APU Mobile Voting System (APUMVS)

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Abstract—The APU Voting System is a system that is aimed at improving the student's convenience when it comes to making a big group decision. The issue that most people faced when talking about a general voting system is the inconvenience of needing to be at a certain location at a specified time as for some, they might be too busy to participate or for those who are disabled which makes it even harder for them to participate. The APU voting system will be developed on the Android Studio IDE while Firebase would be used to authenticate the user and store all relevant data. After developing, the APU Voting system, it can be said that with more time the system can include more features and also more security features that would ensure that this system is able to be fully functional and also secure.

Keywords—APU, Mobile Voting System, Activity Diagram, Log in, Cast Vote

I. INTRODUCTION

With the advancement of smartphone technologies, smartphones have been the centre of our lifestyle with applications that are able to assist in everybody's lifestyle like for example, navigation systems, banking, shopping etc. Smartphone technology in terms of internal specification has also improved so much that it is one day able to replace a user's Personal Computer. So, a "Mobile Voting System" might not be too far fetch as security features are ever evolving and the reliance of smartphones by users are ever increasing. The use of modern security features allows a voting system to be much more secure compare to those that have been conceptualised years ago and with the centralisation of data being stored allows much more convenience if any users were to retrieve those data. The main issue of implementing a "Mobile Voting System" is how user data are being handle. A few requirements that a voting system must meet is voter's privacy, eligibility, uniqueness, fairness, no-coercion, accuracy, receipt-freeness and individual verifiability [1]. By having a "Mobile Voting System" for Asia Pacific University students to use, allows a more streamline voting system that APU is able to control while allowing students in societies to manage those data's and make decisions based on it.

In today's society, people are always on the go and mobile phones are getting more accessible as time goes by. During an election period, all residents of a country would need to vote on a political figure and for some it might be too much of a hassle as they might be in a different country or even for some who are disabled. This issue may decrease the number of participants due to their inabilities to make it to the voting venue. A survey that was done by [2] have found that 49% of respondents have felt the frustrations mostly from problems that are related to congestions such as the long queues. As our

mobile phones starts having hardware implementations of biometric technologies such as fingerprint scanner, facial recognition and so on, having a method of voting with our mobile phone might actually be feasible as it might help with decreasing the number of frauds by having a more secure verification system compared to using traditional passwords as in 2017 Verizon's DBIR, 81% of breaches appears to be made by the use of stolen or weak passwords and based on research made by Conroy which found that majority of consumers are using a limited number of combination for their password and username for their accounts [3]. Although the breaches are able to happen due to having passwords authentication but passwords authentication have a wider spread of use and it is up to the user to enforce them by creating stronger passwords by adding in special characters or by not using the same password for multiple different sites. By implementing a "Mobile Voting System", those who are unable to make it might be able to participate without physically needing to be at the voting venue. Though another issue that can be seen is that for some a Mobile Voting system might be harder to accept due to privacy and security concerns but with a Mobile Voting system, it can solve some of the issues that span from the current voting system. With the current voting system, fraud is quite prevalent as ballots can be manipulated in many ways such as electorate manipulation, manipulation of demography, disenfranchisement etc. Any type of fraud can cause an immeasurable amount of damage to a democratic country. The privacy and security concerns that the people may have could also lend a hand in the people's trust in a Mobile Voting system as some may fear that data breach and leak information may compromise their position in society.

The main aim for this project is to provide a streamline method of voting for Asia Pacific University students that would assist in decision making. The main issue why a mobile voting system has not been implemented into mainstream yet is because of the security issues that may arise from it. A security issue poses a large threat as a successful attack may result in a large impact to the people and surroundings [4]. The risk of data breaches and the impact it may have towards those targeted are just too high to be justified using a mobile voting system where everything and everyone is connected. With that said many smaller mobile voting systems has been used in making small polls and helping users in decision making. A voting system is also needed to adhere to a few requirements such as voter's privacy, eligibility, uniqueness, fairness, no-coercion, accuracy, receipt-freeness and individual verifiability [1]. These requirements ensure that an effective and secure voting system is developed.

