_image_path()
    context['sorted_choices_set'] = self.get_sorted_choices_set()
    return context
```

Once the dynamic content has been populated, Django converts the template to an HTML page which is then returned by the view.

2.5 Software Deployment

The Django web application was deployed to a DigitalOcean Virtual Private Server (VPS) running Ubuntu. A PostgreSQL database was created on the server to store the quiz's data. Although Django includes its own lightweight web server for a development environment, it was necessary to have a more rigorous and secure web server setup for the production environment by using Gunicorn and Nginx. Gunicorn is a Python Web Server Gateway Interface (WSGI) which translates HTTP requests into Python calls that the Django application can process. Nginx is another web server which was used as a reverse proxy, i.e., a server that accepts incoming connections and decides where they should go next.

The domain `www.visualperceptionquiz.com` (no longer in service) was configured to point to the Nginx web server for easy access.

2.5.1 Security

Several measures were taken in order to ensure the basic security of the web application:

- Uncomplicated Firewall (ufw) was used to only allow connections to certain ports, e.g., HTTPS (443), and SSH (22).
- The Django Secret Key was hidden as an environment variable.
- HTTPS was enabled by using Let's Encrypt: a certificate authority (CA) that provides a way to obtain and install free TLS/SSL certificates, thereby enabling encrypted HTTPS on web servers.

This is the server configuration file for Nginx which is set up to listen on port 443 (line 14) and proxy pass to Gunicorn's socket file (line 11):

```
1  server {
2      server_name 164.92.147.223 visualperceptionquiz.com www.visualperceptionquiz.com;
3
4      location = /favicon.ico { access_log off; log_not_found off; }
5      location /static/ {
6          root /home/george/gxb911/mysite/mysite;
7      }
8
9      location / {
10         include proxy_params;
11         proxy_pass http://unix:/home/george/gxb911/mysite/mysite.sock;
12     }
13
14     listen 443 ssl; # managed by Certbot
```

```
15     ssl_certificate /etc/letsencrypt/live/visualperceptionquiz.com/fullchain.pem; # managed by Certbot
16     ssl_certificate_key /etc/letsencrypt/live/visualperceptionquiz.com/privkey.pem; # managed by Certbot
17     include /etc/letsencrypt/options-ssl-nginx.conf; # managed by Certbot
18     ssl_dhparam /etc/letsencrypt/ssl-dhparams.pem; # managed by Certbot
19
20
21 }
22 server {
23     if ($host = www.visualperceptionquiz.com) {
24         return 301 https://$host$request_uri;
25     } # managed by Certbot
26
27
28     if ($host = visualperceptionquiz.com) {
29         return 301 https://$host$request_uri;
30     } # managed by Certbot
31
32
33     listen 80;
34     server_name 164.92.147.223 visualperceptionquiz.com www.visualperceptionquiz.com;
35     return 404; # managed by Certbot
36 }
```

It also refuses to allow connections on port 80 (lines 33-35), further enhancing security.

2.6 Participants

A link to the quiz was posted in several University of Birmingham student Facebook groups. Since the link was public, the participants were free to share the link with others, and anybody could access it. The web application only collected the user's answers, and no other data; therefore, the characteristics of the participants is unclear. However, one can assume that a substantial number of the participants were students aged between 18 and 25, with a mixture of male and female.

Chapter 3

Results

NB: in the following section, (1), (2), and (3) are used to reference each of the three independent variables defined in 2.1.1.

3.1 Data

Overall, 152 users started the quiz, with 93 of those completing all eighty questions (excluding the three practice questions). Therefore, there were **93 participants** in total.

There were 7440 answers in total, of which 6847 were correct (92%, 1dp), and 593 were incorrect (8%, 1dp). The overall error rate was therefore 8%. 278 answers agreed with an incorrect crowd (3.47%, 2dp), with 80 of the participants giving at least one incorrect answer (86%, 1dp).

