Bachelor of Science in Computer Science
May 2021

Comparative study of Canvas and Google Classroom Learning Management Systems using usability heuristics

Ananya Reddivari
Monica Gattupalli

Faculty of Computing, Blekinge Institute of Technology, 371 79 Karlskrona, Sweden

This thesis is submitted to the Faculty of Computing at Blekinge Institute of Technology in partial fulfilment of the requirements for the degree of Bachelor of Science in Computer Science. The thesis is equivalent to 10 weeks of full-time studies.

The authors declare that they are the sole authors of this thesis and that they have not used any sources other than those listed in the bibliography and identified as references. They further declare that they have not submitted this thesis at any other institution to obtain a degree.

Contact Information:
Author(s):
Ananya Reddivari
E-mail: anrd20@student.bth.se

Monica Gattupalli
E-mail: moga20@student.bth.se

University advisor:
Siril Yella, Associate Professor
Department of Computer Science and Engineering

Faculty of Computing
Blekinge Institute of Technology
SE-371 79 Karlskrona, Sweden

Internet : www.bth.se
Phone : +46 455 38 50 00
Fax : +46 455 38 50 57

ABSTRACT

Learning management systems (LMS) are playing a key role in the education systems. Education institutions are using LMS platforms to make the communication and collaboration between teacher and student easier, which inspired this study to measure the user satisfaction in using the different platforms applying usability heuristics. The survey evaluation is used to measure user satisfaction.

The main objective of this study is to measure the user experience while using interactive interfaces. The selected LMS platforms for the research are canvas and google classroom.

The experiment involves creating dummy course in the selected LMS platforms, fabricating the course assignments, gathering the users, and enrolling them into the platforms. The enrolled set of users will complete the assignments and take a survey on their experience with the platforms. Time taken by each user to complete assignments and survey are recorded and collected off-time comments.

The responses of the survey are collected and graphically will interpret each question. Statistical attributes like populated variance and standard deviation are calculated for measuring the user experiences, and they are tabulated for the LMS platforms.

User satisfaction on the canvas and google classroom was measured using usability heuristics. From the survey results, we can conclude that the canvas web application obeys all the usability heuristics, whereas the google classroom obeys only seven of the usability heuristics.

Keywords: Canvas, E-learning platforms, Google classroom, Interactive interfaces, Survey evaluation

ACKNOWLEDGMENTS

We would like to express our sincere gratitude towards our supervisor at BTH, Siril Yella, for guidance and support for completing the thesis. Special thanks to our classmates who cooperated with us to do the survey in the thesis. We would like to thank our families for their moral support. We would also extend our gratitude to all the people who helped us directly or indirectly in completing this thesis.

Authors
Ananya Reddivari
Monica Gattupalli

CONTENTS

ABSTRACT ..... **III**

ACKNOWLEDGMENTS ..... **IV**

CONTENTS ..... **V**

LIST OF FIGURES ..... **VI**

LIST OF TABLES ..... **VII**

LIST OF ACRONYMS ..... **VIII**

1 INTRODUCTION **1**

1.1 AIMS AND OBJECTIVES 2
1.2 RESEARCH QUESTIONS 2
1.3 BACKGROUND: 3
1.4 SCOPE 6
1.5 OUTLINE: 6

2 RELATED WORK **7**

3 METHOD **9**

3.1 INTRODUCING DUMMY COURSES IN SELECTED LMS 9
3.2 SURVEY EVALUATION 15
3.3 RESPONDENTS 15

4 DATA COLLECTION **17**

4.1 SURVEY QUESTIONNAIRE 17
4.2 MAPPING THE USABILITY HEURISTICS WITH THE SURVEY QUESTIONS 22

5 RESULTS AND ANALYSIS **23**

6 DISCUSSION **31**

7 CONCLUSION AND FUTURE WORK **36**

7.1 CONCLUSION 36
7.2 FUTURE WORK 36

8 REFERENCES **2**

APPENDIX **4**

SURVEY QUESTION 5- WITH RESPECT TO THE ASSIGNMENT 4 9
SURVEY QUESTION 7- REGARDING THE ASSIGNMENT 6 9

LIST OF FIGURES

Figure 1: Canvas login page 10
Figure 2: Click on the marked button 11
Figure 3: Click on 'I'M A STUDENT' 11
Figure 4: Sign up using the provided reference 12
Figure 5: After signing up the dashboard appears 12
Figure 6: Click on the 3*3 grid 13
Figure 7: Select Classroom in the products 13
Figure 8: Click on '+' and Join class 14
Figure 9: Write the reference provided to join the class 14
Figure 10: The dashboard after joining the class 15
Figure 11: Survey question 1 17
Figure 12: Survey question 2 17
Figure 13: Survey question 3 18
Figure 14: Survey question 4 18
Figure 15: Survey question 5 18
Figure 16: Survey question 6 19
Figure 17: survey question 7 19
Figure 18: Survey question 8 19
Figure 19: Survey question 9 20
Figure 20: Survey question 10 20
Figure 21: Survey question 11 20
Figure 22: Survey question12 21
Figure 23: Response of survey question 1 23
Figure 24: Response of survey question 2 23
Figure 25: Response of survey question 3 24
Figure 26: Response of survey question 4 24
Figure 27: Response of survey question 5 25
Figure 28: Response of survey question 6 25
Figure 29: Response of survey question 7 26
Figure 30: Response of survey question 8 26
Figure 31: Response of survey question 9 27
Figure 32: Response of survey question 10 27
Figure 33: Response of survey question 11 28
Figure 34: Response of survey question 12 29

LIST OF TABLES

Table 1: Mapping of survey question with usability heuristics 22
Table 2: Likert scale of survey question 11 28
Table 3:Likert scale values of survey question-12 29
Table 4: Variance and Standard deviation of LMS platforms 29

LIST OF ACRONYMS

LMS- Learning Management System
HCI- Human Computer Interface

1 INTRODUCTION

The credibility of an interactive system in any marketplace depends on the satisfaction of the user. User's satisfaction can be measured using usability techniques. *Usability* can be defined as user interaction with the product or system and can be accurately measured by assessing user performance, satisfaction, and acceptability [1]. The technique used in this thesis for comparison is usability heuristics. Usability heuristics are used to identify the usability problems in the user interface design process [2].

In 1994, Jakob Nielsen compared several sets of usability heuristics with a database of existing usability problems drawn from various projects to determine what heuristics best explain actual usability problems[3]. Nelson further derived the ten usability heuristics from the experiment as explained in the section 1.3 under usability heuristics.

Nowadays, LMSs are playing an essential role in education. An LMS processes, stores, and provides educational material and support administration and communication associated with teaching and learning and saves time and money [2]. Different LMS platforms are present, like Fronter, Blackboard, Moodle, Canvas, and Google classroom.

The LMS platforms chosen for comparison are the canvas web application and google classroom web application. The free versions of canvas and google classroom are selected to perform the formal experiment. The results of the experiment do not apply to the paid versions of the platforms.

The LMS platforms like canvas, google classroom, and many others have become essential in today's world because of the following reasons:

- Using the LMS provides improved communication and collaboration between the teachers and the students[3].
- The users have immediate access to the contents of the course.
- The users can update the contents, and it will reach any number of registered users immediately.
- These LMS platforms allow the educational institutions and teachers to efficiently manage the courses according to their requirements [3].

Educational institutions and some businesses save money and time using LMSs [2]. Below are the details about the commonly used and selected LMS platforms for the experiment.

- **Canvas:**
  Canvas is a web-based learning management system. Educational institutes, teachers and students use it to manage online learning and access course materials. Canvas includes a variety of customizable options for course creation and management tools, internal communicational tools. The customizable option in canvas creates a unique way of teaching and learning experiences. Instructors may create and share content using assignments, discussions, modules, quizzes, and pages. Collaborations, conferences, and groups are chosen to build a collaborative learning experience. They can also facilitate real-time course interactions using chat, Announcements as well as the calendar and syllabus. Canvas community provides paid version and a free version for users. Canvas is available in web application and mobile application[4].

- **Google classroom:**
  Google Classroom is a web service developed for educational institutes that simplifies creating, distributing, and grading assignments. Google classroom integrates docs, sheets, slides, Gmail and calendar into the platforms to manage teacher and student communication. Students are invited to the classroom through a private code to get logged into the respective course

automatically. Teachers can add and share content using materials, assignments, and quiz assignments. Google calendar and class drive folder are in builds in the interface in which calendar help to keep track of classes and any special events. The class drive helps to store the course material and student work. The classroom supports many different grading schemes. The teacher can monitor the progress of each student on the assignment. Through announcements, two-way communication is established between teacher and student. Google classroom mobile apps are available for iOS and Android users and available as a web application[5].

The main aim of the thesis is to map the usability heuristics to compare the free version of canvas and google classroom and measure user's satisfaction. A survey was conducted with a questionnaire evaluating the platforms with contexts based on the usability heuristics. The respondents' responses were used to conclude which LMS platform gives a better experience to the user.

User experience can be measured using different evaluation methods. One of the evaluation methods is survey evaluation. The survey was conducted through live interviews and zoom calls to the respondents. The survey results were used to evaluate the LMS platforms [6].

1.1 Aims and objectives

The thesis aims to find out which LMS platform among canvas and google classroom obeys the usability heuristics by surveying the users.

The objectives of the thesis are as follows:

- Analyzing the LMS platforms and creating a course with the same set of tasks in the respective platforms.
- Formulating a questionnaire for the survey with aspects relevant to the usability heuristics.
- Selecting a required mixed set of experienced users and acquainting them with the platforms to pose the survey questionnaire.
- From the results of the survey, concluding which LMS obeys the usability heuristics according to the users.

1.2 Research questions

The following are the research questions for the thesis:

1. How important are the LMS platforms like canvas and google classroom have become?

Motivation: The motivation for this research question is to find out how important the LMS platforms have become nowadays. LMS provides interaction between the students and the educational institutions and promotes e-learning. The LMS platforms are scalable according to the user requirement.

2. Which of the LMS gives a better experience to the user according to the usability heuristics within the scope of the study?
Motivation: This research question will be investigated by surveying the users. The results of the respondents will be statistically evaluated, and the conclusions will be drawn from the survey.

1.3 Background:

Usability is the measure of user satisfaction with the interactive interface. For measuring the satisfaction of the user, there are different techniques called usability components, HCI design principles and usability heuristics. In this thesis, usability heuristics are selected for evaluating the LMS platforms. Further is the detailed explanation of the usability heuristics and other techniques to broaden the context for the sake of comparison.

Usability components:

Nielsen divided usability components into five elements, called attributes. They are learnability, efficiency, memorability, errors and satisfaction[7].

- **Learnability**- learnability means that a user must understand how to use the system as quick as possible. If the UI of the interactive system is inclined to a specific user's, it would be difficult for all the users to learn and understand. In interactive design using both icons and text label and action button make learning easier.

- **Efficiency**- Efficiency means how fast a user can perform a task in an interactive system. Interactive system performance can be improved by adding the hidden shortcut for frequently used tasks.

- **Memorability**- this attribute applies to users who already familiar with the interface. It measures how well users can remember the different functions in the interactive interface.

- **Errors**- Facing error while using the interactive system is quite common. Simple errors that are quickly solved by the user but some error which the users do not solve may affect the effectiveness of an interactive interface.

- **Satisfaction**- ultimately depends on how easy to learn and understand the system, how efficient to use the system. Satisfaction can be evaluated through questionnaires.

Usability Heuristics:

Jakob Nielsen derived ten general principles for user interface design called usability heuristics [3].

- **Visibility of the system status**- The users should be notified about the system' through relevant feedback within an ample amount of time.

- **Match between system and the real world-** The design should speak the users' language. Use words, phrases, and concepts familiar to the user, rather than internal jargon. Follow real-world conventions making information appear natural and logical.
- **User control and freedom**- The user needs an emergency exit from any unwanted activity done by mistake. The interactive interface should support undo and redo actions.

- **Consistency and standards**- The interactive interface should maintain the consistency that means different words, actions mean the same thing even after frequents updates of the interface.

- **Error prevention**- rather than giving a good error message preventing that error in the interface improves efficiency and usage. Eliminating the error-prone conditions and activity in the system helps the user while committing the action.

- **Recognition rather than recall**- This principle deals with minimizing the memory load on the user by actions, options visible, and giving the search bar suggestions. The user should memorize the information thoroughly. The interactive interface should provide instructions and suggestions to make the user work easy and increase the efficiency in usage.

- **Flexibility and efficiency of use**- shortcuts, accelerators in interactive interface increase the system's speed of interaction with both experienced and inexperienced users

- **Aesthetic and minimalist design**- This principle concern about the system's design any dialogue box or pop-up box should not contain information, which is irrelevant or rarely needed. Every extra unit of irrelevant information may diminish the exact usages and relative visibility.
- **Help users recognize, diagnose, and recover from errors** – this principle deals with the recovery from the errors. The error message should be expressed in plain language that means it should not have any code language, clearly indicate the problem, and suggest the appropriate solution.

- **Help and documentation**- Even the system is user-friendly or highly efficient, it is necessary to provide help and documentation. Any such information helps the users to refer when they stuck at any point.

HCI design principles [8]**.**

The HCI design principles of usability are as follows:

- **Principle of humanity**- The interface design should provide improved communication and understanding between and human, human and society, human and computer. The human computer interface design should fully consider the human.

- **Principle of safety and stability**- The design should allow the user to use and operate the interface without losing or destroying the user's personal information. The design of the interface should identify the problems ahead and should provide security

- **Principle of Consistency**- The functions, tasks, and icons and interactions of information should be the same even after the frequent updates of the system.

- **Principle of habit**- most of the users operate the interfaces through intuition, so the designer should consider the users habit in the design, adopt menu names and options, and figures with familiar features.
- **Principle of Flexibility**- The interface also should be customized according to the different needs of users.

- **Principle of Memory**- The designer should provide suggestions, shortcuts for the frequently used action or function and use routine and familiar symbols or objects in the interface.

- **Principle of predictability**- predictability is a kind of method to confirm the result of the actions. The Predictability of the interface is strong the operation will become safer and more efficient.

- **Principle of emotion**: The interface should meet the user's basic emotional needs by orderly arranging, accepting and rejecting various visual elements such as directness and excitement.

- **Principle of assist through multiple-ways** – The interface should assist the user visual, auditory and tactile design, thus strengthening the usability of the interface.