A.   Voting System Security

There are also encryptions that are needed to ensure all data are secure and cannot be easily extracted and used by any external entity. With a Mobile Voting System, what has been proposed by Lopez, Lourdes, Asdrubal Lopez, Javier Silva and Miguel Leon, by using an Android Operating system, they are able to utilized the cryptography tools which has a cryptography library that includes some schemes such as Elliptic curves and bilinear pairings, Special map to point function, Short signature scheme and blind signature scheme [5]. Other than the security requirements and encryptions, biometrics is also a viable option for complementing the security requirements and increasing the security. By 2018, almost every smartphone available has at least a fingerprint scanner and for the more expensive ones there are face recognition and even an iris scanner. But the security concern for fingerprint scanner is that if it were to be intercepted during communication or retrieved from an endpoint, another user will be able to fake their identity and use fake biometrics to disguise themselves as that person, so good security schemes are important to protect biometric data like HTTPS and AES [6]. With how encryption has evolved over the years biometrics data can be stored securely with different companies promoting security, one such company is Verisign which provides Secure Socket Layer (SSL) certificates so that data being move around the internet stays encrypted and will be harder to crack. With security schemes stated user privacy can stay as secure as possible. Even though privacy is a very important aspect of a user, in multiple countries that uses the self-regulatory policy, users are to be responsible about their own privacy and also the privacy and security process [7]. The reason for this policy to exist is to support consumer in making their own effort into protecting their data by gaining the knowledge of online security and steps needed to be taken to ensure that their personal data are secure.

B.   Advantages of e-voting

In terms of practicality , an e-voting systems can offer various advantages over manual voting, one of them is cost, cost can be reduced by reducing the number of materials used in printing and distributing while the next point is increasing participation through the more convenient smartphones by having voters participate remotely from any location. Another point is greater speed and accuracy as having a computer process votes is much quicker and more reliable by being able to reduce the number of miss votes. Fourth is greater accessibility for the disabled as the interface and features are built to assist them. Lastly, flexibility like multiple language and design support [8]. With these advantages stated, a mobile voting system can be seen as an improve version of the current E-voting system and also allows a wider range of participants which will increase the accuracy of the voting result. [10] have stated that mobile phone services have become a mass market commodity where more people are using mobile phones worldwide and has become one of the most adopted means of communication in most countries either developing or developed. According to Telecommunication Regulatory Commission [10], there were 419533 fixed telephone lines and 7758968 mobile lines in Jordan. Although the number extracted is from Jordan, the numbers given shows the number of people that rely more on their mobile phones compare to land lines and that nearly everybody has a mobile phone. These numbers can also be roughly translated to other countries as almost everybody possess at least one mobile phone. Another point that can be said is from Mulliah and Stroulia claims, that reinforce how mobile devices are becoming much more well-equipped compare to the time before, they claimed that "Mobile devices are becoming increasingly powerful and accessible as wireless networks cover most of our daily environment and a variety of software frameworks" [11].

II.   SYSTEM ARCHITECTURE

Figure 1. shows the use case for the APU Mobile Voting system. Based on the use case diagram, the system would include 7 elements which consist of "View Result", "Create Voting Session", "Access Code Verification", "Cast Vote", "Log In", "View all existing Voting Sessions" and "Delete Voting Session".
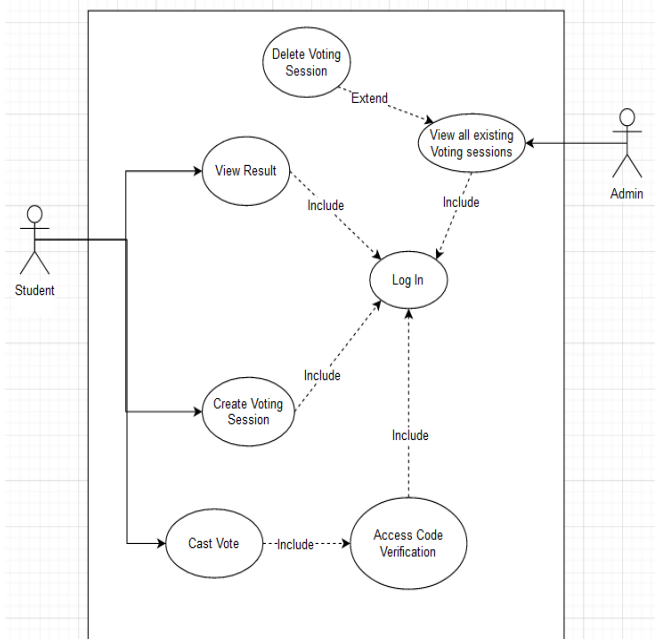