The distribution of correct and incorrect answers is shown in the contingency tables 3.1 and 3.2, along with the graphs shown in Figures 3.1 and 3.2 (see 2.1.1 for variable definitions):

In the graphs shown in Figures 3.1, 3.2, and 3.3, the x-coordinates are abbreviated as follows:

1. The category of difference between the lengths of the lines (1): *"Diff"*
2. The strength of the crowd response (2): *"Resp"*
3. The type of crowd response (3): *"Crowd"*

3.2 Statistical Analysis

Following on from the hypothesis H generated in 2.1.2: *the number of incorrect answers increases when the type of crowd response (3) is incorrect*, a chi-square (χ^2) test of independence was performed

	High Diff (1), Strong Resp (2)	High Diff (1), Weak Resp (2)	Low Diff (1), Strong Resp (2)	Low Diff (1), Weak Resp (2)	
Crowd Correct (3)	911	914	830	809	3464
Crowd Incorrect (3)	885	885	799	814	3383
	1796	1799	1629	1623	6847

Table 3.1: *Contingency Table of Correct Answers*

	High Diff (1), Strong Resp (2)	High Diff (1), Weak Resp (2)	Low Diff (1), Strong Resp (2)	Low Diff (1), Weak Resp (2)	
Crowd Correct (3)	19	16	100	121	256
Crowd Incorrect (3)	45	45	131	116	337
	64	61	231	237	593

Table 3.2: *Contingency Table of Incorrect Answers*

	High Diff (1), Strong Resp (2)	High Diff (1), Weak Resp (2)	Low Diff (1), Strong Resp (2)	Low Diff (1), Weak Resp (2)