The LMS platforms other than canvas and google classroom are-

- **Fronter:** Fronter is a virtual building platform that can easily be structured into practical rooms. A practical room can be a lecture hall, project work area and many more. Each room has the tools required to empower collaboration and learning, such as discussion forums, calendar[9].

- **Blackboard:** Blackboard is one of the leading commercial LMS and most widely adopted LMS. It provides a password-protected environment and has administration tools that make teaching online more accessible[10].

- **Moodle:** Moodle has a simple interface, uses a minimum of words, features rollovers and often includes simple icons with the words to aid users[11].

Statistical attributes

The statistical attributes used for calculating the distributed population are variance and standard deviation.

Variance (σ^2): The variance is a measure of variability. It is calculated by taking the average of squared deviations of mean[12].

$$\sigma^2 = {\sum_i^N (m_i - \mu^2)}\Big/_N \quad \text{- Equation 1}$$

Standard deviation (σ): it is a measure of amount of the variation or dispersion of set of values[12].

$$\sigma = \sqrt{\frac{\sum_i^N (m_i - \mu)^2}{N}} \quad \text{- Equation 2}$$

Tools used:

The tools used are canvas, google classroom, zoom, and google forms.

Canvas and google classroom are the LMS platforms in which the users are registered and get acquainted by completing the assignments in the respective course.

Zoom is a video-conferencing application used to conduct live interviews with users who were not able to be in person.

Google forms were used for posting the questionnaire for the survey, record the responses, and generate the graphs for the recorded response of the questionnaire.

1.4 Scope

In recent years, LMS platforms' usage is increasing and adopted by many educational institutes. User satisfaction plays a significant role in using interactive interfaces. User satisfaction is the primary consideration in the thesis while experimenting on the selected LMS platforms.

The scope of the thesis is limited to the selected LMS platforms canvas and google classroom. The experiment was done on the free version of canvas and google classroom. The results of the survey are not applicable to the paid versions of the platforms and therefore the outcomes of experiment cannot be generalized. Usability heuristics were selected among the other usability techniques to perform the experiment on the platforms. Survey evaluation was used in the experiment to get to know about the user experience. Statistical analysis was done on the obtained data and a conclusion is drawn within the scope of the study.

1.5 Outline:

This thesis focuses on the LMS platforms and the satisfaction of the user while using them. The research question is a literature review on the LMS and the selected LMS platforms. The second research question is concerned with the experiment performed in the study to measure user satisfaction. The LMS platforms canvas and google classroom are selected. A set of the same assignments are given in the selected platforms. A survey questionnaire was mapped with the usability heuristics. The users were to do the same set of assignments on the platforms and answer the survey. The responses of the respondents were graphically converted and statistically analyzed. A conclusion was drawn from the experiment within the scope of the study.

2 RELATED WORK

This section provides an overview of the research papers which are used for the selection of the idea for the thesis.

Nigel Bevan, Jurek Kirakowski and Jonathan Maissel related different approaches to usability based on the product, the user, ease-of-use, actual usage and the context of use and the acceptability of the product by the user. Finally, they concluded usability lies in user interaction with the product or system and can be measured by assessing user performance, satisfaction, and acceptability [1]. This paper is the main inspiration of focusing on the usability aspects to conclude the user satisfaction using the interactive interfaces.

Izwan Nizal Mohd Shaharanee, Jastini Mohd Jamil, and Sarah Syamimi Mohamad Rodzi calculated overall student satisfaction while using google classroom through constant observations. A survey was conducted on the students who enrolled on data mining subject. However, the mean of 4.33 indicated the value of strong agreement on the satisfaction of the usage of google classroom[13]. The idea of focusing on user satisfaction while using the platforms is taken from this report.

Jakob Nielsen listed ten general principles for user interface design known as usability heuristics. They are visibility of system status, match between the system and the real world, user control and freedom, consistency and standards, error prevention, recognition rather than recall, flexibility and efficiency of use, aesthetics and minimalistic design, help user recognize, diagnose and recover from errors and, help and documentation [3]. The listed ten general heuristics are applied on the selected LMS platforms for calculating the user experience.

Katerina Georgouli, Michael Grivas, and Persefoni Zahariou presented different ways of adopting and expanding an open-source learning management system to facilitate learning and educational processes. Finally, they concluded Open-source e-learning platforms have paved a new way of teaching and learning and provided valuable, extensible and powerful tools that can assist in many educational tasks in our department[14]. This paper is the inspiration for taking the open-source e-learning platforms which are used in educational institutions.

Randy Joy Magno Ventayen, Karen Lea A. Estira, Ma Jasmine De Guzman, Christian Mark Cabaluna, & Nieva N. Espinosa had surveyed 125 students to determine the usability of google classroom as an eLearning platform. On the level of satisfaction of using google classroom, 94.9% agreed that they would recommend for online learning with a high weighted mean of 4.15[15]. For the thesis, the google classroom e-learning platform is used, which is inspired from the report.

Cerric Bheki Mpungose and Simon Bheki Khoza collected experience using LMS platforms (Canvas/Moodle) from the postgraduate students. The student described LMS as primarily adopted and use to serve the need of a subject for formal learning. They also find out the common features in both LMS (Canvas/Moodle) like instructor tools, curriculum design, administrator tools and technical specification. Finally, they concluded the LMS gives the option to students to learn and track the progress in formal learning[16]. The idea of using canvas LMS was inspired form this report.

Jakob Nielsen introduced the various usability inspection methods, such as heuristics evaluation, cognitive walkthroughs, formal usability inspection, pluralistic walkthrough, feature inspection, consistency inspection, standard inspection used to inspect the user interface[17]. Survey evaluation inspection method is used to inspect the user interface in this thesis.

Fritz Scheuren presented ten chapters on how to conduct a survey. Those ten chapters deals with planning a survey, collecting the survey data, judging the quality of the survey, focus groups, designing

a questionnaire, and different types of survey techniques and in the final chapter, the author discussed the observations in the sample, types of sampling and size of the population affect the margin error[18]. This paper gave the knowledge about some aspects of survey like how to formulate questionnaire, how to collect survey data.

Priscilla A. Glasow explains some essential aspects of the survey, such as the survey process, the evaluation, and the interpretation of the survey results. This paper also describes the different types of survey questions, such as open-ended questions and closed-ended questions [6]. This paper gave clarity on different kinds of questions and how to interpret the survey results. In this thesis, closed-ended questions are formulated for the survey.

Tanya J.MC Gill, Jane E. Klobas have submitted an overview LMS utilization in higher education using task-technology fit. A total of 267 students participated in the study and measured the standard deviation for LMS utilization[19]. The authors used standard deviation as the measure, but variance and standard deviation are used to calculate the survey results in this thesis.

R.E. Deakin and D.G. Kildea clarified some confusing nomenclature of statistical terms. They derived the finite population like mean, variance, standard deviation, estimated the standard error, and explained the distinction between Root mean square (RMS) and standard deviation[12]. This paper gives the formulas of the populated variance and standard deviation used for calculating user experience.

In this paper, a comparative analysis was performed on the canvas and google classroom LMS platforms over usability heuristics, where the survey was conducted on nine users. The best LMS platform in terms of user experience concluded with a standard deviation and variance scale.

3 METHOD

This chapter includes the method that was followed while doing the formal experiment in this thesis. The summary of the chapter is the conduction of the survey evaluation on the LMS platforms - canvas and google classroom, comparing them with regards to the usability heuristics. A dummy course is introduced in the LMS platforms with the assignments that are discussed in section 3.1. The user's task is to do the assignments on the platforms and to answer the survey questionnaire based on their experience with the platforms. The questionnaire is written based on usability heuristics. The usability heuristics are explained in detail in section 1.3.

3.1 Introducing dummy courses in selected LMS

This section has a detailed description of the creation of the dummy course in the LMS platforms. In the course, seven assignments are being assigned in each LMS platform. Further, all the assignments are explained in detail.
The formal experiment took place on the free version of the canvas web application and google classroom web application. Moreover, the results of the experiment do not apply to the paid versions of the LMS platforms.
Firstly, the course was created in the LMS platforms as one of the authors as a teacher to create the course and upload the assignments into the course, and as a student to get familiarized with the interfaces from the point of view of a user.
The course uploaded on the platforms was named "Thesis" and has the same assignments. There were seven assignments in the course.
This section explains in detail about the seven assignments in the course of the LMS platforms.

Assignment-1

The user's task is to download the template provided, fill in the required details and submit it in the form of a word document or google document accordingly.

Assignment-2

The user's task is to upload a picture of the BTH logo into the respective LMS platforms.

Assignment-3

This assignment consists of a simple quiz that is needed to be answered by the user.

Assignment-4

This assignment is to find the announcement section and to complete the task specified in the announcement. In the announcement section, an announcement with the title "Regarding to the assignment-4" had a task to write the user's name in the comment section of the announcement itself. Finally, if the user could complete the task, then the user is required to write "task completed" or "task not completed" if the user was not able to, in the text area of the submission of the assignment.

Assignment-5

The task in this assignment is to watch a video and PowerPoint presentation slides that are uploaded.

Assignment-6

The user's task here was to find a specified student in the course and message the user with a greeting. If the user was able to this task, the user needs to write 'YES' or 'NO' if not able to complete the task in the text area of submission of the assignment.

Assignment-7

The assignment is to find the 'Help' option on the platforms. If the user could find the option, the user needs to write 'YES' or 'NO' if not able to find the option in the text area of submission of the assignment.

To join the users into the course of the respective LMS platforms, each of the platform had unique reference codes to sign in.

Steps to sign-in into the course in canvas:

Step-1: User must go to the https://canvas.instructure.com/login/canvas website. A page opens as shown in Figure 1.

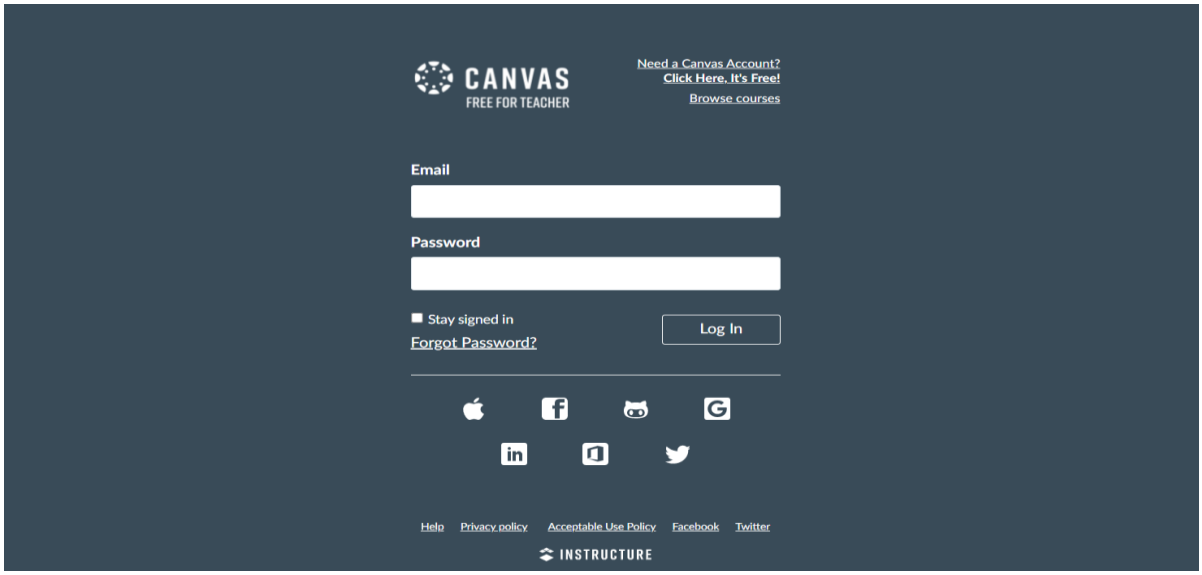

Figure 1: Canvas login page

Step-2: Must click on "Need a Canvas Account? Click Here, It's Free!" as shown in Figure 2.

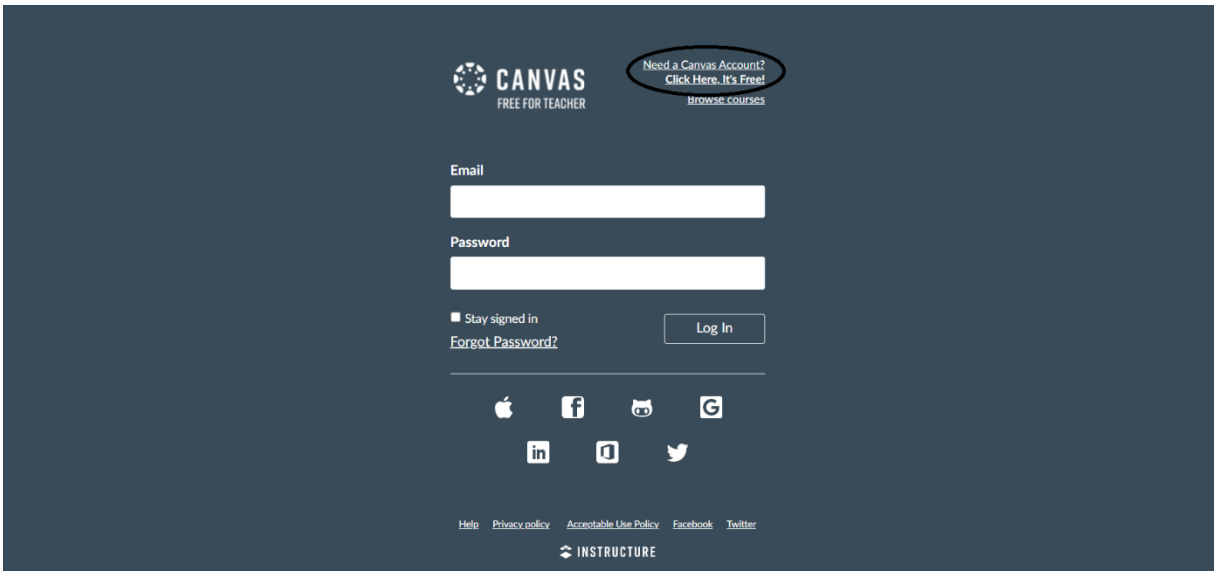

Figure 2: Click on the marked button

Step-3: A page appears as Figure 3, must click on the green "I'M A STUDENT".