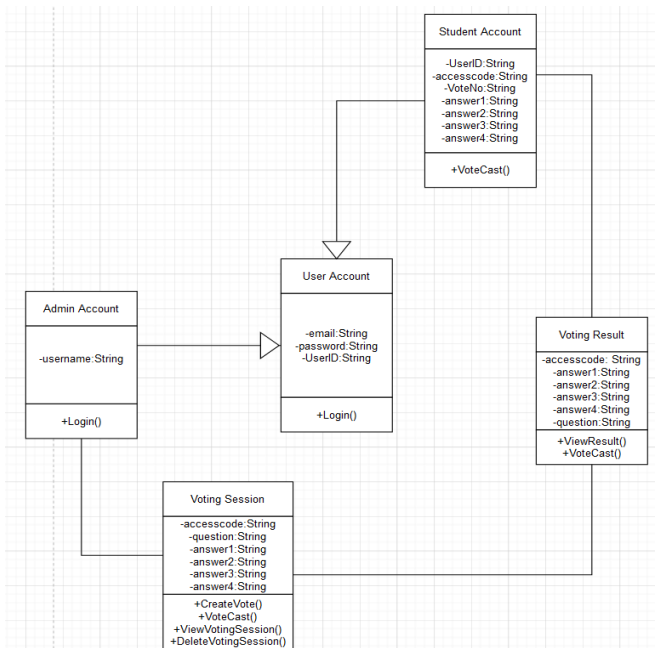Fig. 1.   the use case for the APU Mobile Voting system
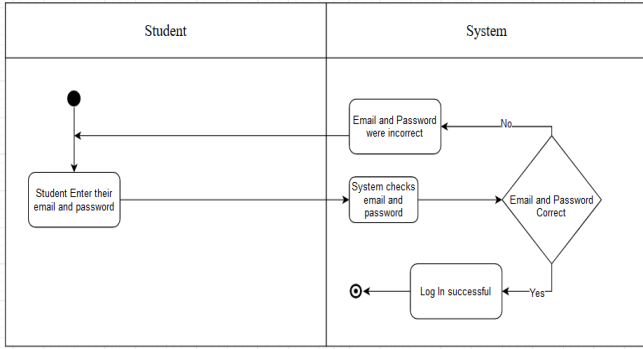

Fig. 2.   Class Diagram

1. Activity diagram

Fig. 3.   Log in Activity

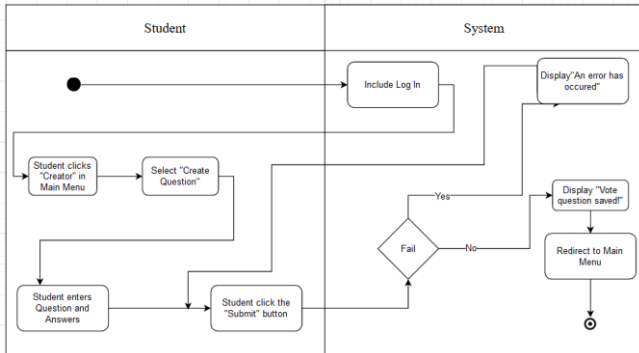## A. Create Vote Question

Fig. 4.   Create Vote Question Activity
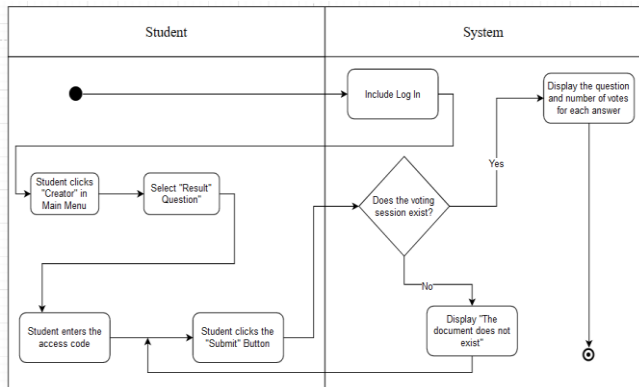
B. View Vote Result