Crowd Correct (3)	27.6290050590219	26.3338954468803	99.7234401349073	102.313659359191
Crowd Incorrect (3)	36.3709949409781	34.6661045531197	131.276559865093	134.686340640809

Table 3.3: *Expected Frequencies of Incorrect Answers*

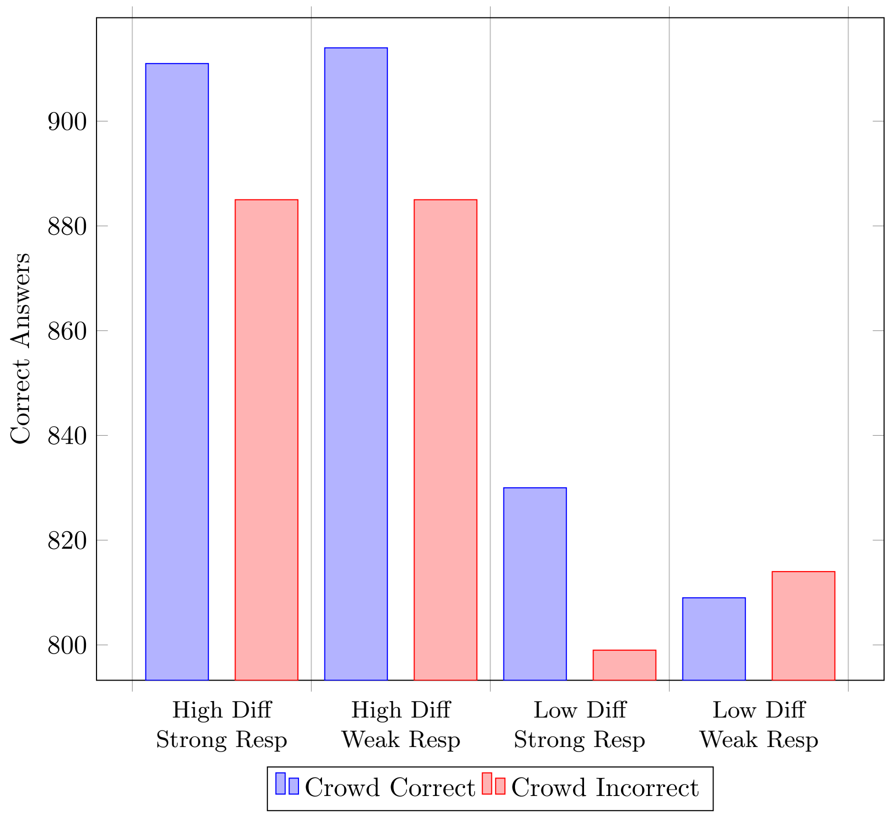

Figure 3.1: *Bar Chart Showing Distribution of Correct Answers*

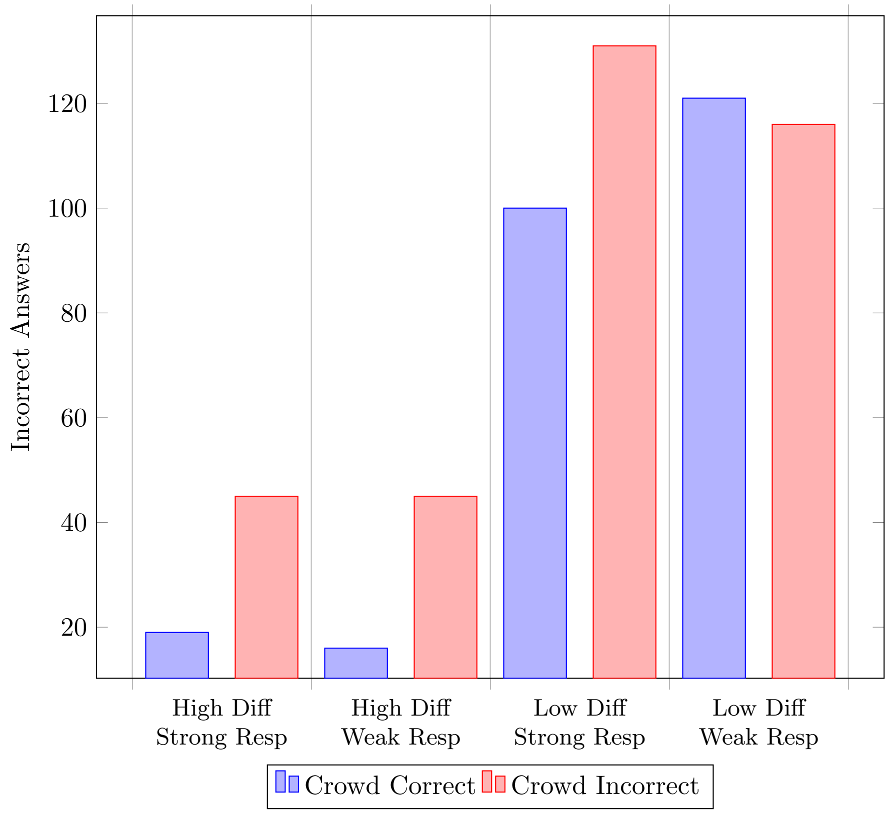

Figure 3.2: *Bar Chart Showing Distribution of Incorrect Answers*

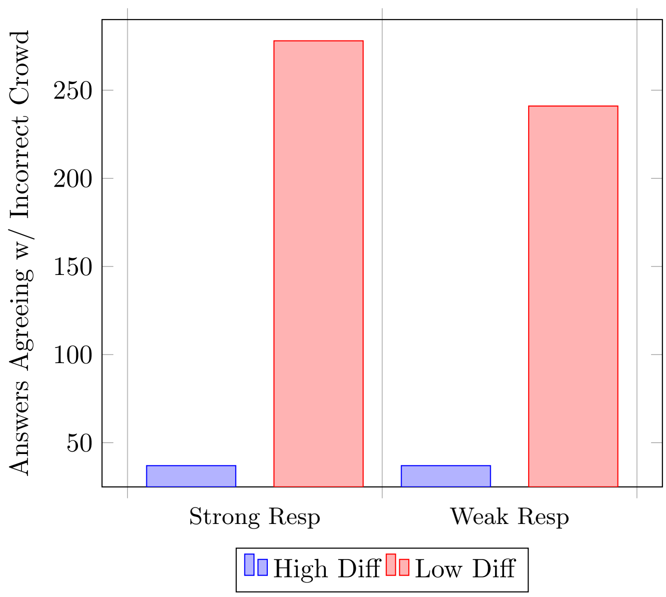

Figure 3.3: *Bar Chart Showing Distribution of Answers that Agreed with an Incorrect Crowd*

to examine the relation between the type of crowd response (3) and the number of incorrect answers. The relation between these variables was significant, $\chi^2(3, N = 93) = 17.88, p = .05$, supporting the hypothesis H. Incorrect answers were more likely when the crowd response was incorrect.

The procedure for conducting a χ^2 test is described as follows:

- The observed frequencies, i.e., the actual data which has been collected, is displayed in a contingency table (see table 3.2).
- The expected frequencies, i.e., the values you expect to find in the contingency table if *no association* exists between the variables, are calculated and displayed in a second contingency table (see table 3.3).