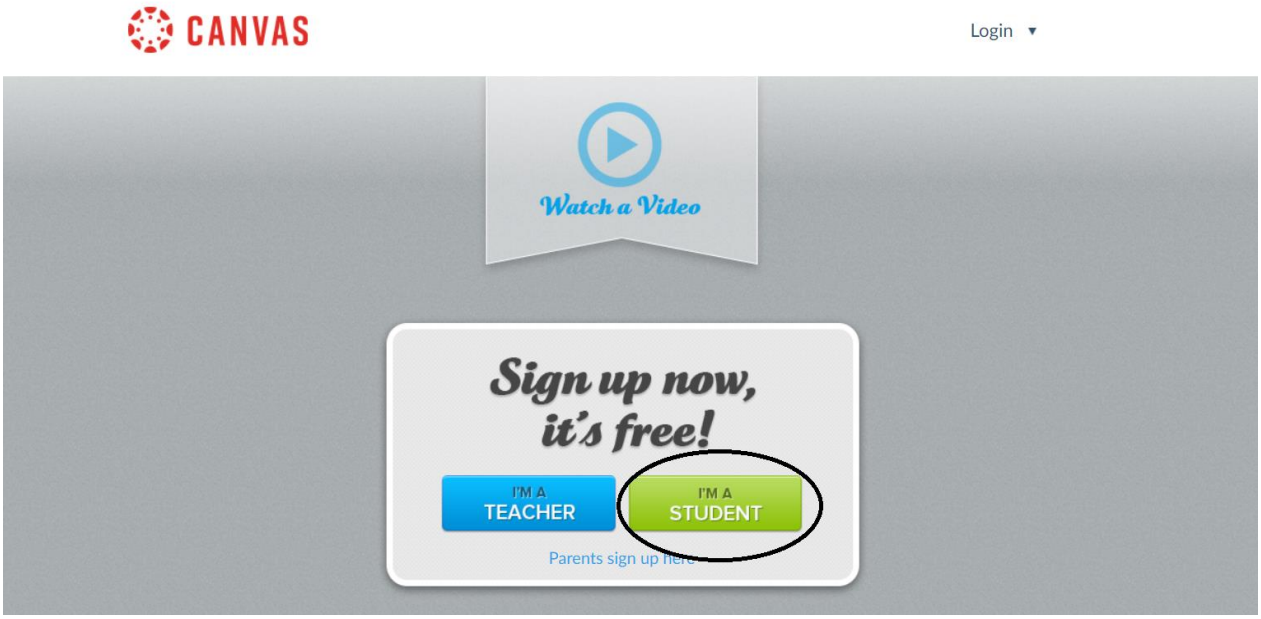

Figure 3: Click on 'I'M A STUDENT'

Step-4: A Student Signup page as shown in Figure 4, then must put the reference code “BNKH3C” in join code section and fill in the required details and click on Start learning.

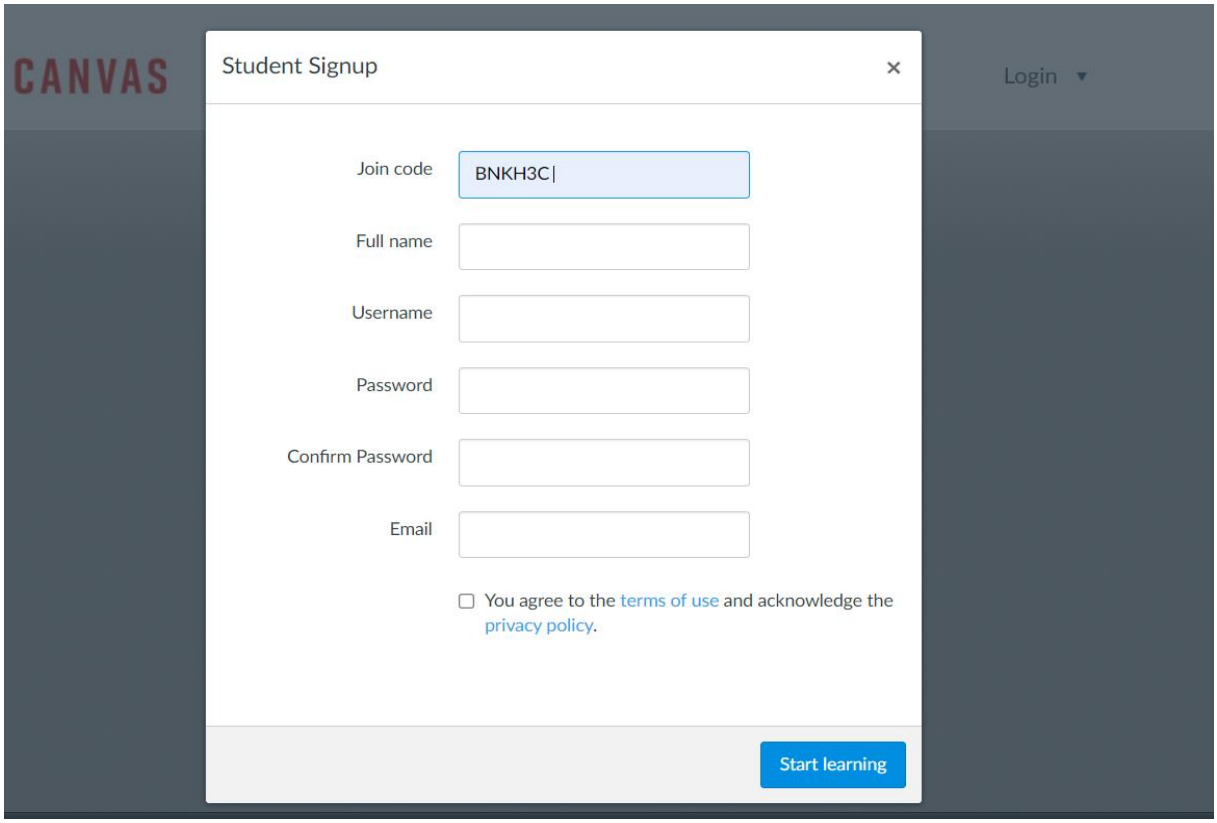

Figure 4: Sign up using the provided reference

The canvas dashboard appears with a course called Thesis as shown in the Figure 5.

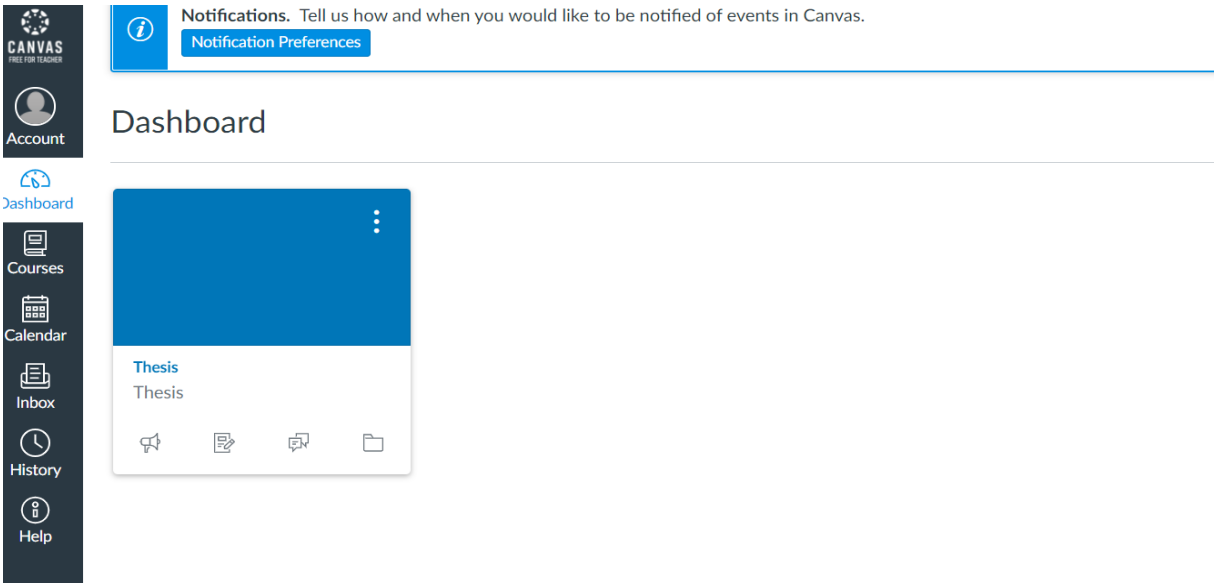

Figure 5: After signing up the dashboard appears

Steps to sign-in into the course in google classroom:

The users were asked to bring their own laptop to do the experiment. Every user had their g-mail account logged into the google chrome.

Step-1: Open google chrome and click on the 3*3 grid on the top right corner of the page as shown in the Figure 6.

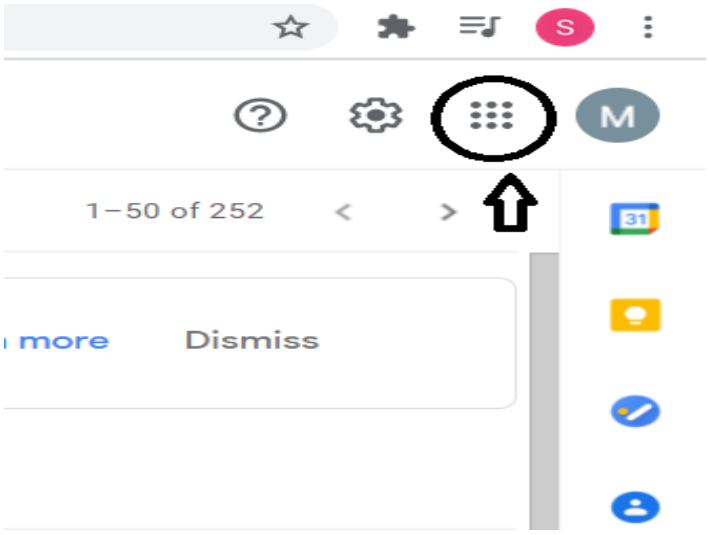

Figure 6: Click on the 3*3 grid

Step-2: Scrolling down among the google products, click on the classroom as shown in the Figure 7.

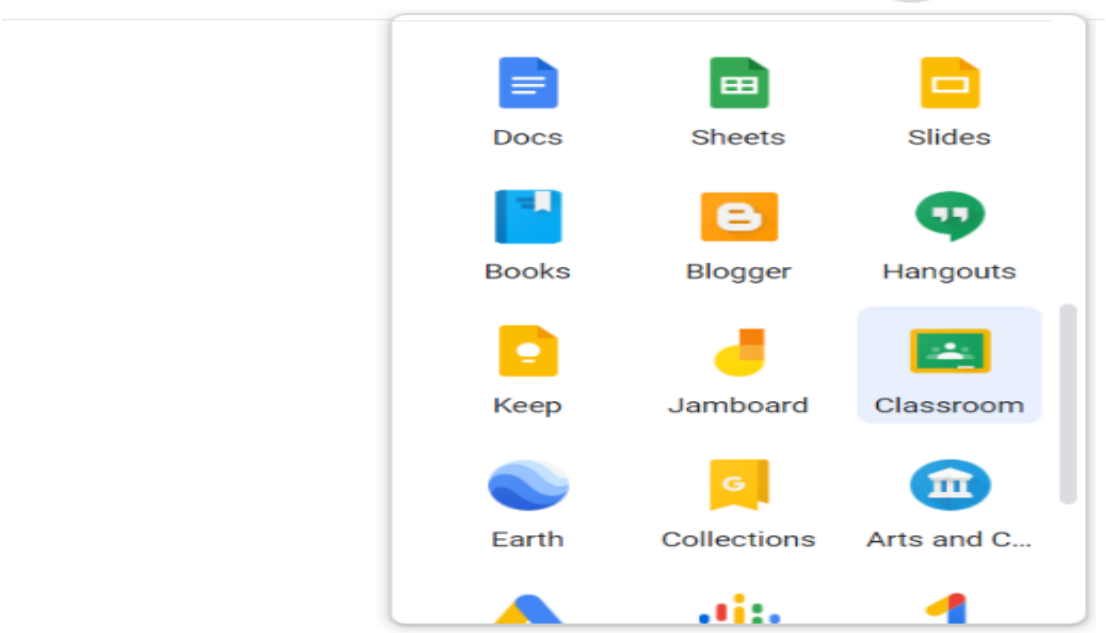

Figure 7: Select Classroom in the products

Step-3: A page appears as in Figure 8, click on the '+' symbol that appear on the right corner, further click on 'Join class'.

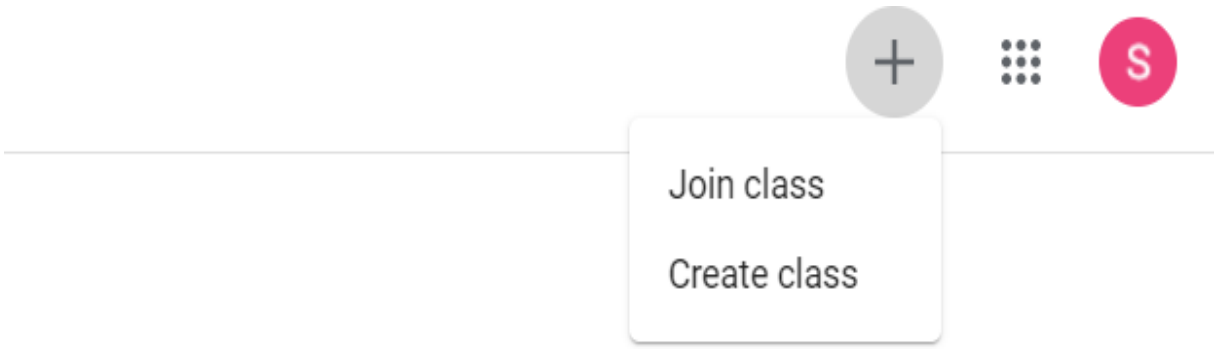

Figure 8: Click on '+' and Join class

Step-4: Enter the reference code "cuthhu5", click on 'Join' as specified in Figure 9.