Fig. 5.   View Vote Result Activity

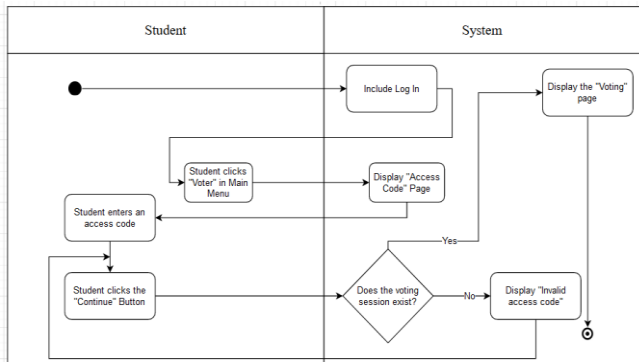## C. Display the Voting Session

Fig. 6.   Display the Voting Session Activity
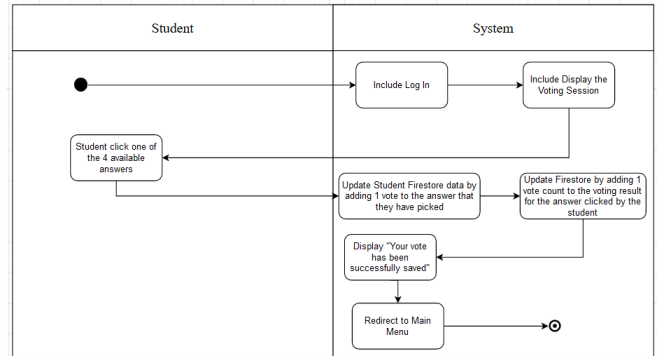
D. Cast Vote

Fig. 7.   Cast Vote Activity
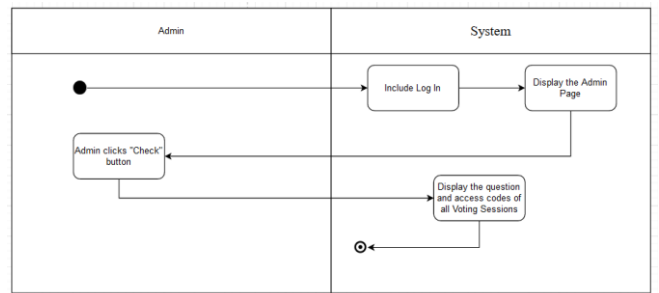
E. View all existing Voting Sessions Activity