- The χ^2 statistic is calculated using a simple formula applied to the values in these two contingency tables: $\chi^2 = \sum \frac{(O-E)^2}{E}$ where O and E represents the observed value, and expected value respectively.
- The significance of this statistic is obtained by comparing it to a *critical value*, which itself is obtained in the χ^2 table [22], using the degrees of freedom $df = (n-1) \times (m-1)$ for the contingency table, where n and m represent the number of rows and columns in the table respectively.

Chapter 4

Evaluation

4.1 Experiment Evaluation

This study hypothesised that the participants would be more likely to give incorrect answers when the crowd was incorrect (3). The results support this hypothesis, and thus, we can reasonably conclude that users of an online quiz can be persuaded to agree with a perceived majority opinion, even if contradicts their own judgement, answering the core research question of this study.

Given that this study produced a conformity effect, with a relatively simple online quiz, one could argue that conformity is likely to occur in many places online, e.g., on social media (researching conformity in a comments section would support this), or live polls like the one shown in Figure 4.1.

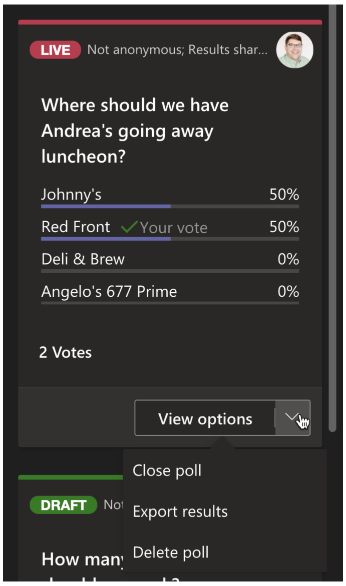

Figure 4.1: Screenshot of a Microsoft Teams Live Poll

It was expected that not all of the users who visited the quiz would go onto to complete all of the questions, however, 93 of the 152 users created completed the quiz (61.2%, 2dp). The original target for the number of participants was 50; therefore, obtaining a sample size of 93 can be considered an achievement, given that higher sample sizes give a better chance of detecting a difference between groups (Whitley and Ball, 2002, [25]).

The results establish that there is a conformity effect in an abstract online setting, although, in line with similar research (Cinnirella and Green, 2007, [7]), conformity was much lower compared to face-to-face (f-t-f) Asch-style experiments (Asch, 1956 [3]; Larsen, 1974 [14]). The error rate of 8% was also lower than the f-t-f experiments from previous literature, which typically had an error rate of one-third. Asch's written response variation (Asch, 1956, [3]), discussed in the related work, had an error rate of 12.5% which is much closer to the 8% rate found in this study. One could argue that this demonstrates that the mode of answering has a big impact on conformity; in an online environment, we can predict that lower social presence reduces conformity. Despite the lower levels of conformity, statistical analysis (3.2) of the results showed that participants were still more likely to give incorrect answers when the crowd was incorrect (3), and the data showed that participants agreed with an incorrect crowd more often when there was a low difference between the lines (1), i.e., when the line judgement tasks were more difficult. There were also more incorrect answers when the crowd was incorrect (3) in almost every category (see Figure 3.2).

Overall, 86% of the participants gave at least one incorrect answer, compared to 75% in Asch's original study [3], and 78% in a similar study (Wijenayake, Berkel, 2020, [26]). This is likely due to the fact that half of the line judgement tasks presented in this study could be considered 'difficult'; that is, not all of the questions were "simple and clear" like they were in the original study. The online quiz did not collect any of the subjects' background information, and therefore contextual factors were not a part of this study, unlike others (Wijenayake, Berkel, 2020, [26]).

Another important difference compared to the f-t-f studies is the lack of an experimenter. Asch described the role of an experimenter as a "third force" in his experiments. Due to the nature of this online study, the presence of an experimenter would have been not only unnecessary, but also counter-intuitive; this experiment aimed to investigate how conformity could *naturally* occur online, and an experimenter was not considered a natural feature of this environment.

Following from the review of related work (1.1), one can argue that the reasons for the lower levels of conformity in this online study, compared to f-t-f studies could be due to the following factors:

- **Reduced social presence:** because the users in this quiz remained anonymous, and they didn't have to announce their judgement *publicly* in front of a physical opposing group, one can assume that the pressure to conform was significantly decreased compared to the f-t-f studies. This is supported by Asch's written response variation which significantly reduced conformity.