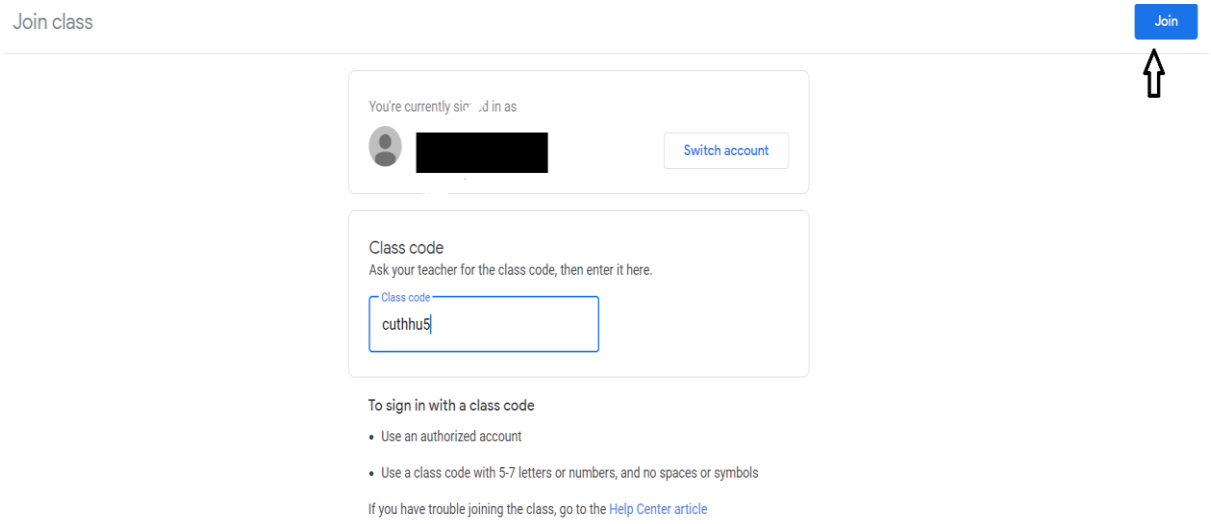

Figure 9: Write the reference provided to join the class

Step-5: A page appears with title ‘Thesis’ and will on the ‘Stream’ section of the page as shown in Figure 10.

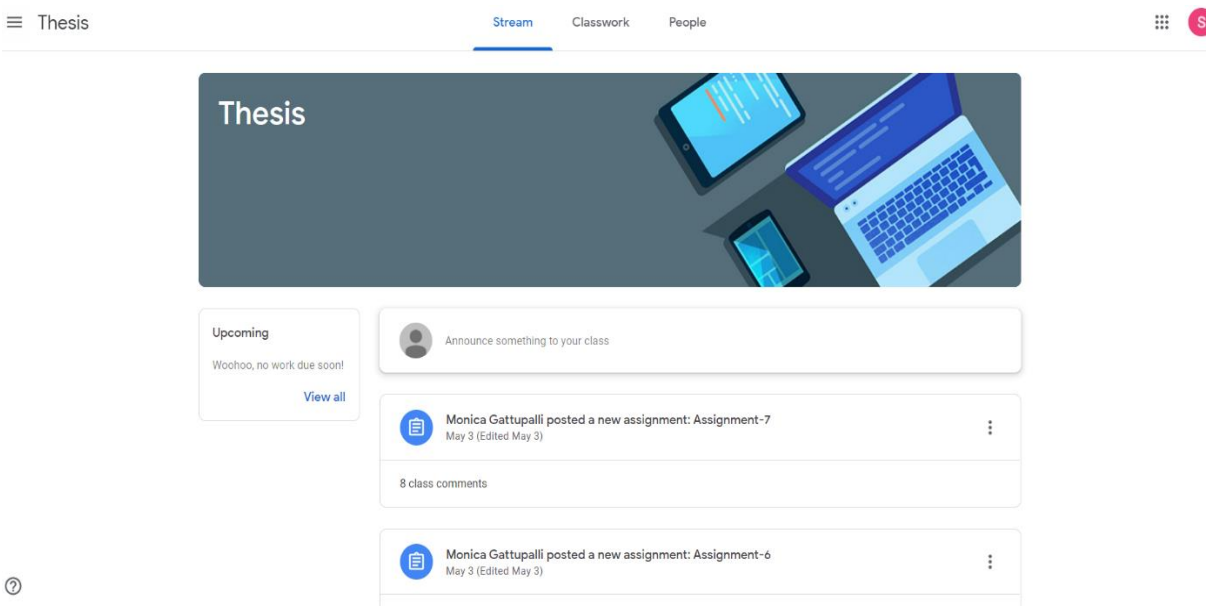

Figure 10: The dashboard after joining the class

3.2 Survey evaluation

A survey is a research method defined as gathering of data from a sample set of respondents to gain and grasp the user feedback[6].

The questionnaire of the survey is related to the assignments that are specified in the below 4.1 section. The questions regarding the assignment are matched with the usability heuristics and is specified in section 4.2.

The survey consists of closed-ended, rating, Likert-scale, multiple-choice, and multiple grid questions. The survey was conducted using google forms.

The survey results are converted into statistical data. Most of the statistical data consists of pie charts and bar graphs.

The anonymity of the respondents of the survey will be not compromised in any situation.

3.3 Respondents

This section consists of the detailed information about the respondents who participated in the survey.

There was a total of nine respondents. In the respondents, there was a bias as eight out of nine were more or less familiar with the canvas application. Only one respondent was not familiar with either of the platforms. The selection bias took place because of the limited accessibility of the respondents.

The consideration of only nine users is because of the time constraint. And mainly, the experiments need more qualitative analysis rather than quantitative analysis. For better results, the experiment is required to be done under the supervision of the authors. So, the selection of the users was truncated due to availability and time limit.

The users' identities are maintained as anonymous. By any means, the anonymity of the users will not be disclosed.

The authors were entirely with users from the beginning to the end of the experiment. Firstly, the user was explained about the LMS platforms and their usages. Briefly explained the things that are needed to be done in the experiment. Five interviews were live and remaining were conducted on the zoom video conferencing application.

The users were guided when joining the course on canvas and google classroom. They were told to do the task assigned to them in each of the LMSs. Furthermore, after experiencing both the platform, they were asked to answer the survey.

The user was clocked from the beginning (from the start of doing the tasks) to the end (until the completion of the survey). Every assignment done by the user was clocked separately and also recorded the time taken to complete the survey.

Users were asked to comment on the LMS platforms from their experience after the completion of the survey. The opinions of the users were noted and were not part of the recorded time.

4 DATA COLLECTION

The data collected in the experiment was done through the survey. This section consists of the survey questions that were posed to the respondents.

4.1 Survey Questionnaire

This section contains the images of the questions posed to users in the survey with options to answer. The survey questions where the closed-ended type with a combination of Likert scale, multiple-choice, and multiple grid questions.

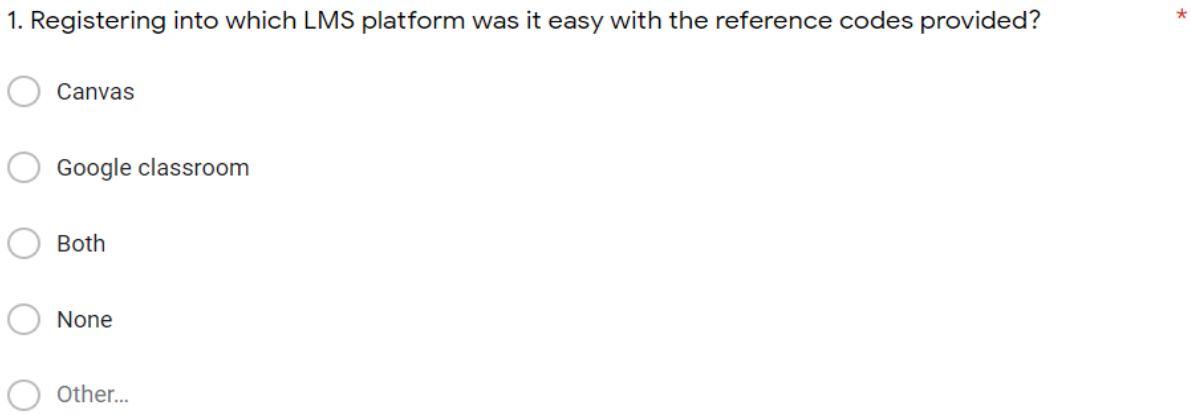

Figure 11: Survey question 1

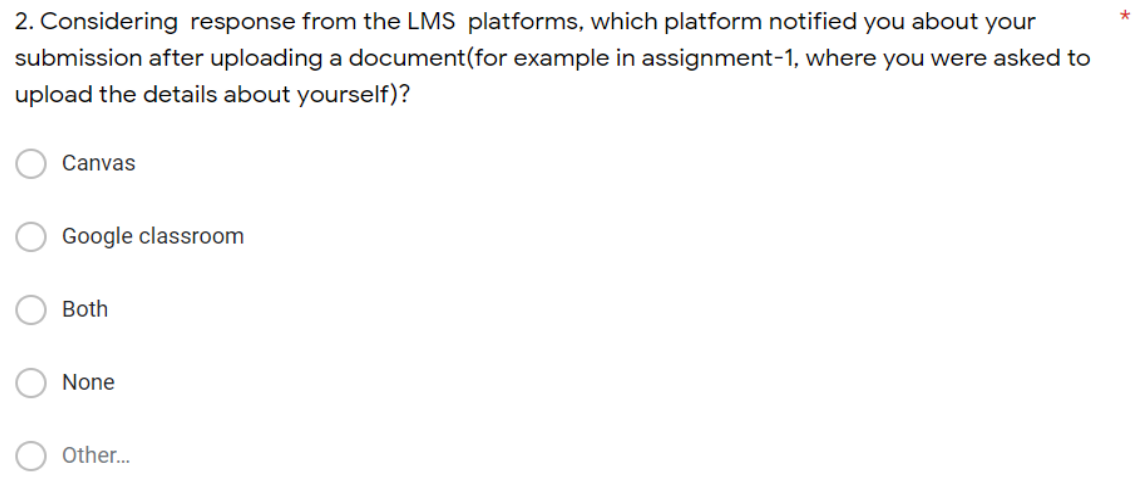

Figure 12: Survey question 2

3. In the assignment-2 you were asked to upload a picture, in which of the LMS platforms was it similar to other applications (like Gmail, social medias etc.) to complete the task? *

- ○ Canvas
- ○ Google classroom
- ○ Both
- ○ None
- ○ Other...

Figure 13: Survey question 3

4. In the LMS google classroom, what do you think the word 'Stream' means? *

- ○ Streaming of a video
- ○ Dashboard
- ○ Announcements
- ○ None of the above
- ○ Other...

Figure 14: Survey question 4

5. In which of the LMS platforms doing the 4th assignment, to find the announcement section and to do the task specified in the announcement was less time-consuming? *

	<1 min	<2 min	>2 min	Unable to complet...
Canvas	○	○	○	○
Google classroom	○	○	○	○

Figure 15: Survey question 5

6. Were you able to watch the video in the assignment-5 without any interruption? *

Figure 16: Survey question 6

7. According to the assignment-6, in which LMS platform finding the student and messaging was easier? *

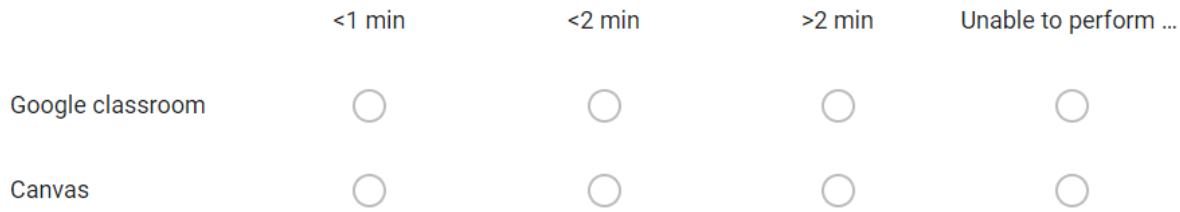

Figure 17: survey question 7

8. The option 'Help' was identified in which LMS platform from your observation? *

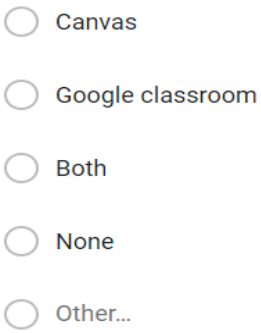

Figure 18: Survey question 8

9. In which of the LMS platform do you think the on-click actions buttons (like home, classroom, announcements, assignments etc.) were easier to find? *

- Canvas
- Google classroom
- Both
- None
- Other...

Figure 19: Survey question 9

10. All things considered done till now, was it easy to find a way out from any action(like to go back to previous page, cancel any dialogue box that appears, etc.) you wanted to do in the LMS platforms? *

	able to undo the ac...	able to undo the ac...	able to in more tha...	was not able to do it
Canvas				
Google classrom				

Figure 20: Survey question 10

11. On the whole, on the scale of 1 to 10, how much are you satisfied with the canvas LMS? *

	1	2	3	4	5	6	7	8	9	10	
Least likely											Most likely

Figure 21: Survey question 11

12. On the whole, on the scale of 1 to 10, how much are you satisfied with the google classroom LMS? *

Figure 22: Survey question12

4.2 Mapping the usability heuristics with the survey questions

The table indicates the usability heuristics that are mapped alongside the survey questions.

Survey Questionnaire	Usability Heuristics
1. Registering into which LMS platform was it easy with the reference codes provided?	7. Flexibility and efficiency of use 8. Aesthetic and minimalist design
2. Considering response from the LMS platforms, which platform notified you about your submission after uploading a document (for example in assignment 1, where you were asked to upload the details about yourself)?	1. Visibility of system status 9. Help users recognize, diagnose and recover from errors
3. In the assignment-2 you were asked to upload a picture, in which of the LMS platforms was it similar to other applications (like Gmail, social medias etc.) to complete the task?	1. Visibility of system status 7. Flexibility and efficiency of use
4. In the LMS google classroom, what do you think the word 'Stream' means?	2. Match between the system and the real world
5. In which of the LMS platforms doing the 4th assignment, to find the announcement section and to do the task specified in the announcement was less time-consuming?	2. Match between the system and the real world
6. Were you able to watch the video in the assignment-5 without any interruption?	5. Error prevention
7. According to the assignment 6, in which LMS platform finding the student and messaging was easier?	6. Recognition rather than recall
8. The option 'Help' was identified in which LMS platform from your observation?	10. Help and document
9. In which of the LMS platform do you think the on-click actions buttons (like home, classroom, announcements, assignments etc.) were easier to find?	4. Consistency and standards
10. All things considered done till now, was it easy to find a way out from any action (like to go back to previous page, cancel any dialogue box that appears, etc.) you wanted to do in the LMS platforms?	3. User control and freedom
11. On the whole, on the scale of 1 to 10, how much are you satisfied with the canvas LMS?	Overall user satisfaction
12. On the whole, on the scale of 1 to 10, how much are you satisfied with the google classroom LMS?	Overall user satisfaction

Table 1: Mapping of survey question with usability heuristics

5 RESULTS AND ANALYSIS

This section consists of the results of the survey conducted on a set of nine users. Eight users in the set were familiar with canvas, and only one of them was not familiar with any of the platforms.