Fig. 8.   View all existing Voting Sessions Activity

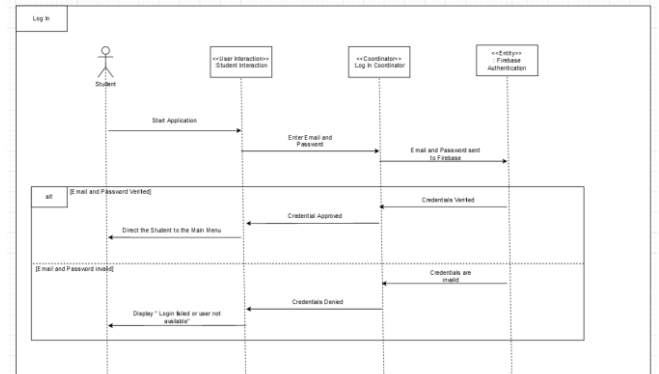## 2. Sequence diagram

A. Log In

Fig. 9.   Log in Sequence

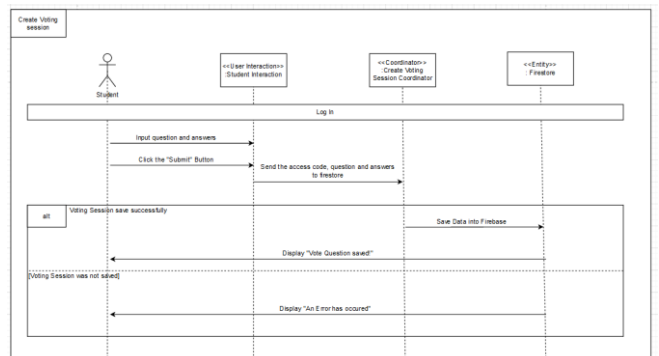## B. Create Voting Session

Fig. 10. Create Voting Session Sequence
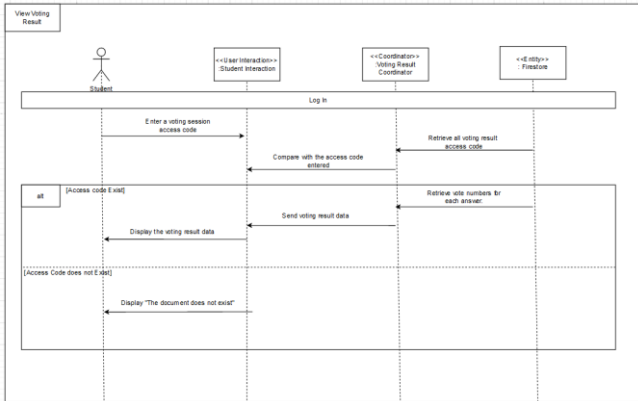
C.   View Voting Result

Fig. 11. View Voting Result Sequence
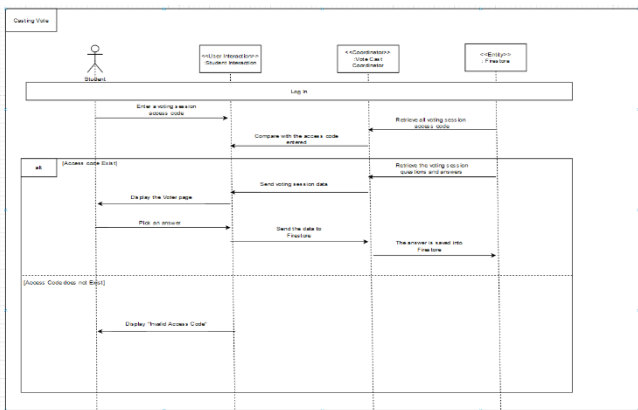
D.   Casting Votes

Fig. 12. Casting Votes Sequence

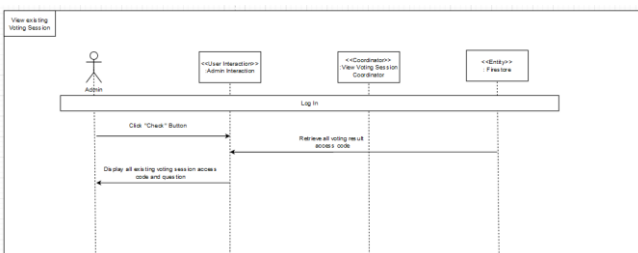## E.   View all existing Voting Sessions

Fig. 13. All Voting Sessions Sequence
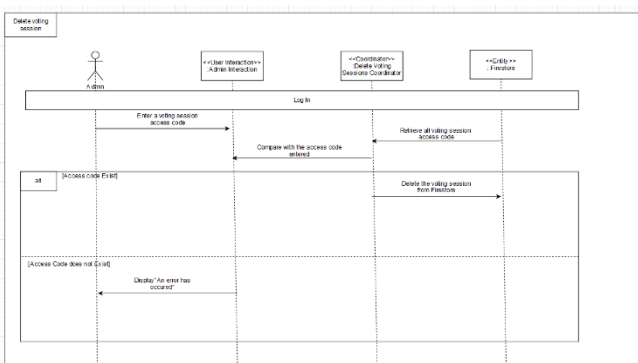
F.   Delete Voting Session Sequence