- **The method of answering:** in this experiment, the users gave their answers using radio buttons—a common graphical control element—however, in most of Asch's original experiment trials, participants declared their answers to an experimenter *in the presence of a physical group*. It is reasonable to assume that this factor alone increased the pressure that the participant felt in defying an incorrect majority group; therefore, one can expect conformity to decrease as soon as the publicity of the judgements are removed.
- **Presentation of the group judgement:** this experiment aimed to represent a group judgement by presenting a graphical representation of fake data titled "How others answered". This is similar to Cinnirella and Green's study [7] which presented the group judgements as a bar chart titled "See how others have answered have answered this question...". However, one could argue that people are much less likely to trust this abstract representation of a group, compared to an actual f-t-f group where the channels of communication are much greater, and perhaps more powerful too, e.g., nonverbal communication [12]. Trust in the validity of the group judgements could be a big factor in the likelihood to conform. Additionally, Asch found that the size of the majority was a key factor in his experiments (Asch, 1956, [3]); conformity was lower with only one acting participant, compared a majority size of three which greatly increased conformity. In this study, there was no indication of a majority size; only a suggestion of the distribution of answers among the fictitious previous participants which could account for the findings.

4.1.1 Future Research

It is important that designers of software systems that have user-user interaction understand how conformity manifests in online behaviour; based on these considerations, future research is needed that further investigates the nature of online conformity. Here are some suggestions:

- Investigate conformity in online groups using an Asch-style line judgement task, but instead of graphically presenting the group judgements, introduce a *comments section* where there are other (fake) users doing the quiz *at the same time* as the participant. In order to investigate the effect of increasing social presence on online conformity, one group of participants could remain anonymous users, e.g., "anonymousduck123", whereas another group of participants would have to create a profile at the start of the quiz with their name and photograph.

- We could further attempt to increase social presence by convincing the participant that they are in a voice call with *'other participants'*, who are actors. On some of the questions, the *'other participants'* would unanimously give incorrect judgements, just like the original Asch experiment [3].
- It would be interesting to test if there is a conformity effect on a polarising judgement task, e.g., a *"Yanny or Laurel"* [28] style auditory illusion where the participant must select an option for which sound they hear from an audio recording.
- In order to investigate conformity online in a political context—relevant to the current questions surrounding echo chambers on social media—the participant is placed in a fake scenario: there are two tribes battling for control in some imaginary land (aiming to mimic a polarised political situation). One group of participants are exposed to social media posts in favour of one tribe; the other group are exposed to posts in favour of the other tribe. At the end, the participant must select which tribe they think should have control over the land.

4.2 Software Evaluation

In this section, we will evaluate the effectiveness of the online quiz created to run this study by revisiting the functional and non-functional requirements defined in section 2.3.1.

4.2.1 Participant Functional Requirements

Requirement	**Met (Y/N)**	**Comments**
...be registered as a user after I visit the quiz website and start the questions	Y	Created by `UserForm`
...view and answer the quiz questions	Y	Implemented by `QuestionChoiceForm` and `QuestionFormView`
...view data for *"How others answered"* before I answer a question	Y	This data was presented using progress bars in the `QuestionFormView`
...be updated on my progress as I complete the quiz, and when I finish the quiz	Y	Implemented by `InfoView`

4.2.2 Experimenter Functional Requirements

Requirement	Met (Y/N)	Comments
...create, edit, and delete questions	Y	Functionality already provided by Django's built in admin panel
...create, edit, and delete choices corresponding to a given question	Y	Functionality already provided by Django's built in admin panel
...create and edit data for "How others answered"	Y	Functionality already provided by Django's built in admin panel
...view and collect answers	Y	Implemented using a custom Django command called `results`

4.2.3 Non-functional Requirements

Requirement	Met (Y/N)	Comments
...load as quickly as possible	Y	`QuestionFormView` only had one 1.3MB image each
...involve as few interactions with the user interface as possible.	Y	Maximum of two interactions per page (`QuestionFormView`)
...work intuitively on as many devices as possible	Y	Use of the Bootstrap front-end library ensured that the application was responsive to many different screen sizes
...store each user's answers	Y	Answers were stored in an `ArrayField` for each `User` object
...present the questions in a random order	Y	An algorithm was used to retrieve the questions in a random order

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