The responses to the survey are shown in the form of graphs.

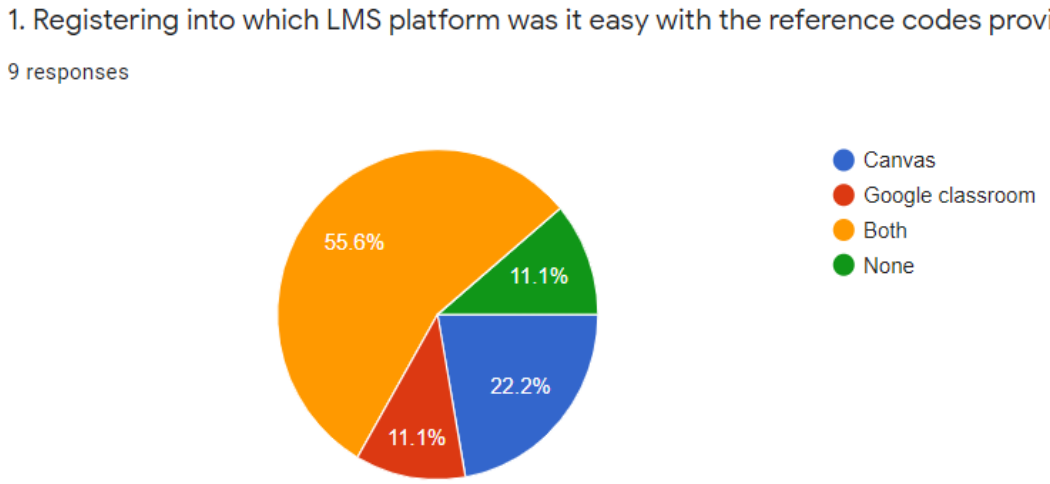

Figure 23: Response of survey question 1

From Figure 23**,** the majority of the respondents found it easy to register into both LMS platforms. 22.2% of the participants found canvas easy to register into. Only 11.1% of the population found it easy to register into the google classroom. And 11.1% of the population found none of the platforms easy to register into the platforms.

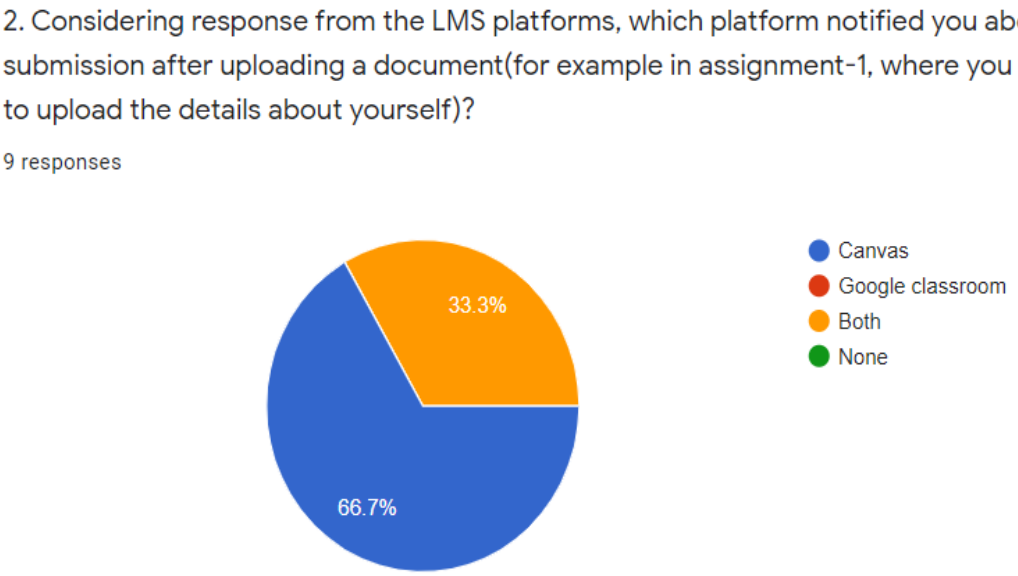

Figure 24: Response of survey question 2

From Figure 24, 66.7% of the participants voted to canvas and 33.3% to both the platforms to notify them after submitting a document.

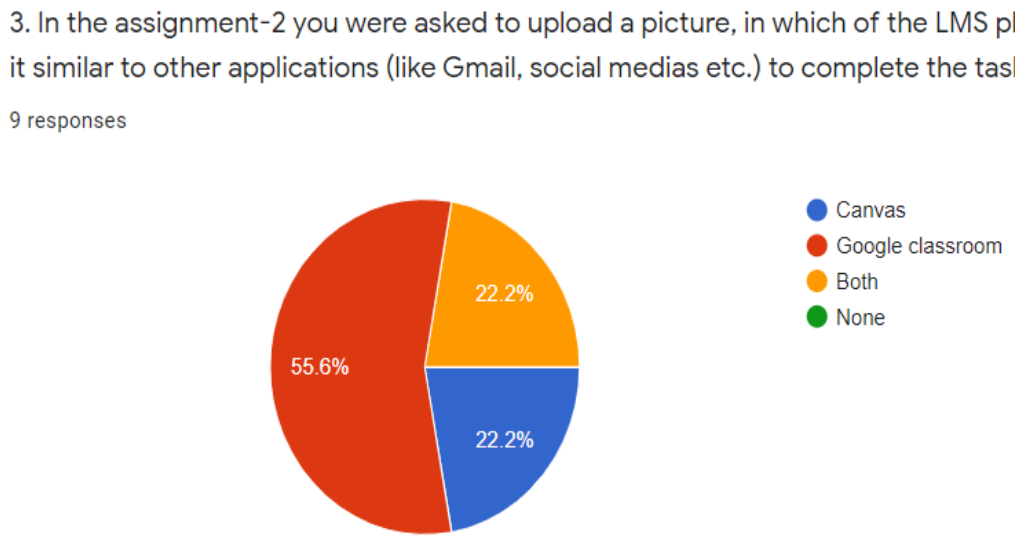

Figure 25: Response of survey question 3

From Figure 25 response to the third survey question, 55.6% of the population agrees with google classroom, 22.2% agrees with canvas, and 22.2% thinks both.

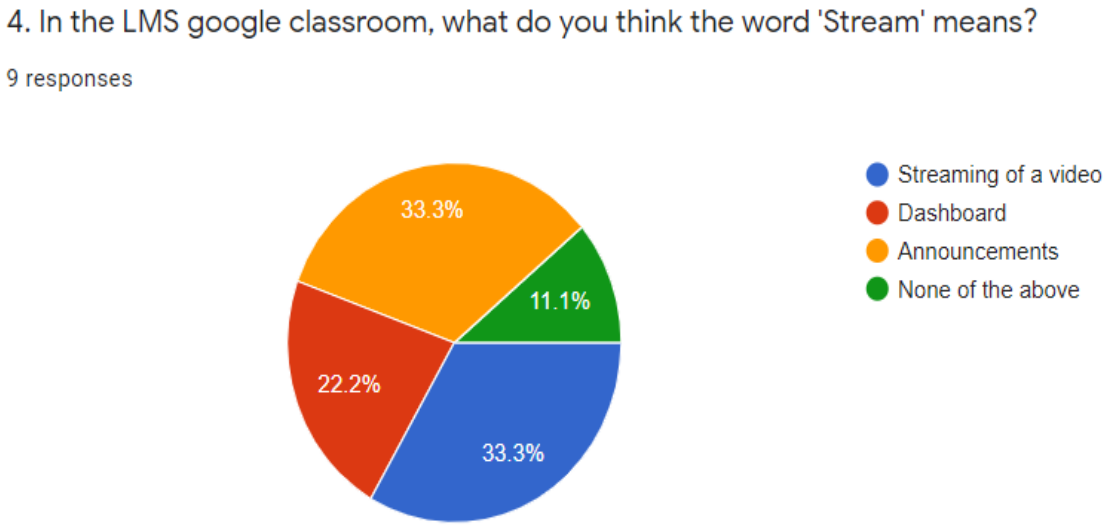

Figure 26: Response of survey question 4

From the responses of the fourth survey question as shown in Figure 26, 33.3% of the participants think the word stream means announcements, 33.3% of the respondents think it is streaming of a video, 22.2% of the respondents think it is the dashboard, and the remaining 11.1% think it is not relevant any of the options specified.

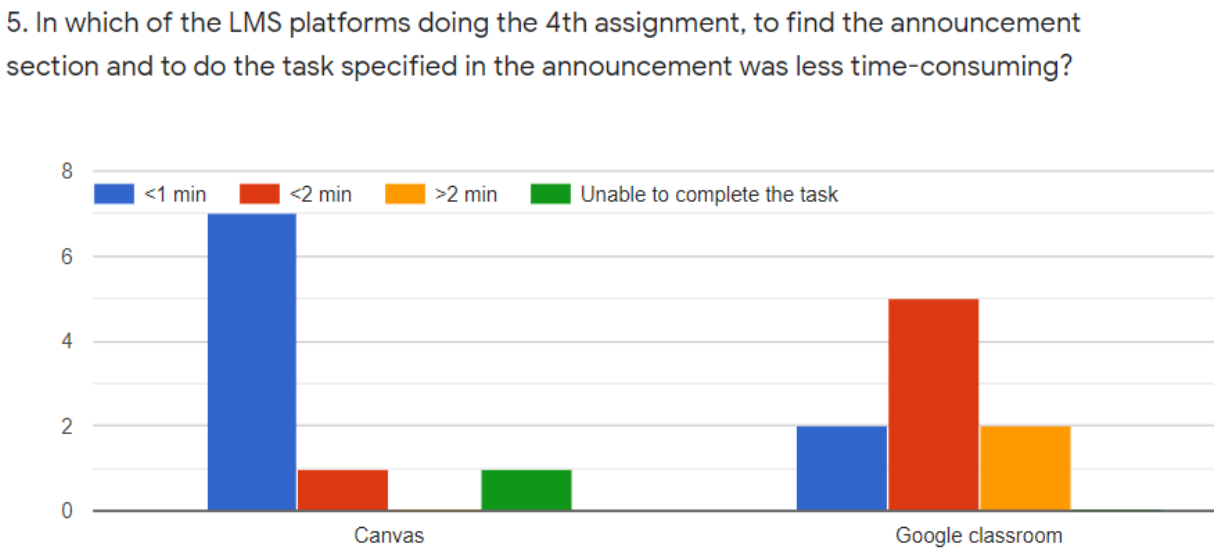

Figure 27: Response of survey question 5

In Figure27, the bar graph is plotted for google classroom and canvas separately. In the case of canvas, seven out of nine were able to do the task in less than a minute, one of them was able to do the task in less than two minutes, and another one was not able to do the task at all.

Whereas in the case of google classroom, everybody was able to finish the task. Two out of nine respondents were able to complete the task in less than one minute, five out of nine were able to complete the task in less than two minutes, and the other two were able to complete it in more than two minutes.

This bar graph represents how much time it took for the participants to complete the task, in their opinion. However, the actual time for the completion of the task has been calculated.

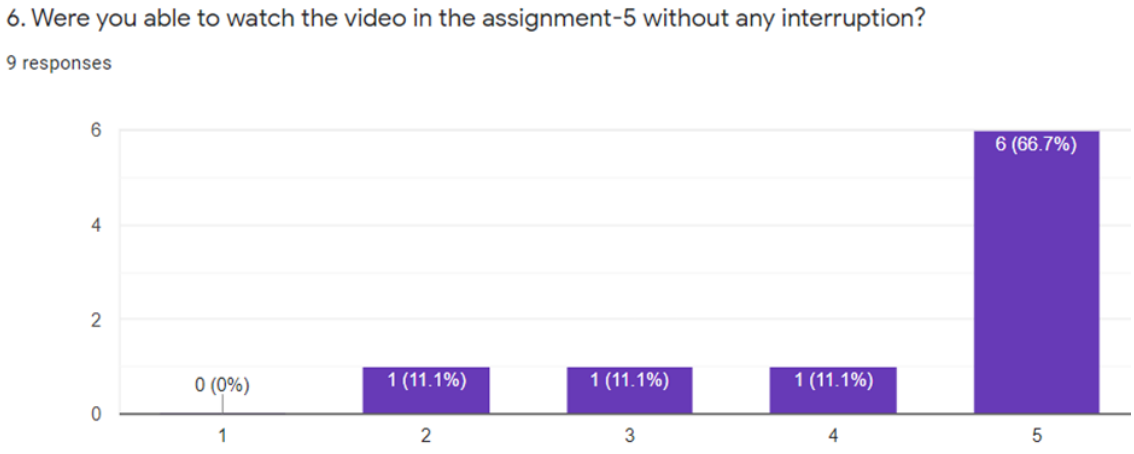

Figure 28: Response of survey question 6

In Figure 28, six out nine members most likely did not have any interruptions while watching the video, the other three rated four, three and two on the Likert scale out of five.