Fig. 14. Delete Voting Session Sequence
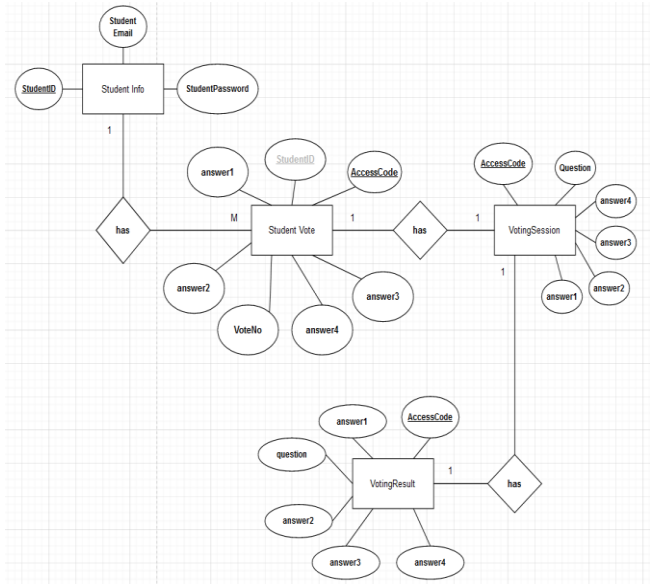
G.   Entity Relationship Diagram(ERD)

Fig. 15. ERD for the APU Mobile Voting System

III.   TEST PLAN FOR UNIT TESTING

The test plan for the APU Mobile Voting system would be made to identify the test cases which are the features of the system and then identify the expected result of the system when it has performed that the specified tasks. This would allow the developers to identify if any of the features are performing out of the expected results set and would be deemed as a bug and should be investigated and fixed. The test plan would have a table to help register the test that should be done to the APU Mobile Voting system.

TABLE I.   TEST PLAN

No.	Test Case	Description	Expected Result	Actual Result
Log In				
1	Correct email and password	The email and password entered are from a registered student.	The user would be directed to the main menu.	
2	Email and password field are left empty	The email and password field are left empty	A toast message will display "Please Enter your Email and Password"	
3	Incorrect email and password	The email and password entered are not from a registered user	A toast message will display "Login Failed or User not Available"	
4	Enter Admin username and password	The Admin username and password entered.	The user would be directed to the Admin page.	
Create Voting Session				
1	question text field is left empty	No data is being inserted into the Question field.	A toast message will display "Please do not leave the Question box or the first two answers empty!"	
2	All answer text field	No data are inserted into the four-answer text field	A toast message will display "Please do not	

	are left empty		leave the Question box or the first two answers empty!"	
3	All question and answer text field are filled up	All answer and question text field have data inserted	A toast message will display "Vote question saved!" and redirect the user back to the Main Menu	
View Voting Result				
1	No access code is entered	No access code was entered in the access code text field	A toast message will display "The access code field is empty"	
2	Invalid access code is entered	An access code to a non-existent voting session is entered	A toast message will display "The document does not exist"	
3	A valid access code is entered	An access code from an existing voting session is entered	The question and number of votes that each answer has accumulated would be displayed to the user	
Vote Casting				
1	No access code is entered	No access code was entered in the access code text field	A toast message will display "Access code field is empty"	
2	Invalid access code is entered	An access code to a non-existent voting session is entered	A toast message will display "Invalid Access code"	
3	A valid access code is entered	An access code from an existing voting session is entered	It would bring the user to the Voting page	
4	Clicking an invalid answer button	Clicking on the answer button with no value	The button would be disabled, and no interaction can be made to the button	
5	Clicking a valid answer button	Clicking on a button with values in it	A toast message will display "Your vote has been successfully saved" and the vote will be stored into the Firestore database	
View Voting Sessions				
1	Click the "Check" button	The "Check" button is clicked to retrieve all existing voting sessions from the Firestore database	The system would display all voting session that has been created	
Delete Voting Session				
1	No access code is entered	The access code text field is left empty	A toast message will display "Access code field needs to be filled up!"	
2	Invalid access code was entered	The access code entered is from a non-existent voting session.	A toast message will display "Voting Session cannot be deleted or does not exist"	
3	Valid access code was entered	The access code entered was from an existing voting session	A toast message will display "Voting Session has been deleted" and the vote will be deleted from the Firestore database	

IV.   IMPLEMENTATION

The Log in page is where the students would need to authenticate themselves as to ensure that those students are who they say they are by logging in with their email and password. The system would use the students email and password that they have submitted and verify it with the Firebase Authentication API as for this prototype the Firebase Authentication API is used in authenticating the students. Once Firebase Authentication has found that the user exist it would direct them to the Main Menu of the APU Mobile Voting system while also saving their account in their local device where the students would not need to constantly log in every time they open the application. The Admin is also able to log in under a special username and password to access the Admin page. The Main Menu page is where the students would be directed to after successfully logging into the APU Mobile Voting system where they would have the choice of Signing Out, going to the Creator Page or going to the Voter Page. The Creator Menu page is where the students would be directed to after clicking the "Creator" button in the Main Menu page where they would have the choice of Create Question, View Results or going back to the Main Menu Page.

For the Creating Voting Session page is where the students are able to create a voting session by inserting the Question and a maximum of 4 Answers. For this version, the access code will be a 4 digit randomly generated code which will be used to allow other students to join the session and cast their votes. The question cannot be left empty while at least 2 answers are required to be filled up before saving it into the Firestore database. The View Result page is where students are able to view the vote results. To view the results the access code would need to be inserted into the access code text field which would be used by the system to retrieve the correct voting session result. The result page would display the question and the number of votes each answer has accumulated.
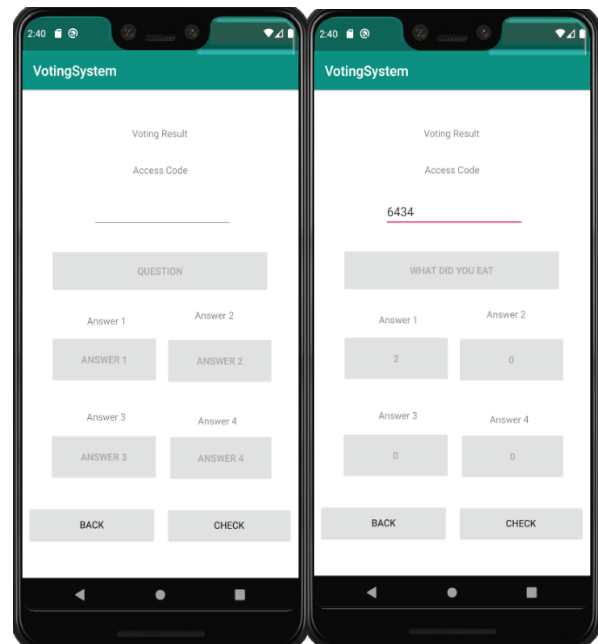

Fig. 16. View Result page

The Access Code page is where the student would need to enter their access code so that they are able to enter the voting session. The student would just need to enter a valid access

code and click the "Continue" button which would then redirect them to the corresponding voting session. The Access Code page would also check if the voting session exist and has the user access this voting session before. The Voting page is where the students would able to cast their votes. Each student would only be able to vote once per voting session and the vote made by the student would be logged in the Firestore database while another collection within the Firestore database is made to calculate and store the number of votes for each answer which would then be able to be retrieve at the View Result page. The Admin page would only be accessible to the admin with their specialised username and password. In the Admin page, the admin is able to check all existing voting sessions that was created and delete them by entering the voting session's access code and clicking the "Delete" which would then delete the document from the Firestore database.