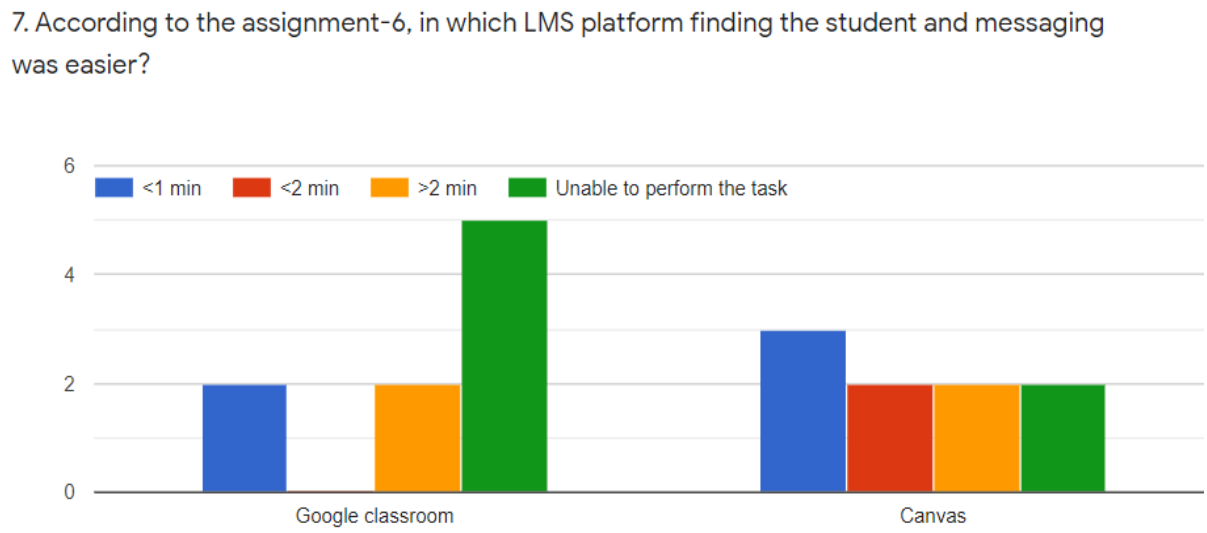

Figure 29: Response of survey question 7

In Figure 29, the bar graphs are plotted for google classroom and canvas separately. In the case of google classroom, two users were able to complete the task in less than one minute, two users were able to complete the task in more than two minutes, and five of them were not able to perform the task.

Whereas in the case of canvas, three users were able to perform them in less than a minute, two of them were able to perform the task in less than two minutes, two of them were able to perform the task in more than two minutes, and two to them were unable to do the task.

This bar graph represents how much time it took for the participants to complete the task, in their opinion. However, the actual time for the completion of the task has been calculated.

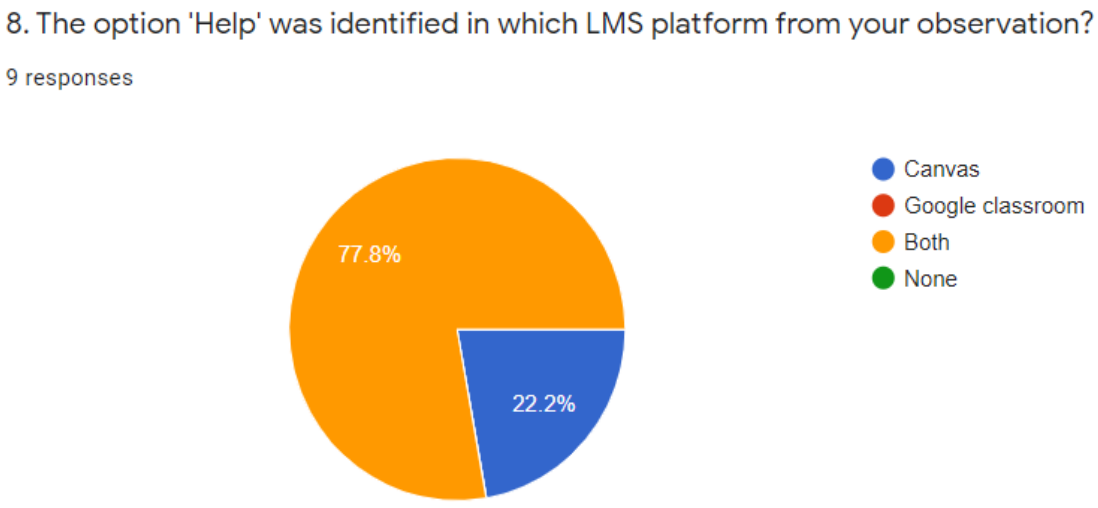

Figure 30: Response of survey question 8

In the pie-chart shown in the Figure 30, 77.8% of the respondents were able to find the help option in both the platforms and 22.2% where only to find in canvas.

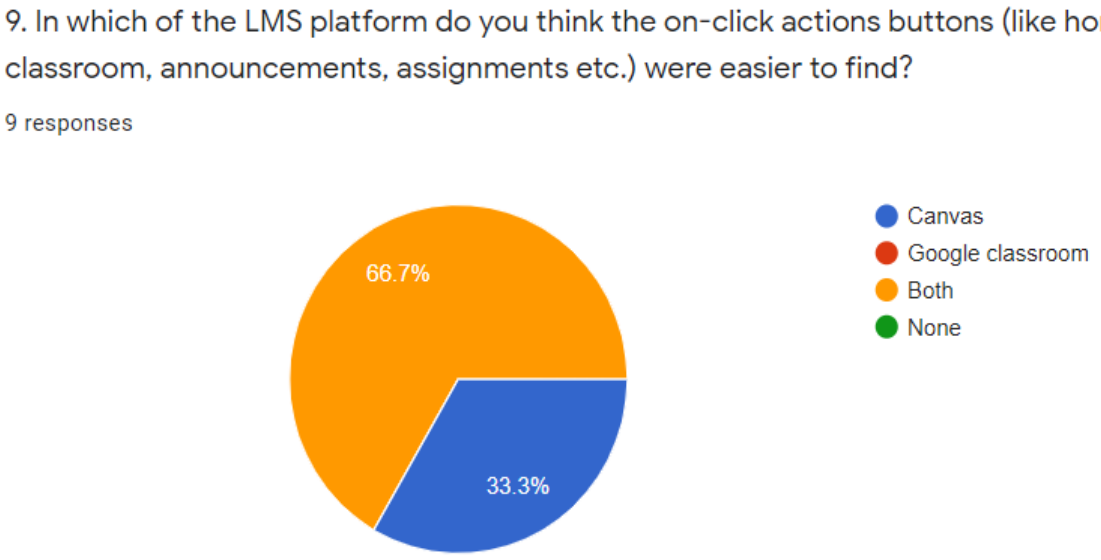

Figure 31: Response of survey question 9

From the pie-chart shown in the Figure 31, 66.7% of the users think in both the platforms finding of the on-click action buttons was easy and 33.3% think the on-click actions were easier to find on canvas.

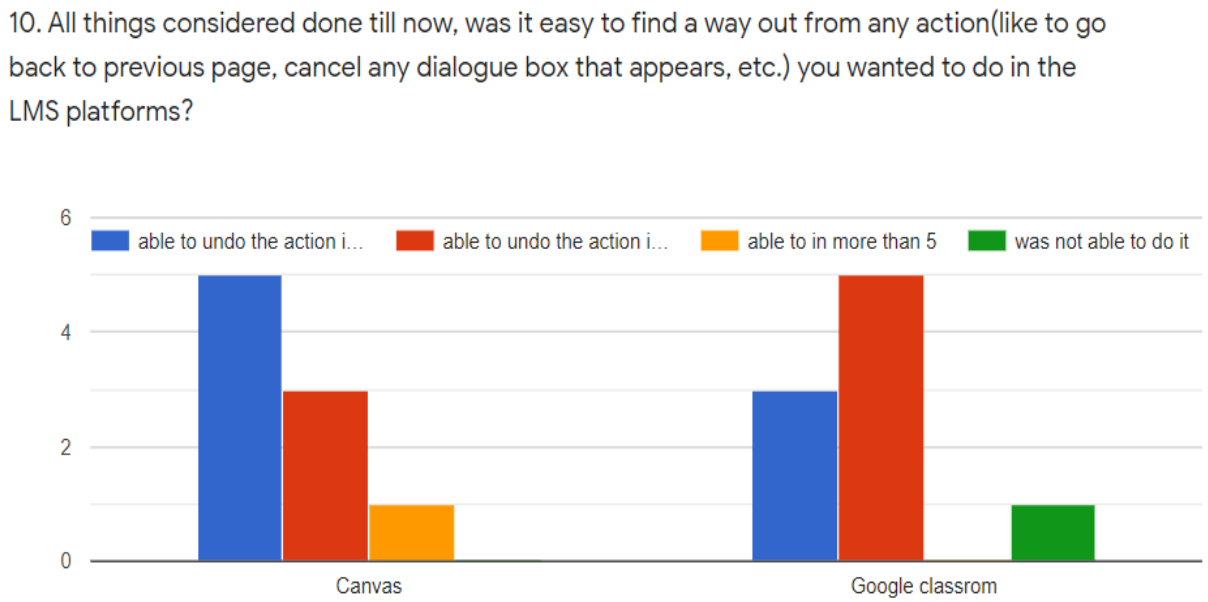

Figure 32: Response of survey question 10

From the bar graphs shown in Figure 32, in the case of canvas, five out of nine were able to the specified task in one click, three were able to do it in less than five clicks, and one was able to do it in more than five clicks. Whereas in google classroom, three out of nine participants were able to do it in one click, five could do it in less than five clicks, and one could not do it.

The user experience of canvas and google classroom was rated 1-10, where one is least likely, and ten is most likely. Standard deviation and variance were taken as measures to compare the user experience.

Canvas:

The below bar graph is the result of user experience rated on a scale of 1-10 for Canvas LMS platform.

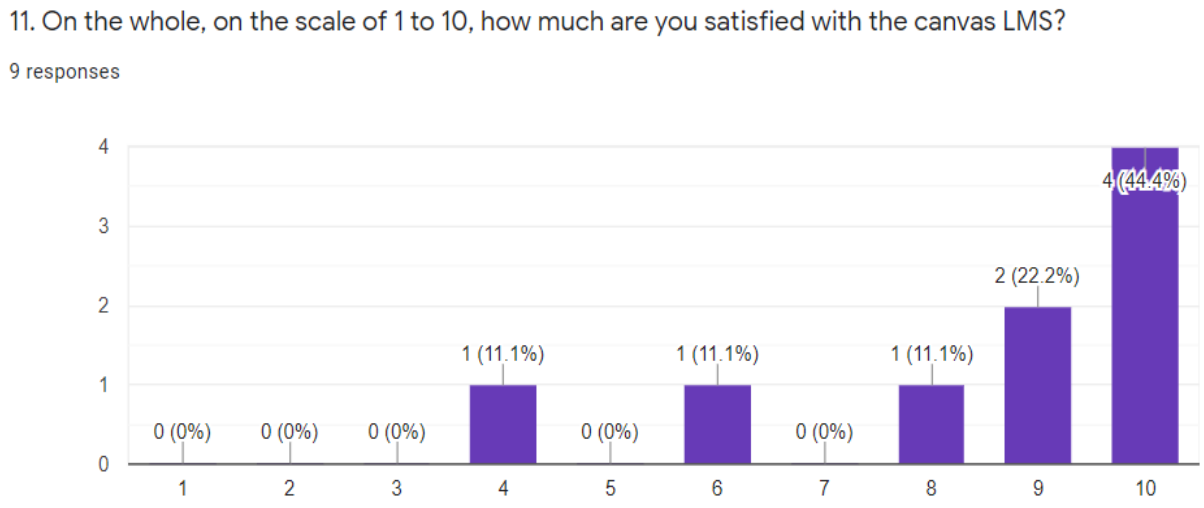

Figure 33: Response of survey question 11

From Figure 33, user was asked to rate on a scale of 1-10 that how much that they were satisfied while using the Canvas LMS platform. Refer to Table-2 to know the Likert scale of survey question-11.

Likely scale	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Values	0	0	0	1	0	1	0	1	2	4

Table 2: Likert scale of survey question 11

Google Classroom:

The below bar graph is the result of user experience rated by the respondents on a scale of 1-10 for Google classroom LMS platform.

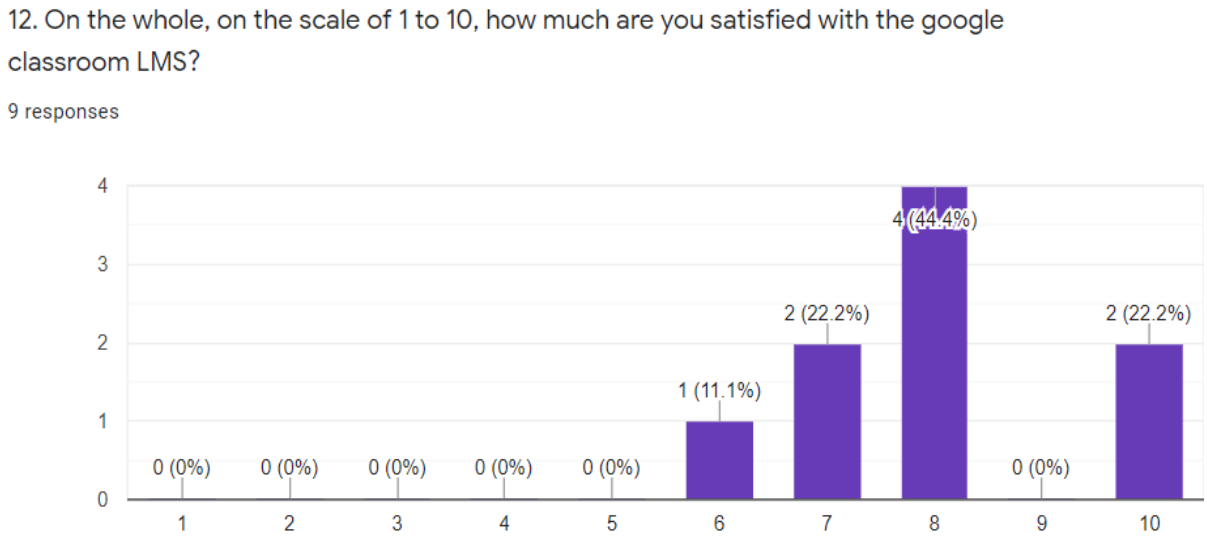

Figure 34: Response of survey question 12

From Figure 34, user was asked to rate on a scale of 1-10 that how much that they were satisfied while using the canvas LMS platform. Refer to Table-3 to know the Likert scale of survey question-12.

Likely scale	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Values	0	0	0	0	0	1	2	4	0	2

Table 3:Likert scale values of survey question-12

LMS platforms	**Variance (σ^2)**	**Standard deviation(σ)**
Canvas	4.0644	2.0160
Google classroom	1.55	1.247

Table 4: Variance and Standard deviation of LMS platforms

From the Table 4, both the variance and standard deviation of canvas are high when compared to Google classroom. From the calculation of the ratings given by the participants, canvas gave the better user experience than google classroom.

6 DISCUSSION

In this section, the research questions specified in section 1.2 are explained in detail. The first question will be explained by the literature review conducted by the authors. Furthermore, the second will be explained by making use of the survey conducted.

Research Question 1:

How important are the LMS platforms like canvas and google classroom have become?