V. SYSTEM VALIDATION

A. Unit Testing

TABLE II.   UNIT TESTING

No.	Test Case	Description	Expected Result	Actual Result
1	Correct email and password	The email and password entered are from a registered student.	The user would be directed to the main menu.	The user would be directed to the main menu.
2	Email and password field are left empty	The email and password field are left empty	A toast message will display "Please Enter your Email and Password"	A toast message will display "Please Enter your Email and Password"
3	Incorrect email and password	The email and password entered are not from a registered user	A toast message will display "Login Failed or User not Available"	A toast message will display "Login Failed or User not Available"
4	Enter Admin username and password	The Admin username and password entered.	The user would be directed to the Admin page.	The user would be directed to the Admin page.

B. Create Voting Session

TABLE III.   CREAT VOTING SESSION

No.	Test Case	Description	Expected Result	Actual Result
1	question text field is left empty	No data is being inserted into the Question field.	A toast message will display "Please do not leave the Question box or the first two answers empty!"	A toast message will display "Please do not leave the Question box or the first two answers empty!"
2	All answer text field are left empty	No data are inserted into the four-answer text field	A toast message will display "Please do not leave the	A toast message will display "Please do not leave the Question box
3	All question and answer text field are filled up	All answer and question text field have data inserted	A toast message will display "Vote question saved!" and redirect the user back to the Main Menu	A toast message will display "Vote question saved!" and redirect the user back to the Main Menu

(continued) | | | Question box or the first two answers empty!" | or the first two answers empty!" |

C. View Voting Result

TABLE IV.   VIEW VORING RESULTS

No.	Test Case	Description	Expected Result	Actual Result
1	No access code is entered	No access code was entered in the access code text field	A toast message will display "The access code field is empty"	A toast message will display "The access code field is empty"
2	Invalid access code is entered	An access code to a non-existent voting session is entered	A toast message will display "The document does not exist"	A toast message will display "The document does not exist"
3	A valid access code is entered	An access code from an existing voting session is entered	The question and number of votes that each answer has accumulated would be displayed to the user	The question and number of votes that each answer has accumulated would be displayed to the user

D. Vote Casting

TABLE V.   VOTE CASTING

No.	Test Case	Description	Expected Result	Actual Result
1	No access code is entered	No access code was entered in the access code text field	A toast message will display "Access code field is empty"	A toast message will display "Access code field is empty"
2	Invalid access code is entered	An access code to a non-existent voting session is entered	A toast message will display "Invalid Access code"	A toast message will display "Invalid Access code"
3	A valid access code is entered	An access code from an existing voting session is entered	It would bring the user to the Voting page	It would bring the user to the Voting page
4	Clicking an invalid answer button	Clicking on the answer button with no value	The button would be disabled, and no interaction can be made to the button	The button would be disabled, and no interaction can be made to the button

| 5 | Clicking a valid answer button | Clicking on a button with values in it | A toast message will display "Your vote has been successfully saved" and the vote will be stored into the Firestore database | A toast message will display "Your vote has been successfully saved" and the vote will be stored into the Firestore database |

E.   View Voting Session

TABLE VI.   VIEW VOTING SESSION

No.	Test Case	Description	Expected Result	Actual Result
1	Click the "Check" button	The "Check" button is clicked to retrieve all existing voting sessions from the Firestore database	The system would display all voting session that has been created	The system would display all voting session that has been created

VI.   DISCUSSION

At the end of the project, the APU Mobile Voting system was able to solve the problem of providing the user the convenience of being able to participate in the voting process no matter where they are, this is important as this is the main idea of the APU Mobile Voting system existing. The limitations that the developer have found when developing this system is that at the moment the APU Mobile Voting system is unable to identify the voter and the creator of the voting session while in terms of security, Firebase Authentication deals with user authentication while Firestore would be secure based on the security rules that the developer would set. If possible, in the future, the enhancement that the developer would like to make would be to allow the system to keep track of users who are the creator of the voting session, add more security features such as SSL etc, and also the ability to add more possible answers to the voting session as now it is only limited to 4 at the moment. If given the time, the developer would add more security features in the system such as SSL, Encryptions etc while also implementing fingerprint or facial scanner to logged into the system. The computational challenges that the developer have found was that since the developer has not work with Android Studio before there was much learning and understanding on how to design the pages/activity while also trying to figure out the special syntax that are available to Android Studio and Firebase.

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