In today's world, the educational sector is getting rapidly globalized. Internationalization happens with the utilization of e-learning platforms. E-learning is a formalized teaching and learning system which is performed using electronic resources[20]. E-learning is the means for distance learning. Virtual learning systems like the LMS platforms are becoming popular in the learning and teaching process.

Virtual education or e-learning has gained efficiency in the new paradigm of higher education as most educational institutions promote it. Adopting the LMS platform into the education system made supervision more accessible and established. The e-learning platforms provide productive communication between teacher and students.

E-learning is not only well known in the educational sector but also in the corporate sector. The e-learning platforms are used to conduct training programs for the employees by multinational companies.

There is no doubt that the traditional method of teaching should not be ignored in some of the practical cases like in medicine, civil engineering and many more. But a study found that the schools using the e-learning platforms are a step ahead of the schools teaching the traditional method. In the same article, it is believed that remembrance of the human brain is much greater when seeing and hearing from moving videos or pictures [20].

An LMS ensures a platform for virtual learning by enabling the tracking of the learning, management, delivery, communication, testing, scheduling and the registration process[21]. A set of flexible tools are given to the instructors by the LMS platforms to make their work easier, and the provided LMS features are time-saving. By using these LMS platforms, the learners and the instructors are no longer needed in the same location to be present physically.

The LMSs provide great value by providing a means to sequence content and to create a manageable structure for instructors of the educational institutions. According to the statistics provided by the Browne, Jenkins, and Walker, 95% of the higher educational institutes in the UK were using LMS in 2005. Swedish academics believed that future course offerings would be benefitted from using the LMSs. In the UK and Ireland, there were extensive implementations of virtual learning via LMSs. Even many colleges and universities have purchased and are using LMSs.

In the current situation because of the COVID-19, now the usage of the LMSs is becoming more prominent even in the developing countries. Because of this virtual learning is encouraged and this is done by the LMSs platforms.

LMS offers several advantages and supports educational institutions, including face-to-face learning, online and blended learning. Moreover, it provides easy administration with a user-friendly, web-based environment. It can effectively manage signups/registrations, communication/messages, uploads /downloads of course materials, track student progress, and provide security for personal information. Some of the LMS platforms can directly be accessed through the institutions paid versions of the platforms.

The reason for choosing the canvas and the google classroom was the authors were only familiar with these LMS platforms. The free versions of the canvas and google classroom are chosen as they were more accessible. The results obtained in the experiment in the second research question do not apply to the paid versions of the LMS platforms. Further is a detailed explanation of canvas and google classroom along with their paid versions.

Canvas provides an effective way of communication, collaboration, and a lot more customizable management tool. It also includes the Canvas app Centre, which helps the instructors to know about the services, options, and tools in the interface. Instructors can provide the student with comprehensive feedback on assignment and quiz submission using SpeedGrader and manage grade in the Canvas Gradebook.

Canvas offers a wide range of customizable options depending on the educational institution's needs.
Features provided by the paid version[22]:

1. Custom authentication is available,
2. Canvas will give access to the external tools for Chat, Roll calls, SCORM(Assignment),
3. Admin sets storage, and 50 MB was provided to the user/group,
4. Provides options like Theme editor, blueprint, Multiple grading periods, calendar schedular, Admin Tools, Content security policy.

The institutions should opt for the paid version of the canvas, and the pricing depends on the number of users.

Google classroom ties google drive, google docs, google sheets, google slides, google forms, google sites, Gmail and more together and make the effective usage of the platform. Google calendar is also integrated to help with assignment's due dates. Google Classroom creates a separate folder in the respective users google drive, where the student can submit work that can be graded by the teacher.

Google classroom paid version [23]
In general, Google classroom integrated with the G-Suite application. In the paid version G-suite application includes additional features like

1. Advance video conferencing,
2. Advanced security and premium support.

An individual license is provided for a cost of $4 per month.

Research question 2:

Which of the selected LMSs gives a better experience to the user according to the usability heuristics within the scope of the study?

Motivation: This research question will be investigated by surveying the users. The results of the respondents will be statistically evaluated, and the conclusions will be drawn from the survey.

A survey on nine users has been conducted to support the motivation, and the results have been gathered. Further in this section the results of the survey are explained regarding the related usability heuristics.

The experiment was conducted on the free versions of the canvas and the google classroom. The authors were enrolled into the LMS platforms, one of them as a teacher and the other as a student. A dummy course named ‘Thesis’ was introduced into the platforms, and the course contained seven assignments.

Nine users were selected for performing this experiment. Eight out of nine users were familiar with canvas. Moreover, one was not familiar with any. This selection bias took place because of the time limitation. These were the users the authors could get hold of to perform the experiment.

The users were given an overview of the platforms and the experiment. The users were provided with help by the authors when registering into the LMS platforms' dummy course.

The task of the users was to complete the seven assignments in the LMS platforms. The users first selected one of the LMS platforms to complete the assignments and then the other to do the same. After completing the assignments in the LMS platforms, they were asked to answer the survey in a google form provided by the authors. The users were clocked the whole time from doing the assignments and to answering the survey. Furthermore, the users were asked to express their view about their experience on the LMS platforms, which were off the time comments.

Below is the explanation and discussion about the each of the survey question mentioned in section 5.

Survey question 1 in section 4.1 is related to two usability heuristics as mentioned in Table 1. The two heuristics that are related to question 1 are flexibility and efficiency of use, aesthetic, and minimalist design. The heuristic flexibility and efficiency of use are mapped to this question. While registering into the LMS platforms, the authors wanted to check how flexible and efficient it is to join with the reference codes. The heuristic, aesthetic and minimalist design was mapped because the authors wanted to know if the LMS platforms use minimum steps to join the course with the provided reference code. The response for the survey question 1 was diverse can be observed in Figure 23. More than half of the respondents voted for both platforms with 55.6%, the canvas had 22.2%, while google classroom had 11.1%, and the remaining was voted for none. When these percentages are calculated in numbers, canvas has seven votes and google classroom has six votes; even though everyone in the survey was first time users for google classroom, the ballots for google classroom one less than canvas. So, it can be considered that the two usability heuristics matched with the LMS platforms are satisfied.

In survey question 2, specified in Figure 12, was mapped with two usability heuristics, namely visibility of the system status and help users recognise, diagnose, and recover from errors. The context to consider these heuristics was, when a user tries to upload a file, the user must be informed about the uploading and uploaded information of the file. The heuristic, visibility of the system status can be considered in this context because the user must be informed about the status of the process and the system in an interface. The other heuristic, help users recognize, dragonise, and recover from errors, was considered here as the interactive interface should inform the user about any errors that occur while doing a process in the system. The response to the question in Figure 24 leans towards the canvas. 66.7% of the respondents vote for canvas, and 33.3% vote for both. Total canvas gained nine votes, and google classroom gained three. So, it can be considered that the usability heuristics matched in question 2 are satisfied in the canvas application but not much of satisfaction in google classroom.

Figure 13 represents survey question 3, which was mapped with the usability heuristics, visibility of the system status, and flexibility and efficiency of use. The user was asked to upload a picture in assignment-2 and asked which of the platform's process was similar to the daily use applications. The heuristic visibility of the system status was matched because the user should be informed about the status of the process happening in the system. And the other heuristic, flexibility and efficiency of use was used to know whether the user found it efficient and precise to do the task assigned to them. The answers to this survey question lean towards google classroom. 55.6% of the population voted for google classroom, 22.2% voted for the canvas application, and 22.2% voted for both the platforms. In the calculation of percentages in number, the google classroom has seven votes, and the canvas has only four votes. So, it can be considered that the usability heuristics matched to the survey question 3 are satisfied in google classroom more when compared to the canvas application.

Survey question 4 is represented in Figure 14; the usability heuristic matched is the match between the system and the real world. This question is exclusively for google classroom. The context of this

question is to find out the word stream is matched between the system and the real world. The result of the question is in Figure 26, the answers for the survey question are varied. 33.3% of the respondents think the word stream means announcements, other 33.3% thinks streaming of a video, 22.2% think stream means dashboard and 11.1% opted for none of the above. In numbers, three voted for streaming of a video, three voted for announcements, two voted for the dashboard and one for none. Because of the variety of answers of the respondents, it is safe to say that google classroom does not satisfy the heuristic match between the system and the real world.

Survey question 5 is represented in Figure 15, the usability heuristic matched is the match between the system and the real world. The survey question is related to assignment 4, where the user is supposed to find the announcement section and do the task specified in the announcement. And the user should answer how much time did it take to complete the job on both platforms. In Figure 27, the bar graph is plotted for google classroom and canvas separately. In the case of canvas, seven out of nine were able to do the task in less than a minute, one of them was able to do the task in less than two minutes, and another one was not able to do the task at all. Participant 5, a canvas user, could not do the task because of a glitch. Whereas in the case of google classroom, everybody was able to finish the task. Two out of nine respondents were able to complete the task in less than one minute, five out of nine were able to complete the task in less than two minutes, and the other two were able to complete it in more than two minutes. This bar graph represents how much time it took for the participants to complete the task, in their opinion. However, the actual time for the completion of the task has been calculated. So, it can be considered the usability heuristic the match between the system and the real world is satisfied more in canvas. The conflicting point to be noted is, every respondent is a first-time google classroom user and were able to do the task successfully.

In survey question 6 in Figure 16, which is mapped with the usability heuristic, error prevention. The context of this question is to find out that the user was able to watch the video in assignment 5 without any interruptions. Respondent 5 had an issue while playing the video in the google classroom. In Figure 28, six out nine members most likely did not have any interruptions while watching the video, the other three rated four, three and two on the Likert scale out of five. So, it can be considered that usability heuristic error prevention is done in both platforms.

In survey question 7 in Figure 17, the usability heuristic matched is recognition rather than recall. The context of the survey question is to do the task specified in assignment 6, where the user has to find and message a user. In Figure 29, the bar graphs are plotted for google classroom and canvas separately. In the case of google classroom, two users were able to complete the task in less than one minute, two users were able to complete the task in more than two minutes, and five of them were not able to perform the task. Whereas in the case of canvas, three users were able to perform them in less than a minute, two of them were able to perform the task in less than two minutes, two of them were able to perform the task in more than two minutes, and two to them were unable to do the task. This bar graph represents how much time it took for the participants to complete the task, in their opinion. However, the actual time for the completion of the task has been calculated. The task was completed by most of the users in canvas, whereas only one user was able to complete the task in the google classroom. So, it can be considered that the canvas satisfies this usability heuristic.

In survey question 8 in Figure 18, the usability heuristic mapped is help and document. The question was to know if the user was able to find the help option in the LMS platforms. According to the responses to the question in Figure 30, 77.8% of the users voted for both, and 22.2% of the users voted for canvas. When the percentages are converted into numbers, then nine users are able to find canvas, and seven of them were able to find the help option in the google classroom. So, as it is a first time for every user with the google classroom, the number of votes is almost equal to the number of votes for canvas with a difference of two. The heuristic help and documentation are satisfied in canvas and google classroom.

In survey question 9 in Figure 19, mapped with usability heuristic consistency and standards. The context of this question is to find out does the LMS platforms maintain consistency and standards in the finding of the on-click action buttons. From the pie-chart shown in Figure 31, 66.7% of the users think

in both the platforms finding of the on-click action buttons was easy, and 33.3% think the on-click actions were easier to find on canvas. When the percentages are converted into numbers, the canvas has nine out of nine votes and google classroom has six votes. So, from this observation canvas satisfies wholly, and the google classroom satisfies the usability heuristic partially.

Survey question 10 in Figure 20, mapped with the usability heuristic user control and freedom. The context of this survey question is to find out whether the user will be able to undo any unwanted action in the LMS platforms. From the bar graphs shown in Figure 32, in the case of canvas, five out of nine were able to the specified task in one click, three were able to do it in less than five clicks, and one was able to do it in more than five clicks. Whereas in google classroom, three out of nine participants were able to do it in one click, five could do it in less than five clicks, and one could not do it. So, we can say that canvas satisfies this usability heuristic more than google classroom.

Survey question 11 in Figure 21 is the overall satisfaction of the user in the canvas application. From the results observed in Figure 33, variance and standard deviation was calculated. 4.06 and 2.01 are the variance and standard deviation of the canvas application, respectively.

Survey question 12 in Figure 22 is the overall satisfaction of the user in the google classroom application. From the results observed in Figure 34, variance and standard deviation was calculated. 1.55 and 1.24 are the variance and standard deviation of the google classroom application, respectively.

Comparing the variance of the LMS platforms, canvas has a more significant variance than the google classroom in the overall satisfaction rating by the respondents.

From the Appendix, the average time taken by a participant to complete the survey is 3 min 38 s. Participant 9 was the fastest to complete the survey under 2 min 01 s, and participant 7 was the slowest to complete the survey at 6 min 09 s.

The average time taken by a participant to complete the whole experiment is 26 min 57 s. Participant 4 was the fastest to complete the whole experiment under 19 min 58 s, and participant 1 was the slowest to complete the whole experiment at 32 min 03 s.

Refer to the Appendix of the participants to get to know about the thoughts of the users.

Google classroom did not have an option for messaging any other user in the interface. But the participant 4 could complete the task as specified in assignment 6 to message a specified user. This was an unexpected discovery made by the authors while doing the experiment with the user. At the same time, no other user had the option to message in the google classroom.

There were several glitches faced by the user while doing the formal experiment. Some of the users were not able to comment in the announcement and submission text area in canvas. The video went blank for one of the participants in google classroom. The google classroom's session expired when an opened google document is not used for a while. And a server rejected error was faced by one of the users while uploading a document into the google classroom.

Appendices related to survey question 5 and survey question 7 are the actual time of completion of the assignment and at what time the participants thought completed for assignment 4, and assignment 6, respectively.

In the appendix, survey question 5 related to the assignment 4, the respondents guessed the timing closer to the actual time calculated. Only one user was not able to do the task in the canvas because the user was unable to write in the announcement section. In the appendix, survey question 7 related to the assignment 6, most of the users were unable to do the task given to them in google classroom.

7 CONCLUSION AND FUTURE WORK

7.1 Conclusion

This study focuses on user satisfaction while using the LMS platforms like Canvas and google classroom, where usability heuristics are criteria for measuring user satisfaction. This experiment is conduction on the free versions of the selected LMS platforms. A course is introduced in both LMS platforms and created seven Assignments in them. Nine users were selected for the study, and they were logged into the LMS platforms under the authors' guidance and completed the assignments. Based on the course assignments, the survey questions are formulated and mapped to usability heuristics. The survey conducted in google forms, and the obtained results are depicted in graphs.

Based on the results, the Canvas web application satisfies all the usability heuristics were the google classroom web application satisfies only six out of ten usability heuristics, they are:

- Visibility of the system status
- User control and freedom
- Consistency and standards
- Error prevention
- Flexibility and efficiency of use
- Aesthetics and minimalist design
- Help and documentation

In final Canvas web application gives a better user experience than the google classroom web application within the scope of the study

7.2 Future Work

As future work, this study can be extended in different ways like

- Adding various assignments in the course.
- Adding more than one course to the LMS platforms.
- The survey can be conducted on a more extensive set of users.
- The survey can be conducted on a diverse group of users, such as teacher and students.
- The experiment can be performed on the paid version of selected LMS platforms.
- One can use HCI design principles or usability components for measuring the user's satisfaction.
- One can use various usability inspection method like cognitive walkthrough, formal usability inspection, pluralistic walkthrough, feature inspection, consistency inspection in place of survey evaluation.
- This study can conduct on the mobile versions of the selected LMS platforms.

8 REFERENCES

[1] N. Bevana, J. Kirakowskib, and J. Maissela, "What is Usability," 1991.

[2] C. D. Rosell and E. -learning Specialist, "9 Advantages of Powerful Learning Platforms or LMS | CAE," *CAE Computer Aided E-learning*, Jan. 21, 2021. https://www.cae.net/lms-learning-platforms-advantages/ (accessed Apr. 07, 2021).

[3] "b251093aee730ab9772db2e1a8a7eb8522cb.pdf." Accessed: Apr. 08, 2021. [Online]. Available: https://pdfs.semanticscholar.org/5f03/b251093aee730ab9772db2e1a8a7eb8522cb.pdf

[4] "What is Canvas?," Jul. 20, 2020. https://community.canvaslms.com/t5/Canvas-Basics-Guide/What-is-Canvas/ta-p/45 (accessed May 16, 2021).

[5] "Google Classroom," *Wikipedia*. May 15, 2021. Accessed: May 16, 2021. [Online]. Available: https://en.wikipedia.org/w/index.php?title=Google_Classroom&oldid=1023268512

[6] "SurveyResearchReading.pdf." Accessed: May 09, 2021. [Online]. Available: http://www.uky.edu/~kdbrad2/EPE619/Handouts/SurveyResearchReading.pdf

[7] S. Minhas, "Usability: A key part of design process," *Medium*, May 14, 2021. https://blog.prototypr.io/usability-a-key-part-of-design-process-f0d33cf69a97 (accessed May 16, 2021).

[8] G. Chao, "Human-computer interaction: The usability test methods and design principles in the human-computer interface design," in *2009 2nd IEEE International Conference on Computer Science and Information Technology*, Aug. 2009, pp. 283–285. doi: 10.1109/ICCSIT.2009.5234724.

[9] A. A. Bechina and E. Hustad, "A Framework to Understand Enablers and Inhibitors in a Learning Management System: Experiences from Fronter," p. 7, 2010.

[10] F. Martin, "Blackboard as the Learning Management System of a Computer Literacy Course," *J. Online Learn. Teach.*, vol. 4, Jan. 2008.

[11] J. Melton, "The LMS moodle: A Usability Evaluation," p. 25.

[12] R. E. Deakin and D. G. Kildea, "A Note on Standard Deviation and RMS," *Aust. Surv.*, vol. 44, no. 1, pp. 74–79, Jun. 1999, doi: 10.1080/00050351.1999.10558776.

[13] I. N. M. Shaharanee, J. M. Jamil, and S. S. M. Rodzi, "The Application of Google Classroom as a Tool for Teaching and Learning," vol. 8, no. 10, p. 4.

[14] K. Georgouli, M. Grivas, and P. Zahariou, "Different uses of an open code LMS for educational support," *Facta Univ. - Ser. Electron. Energ.*, vol. 18, no. 2, pp. 285–298, 2005, doi: 10.2298/FUEE0502285G.

[15] R. J. M. Ventayen, K. L. A. Estira, M. J. D. Guzman, C. M. Cabaluna, and N. N. Espinosa, "Usability Evaluation of Google Classroom: Basis for the Adaptation of GSuite E-Learning Platform," *Asia Pac. J. Educ.*, vol. 5, no. 1, p. 5, 2018.

[16] C. B. Mpungose and S. B. Khoza, "Postgraduate Students' Experiences on the Use of Moodle and Canvas Learning Management System," *Technol. Knowl. Learn.*, Sep. 2020, doi: 10.1007/s10758-020-09475-1.

[17] "259963.pdf." Accessed: Apr. 08, 2021. [Online]. Available: https://dl-acm-org.miman.bib.bth.se/doi/pdf/10.1145/259963.260531

[18] "What is a Margin of Error10," p. 68.

[19] T. J. McGill and J. E. Klobas, "A task–technology fit view of learning management system impact," *Comput. Educ.*, vol. 52, no. 2, pp. 496–508, Feb. 2009, doi: 10.1016/j.compedu.2008.10.002.

[20] "What is E-learning? Definition of E-learning, E-learning Meaning," *The Economic Times*. https://economictimes.indiatimes.com/definition/e-learning (accessed Jun. 04, 2021).

[21] N. Cavus, "Selecting a learning management system (LMS) in developing countries: instructors' evaluation," *Interact. Learn. Environ.*, vol. 21, no. 5, pp. 419–437, Oct. 2013, doi: 10.1080/10494820.2011.584321.

[22] "Canvas_Account_Comparisons.pdf." Accessed: May 29, 2021. [Online]. Available: https://s3.amazonaws.com/tr-learncanvas/docs/Canvas_Account_Comparisons.pdf

[23] “Differences between free and paid services - Google Classroom Community.” https://support.google.com/edu/classroom/thread/22751841/differences-between-free-and-paid-services?hl=en (accessed May 29, 2021).

APPENDIX

This section is about the recorded time of the participants to complete the tasks assigned to them in the LMS platforms, survey time and some the off the time comments suggested by them.

Participant-1

Total time: 32min 3 s

Assignments	Time taken to complete the task in Canvas	Time taken to complete the task in Google classroom
Assignment-1	2 min 23 s	1 min 42 s
Assignment-2	48 s	34 s
Assignment-3	38 s	55 s
Assignment-4	33 s	4 min
Assignment-5	3 min 46 s	35 s
Assignment-6	2 min 4 s	2 min 23 s
Assignment-7	32 s	1 min 3 s

Survey time: 2 min 34 s

Suggestions and views of the participant-

- Improvement needed in the design of the 'Help' icon in google classroom.
- Faced 'access expired' issues, solved by reloading the page in the google classroom.
- Had difficulty in finding the announcements section in the google classroom.
- Suggested to have an option for messaging beside the name of the person.

Participant-2

Total time: 28 min 37 s

Assignments	Time taken to complete the task in Canvas	Time taken to complete the task in Google classroom
Assignment-1	1 min 47 s	2 min 27 s
Assignment-2	50 s	38 s
Assignment-3	52 s	1 min 6 s
Assignment-4	1 min 25 s	2 min 5 s
Assignment-5	1 min 55 s	12 s
Assignment-6	2 min 20 s	2 min 18 s
Assignment-7	20 s	20 s

Survey time: 4 min 10 s

Suggestions and views of the participant-

- The user thinks google classroom is in the need of the user (student, teacher) profiles.
- The option ‘Report abuse’ is only present in google classroom but not in canvas.

Participant-3

Total time: 21 min 50 s

Assignments	Time taken to complete the task in Canvas	Time taken to complete the task in Google classroom
Assignment-1	1 min 50 s	51 s
Assignment-2	1 min 10 s	25 s
Assignment-3	30 s	29 s
Assignment-4	3 min 33 s	1 min 39 s
Assignment-5	10 s	6 s
Assignment-6	2 min 8 s	37 s
Assignment-7	32 s	20 s

Survey time: 2 min 30 s

Suggestions and views of the participants-

- Felt google classroom has good interface and is much simplified than canvas.
- Thinks canvas is outdated when compared to google classroom.

The user faced issues while texting people and writing in the submission text area. The pointer was not working properly.

Participants-4

Total time: 19 min 58 s

Assignments	Time taken to complete the task in Canvas	Time taken to complete the task in Google classroom
Assignment-1	1 min 44 s	1 min 8 s
Assignment-2	1 min 39 s	49 s
Assignment-3	28 s	19 s
Assignment-4	1 min 6 s	1 min 1 s
Assignment-5	42 s	35 s
Assignment-6	1 min 38 s	1 min 2 s
Assignment-7	17 s	28 s

Survey time: 3 min 56 s

Suggestions and views of the participant-

- The user felt google classroom had easier and an eye-catching interface.

- And canvas had many options which made it look clumsy.

Note: this is the only user in the survey to have the option to message another person in the course in google classroom. The authors are not sure of the reason as of why only this user had the message option to chat with the specified user in the google classroom and did not have the message option to chat with any other users present in the course.

Participant-5

Total time: 27 min 41 s

Assignments	Time taken to complete the task in Canvas	Time taken to complete the task in Google classroom
Assignment-1	2 min 15 s	1 min 45 s
Assignment-2	30 s	36 s
Assignment-3	52 s	34 s
Assignment-4	1 min 45 s	1min 58 s
Assignment-5	1 min 39 s	55 s
Assignment-6	2 min 23 s	1 min 37 s
Assignment-7	46 s	1 min 26 s

Survey Time: 4 min 15 s

Suggestions and views of the participant-

- Thinks canvas is easy to use.

The user had an issue while playing the video on google classroom, the screen went blank without playing the video.
This user had the same problem as the participant 3 in canvas, in the commenting section of the announcement and submission text area. Had to submit a word document instead of writing in the text area.

Participant-6

Total time: 23 min 28 s

Assignments	Time taken to complete the task in Canvas	Time taken to complete the task in Google classroom
Assignment-1	1 min 36 s	2 min 19 s
Assignment-2	18 s	3min 6 s
Assignment-3	21 s	40 s
Assignment-4	1 min 3 s	3min 37 s
Assignment-5	42 s	1 min 30 s
Assignment-6	1 min 3 s	1 min 2 s
Assignment-7	14 s	42 s

Survey Time: 2 min 47 s

Suggestions and views of the participant-

- Considers that improvements are needed in the submission section of the assignments in the google classroom.
- Considered canvas is a good interface.

Participant-7

Total time: 31 min 5 s

Assignments	Time taken to complete the task in Canvas	Time taken to complete the task in Google classroom
Assignment-1	2 min 46 s	50 s
Assignment-2	1 min 5 s	27 s
Assignment-3	42 s	1 min 18 s
Assignment-4	1 min 30 s	1min 35 s
Assignment-5	2 min 57 s	3min 17 s
Assignment-6	1 min 56 s	2 min 17 s
Assignment-7	30 s	25 s

Survey Time: 6 min 9 s

Suggestions and views of the participant-

- Felt canvas has its own video player and google classroom has you tube like video player.
- Wanted a profile for the users in google classroom as in the canvas website.
- Felt the navigation will be difficult in google classroom with addition of courses.

Participant-8

Total time: 24 min 30 s

Assignments	Time taken to complete the task in Canvas	Time taken to complete the task in Google classroom
Assignment-1	2 min	2 min 49 s
Assignment-2	30 s	2 min 6 s
Assignment-3	34 s	34 s
Assignment-4	1 min 17 s	2min 02 s
Assignment-5	10 s	1 min 15 s
Assignment-6	1 min 26 s	1 min 23 s

Assignment-7	31 s	46 s

Survey Time: 2 min 08 s

Suggestions and views of the participant-

- Felt canvas was more user friendly when compared to the google classroom.

Participant-9

Total time: 30 min 31 s

Assignments	**Time taken to complete the task in Canvas**	**Time taken to complete the task in Google classroom**
Assignment-1	2 min 41 s	2 min 27 s
Assignment-2	17 s	6 min
Assignment-3	20 s	18 s
Assignment-4	1 min 9 s	2 min
Assignment-5	15 s	3 min 37 s
Assignment-6	1 min 13 s	1 min 39 s
Assignment-7	18 s	18 s

Survey Time: 2 min 1 s

The only respondent of the survey who was not familiar with the platforms. The user was provided with a brief introduction of the platforms.

Suggestions and views of the respondents-

- Felt google classroom was easier to use than canvas.
- Felt messaging was difficult in canvas.

The user had an issue while uploading the BTH logo into the google classroom. A ‘Server rejected’ message was displayed.
As a first-time user of the platforms, the user would recommend google classroom to others.

Survey question 5- with respect to the assignment 4

The actual time of completion vs user guessed time of the submission by the participants.

Participant	Canvas (user expected time)	Canvas (actual time)	Google classroom (user expected time)	Google classroom (actual time)
Respondent 1	<1 min	33 s	>2 min	4 min
Respondent 2	<1 min	1 min 25 s	<1 min	2 min 5 s
Respondent 3	<1 min	3 min 33 s	<2 min	1 min 39 s
Respondent 4	<1 min	1 min 06 s	<2 min	1 min 01 s
Respondent 5	Unable to do	1 min 45 s	>2 min	1 min 58 s
Respondent 6	<1 min	1 min 03 s	<2 min	3 min 37 s
Respondent 7	<1 min	1 min 30 s	<1 min	1 min 35 s
Respondent 8	<1 min	1 min 17 s	<2 min	2 min 02 s
Respondent 9	<2 min	1 min 09 s	<2 min	2 min

Survey question 7- regarding the assignment 6

The actual time of completion vs user guessed time of the submission by the participants.

Participant	Canvas (user expected time)	Canvas (actual time)	Google classroom (user expected time)	Google classroom (actual time)
Respondent 1	<2 min	2 min 45 s	>2 min	2 min 23 s
Respondent 2	Unable to do	2 min 20 s	Unable to do	2 min 18 s
Respondent 3	<1 min	2 min 08 s	Unable to do	37 s
Respondent 4	>2 min	1 min 38 s	<1 min	1 min 02 s
Respondent 5	<2 min	2 min 23 s	Unable to do	1 min 37 s
Respondent 6	<1 min	1 min 03 s	Unable to do	1 min 02 s
Respondent 7	Unable to do	1 min 56 s	Unable to do	2 min 17 s
Respondent 8	<1 min	1 min 26 s	<1 min	1 min 23 s
Respondent 9	>2 min	1 min 13 s	>2 min	1 min 39 s


BLEKINGE TEKNISKA HÖGSKOLA
BTH