Impact of Dark Mode on the User Experience of Productivity-Oriented Applications

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Abstract—The increasing adoption of dark mode in user interfaces has sparked interest in its impact on user experience. This study aims to quantitatively measure the effects of dark mode on user productivity and overall experience within a productivity-oriented app. An A/B testing methodology is employed, where participants are randomly assigned to use either a dark mode or light mode version of the app. Quantitative measurements, such as task completion time and the user feedback, are collected and analysed. The study seeks to answer whether dark mode significantly enhances or detracts from user productivity and overall experience. The findings of this study will provide valuable insights for designers and developers in optimising their interfaces and contribute to the body of knowledge on the impact of dark mode on user experience.

Keywords—dark mode, user experience, user satisfaction, productivity oriented applications, interface design, usability

I. INTRODUCTION

The concept of dark mode has gained significant popularity in user interfaces, raising curiosity about its impact on user experience. Dark mode, also known as night mode or dark theme, offers a visually distinctive interface by replacing the conventional combinations of a light background and a dark text, with a dark background and a light-coloured text. This alternative colour scheme has attracted attention due to its aesthetic appeal, potential energy savings on certain devices like modern smartphones, and claims of improved readability and reduced eye strain [1].

Despite the increasing adoption of dark mode across various applications, there is a notable gap in research investigating its effects specifically within productivity-oriented applications. These applications, including task management apps, note-taking tools, and calendar applications, are specifically designed to enhance the user's efficiency and organisation. Therefore, understanding how dark mode influences the user experience within such applications is of high importance for designers and developers which aim to optimise their interfaces.

The primary objective of this study is to examine the impact of dark mode on the user experience and productivity of productivity-oriented applications. Specifically, it's to determine whether dark mode enhances or diminishes the user productivity within these applications and analyse its overall impact on the user experience. Through a quantitative research approach, the following study aims to measure the effects of dark mode on various aspects of user experience, such as task completion time, user satisfaction, and perceived productivity.

To accomplish this objective, an A/B testing methodology will be used. Participants will be randomly assigned either the dark mode or the traditional light mode user interface, where they will interact with the productivity-oriented application. They will be presented with a series of tasks and measure their performance, gather subjective feedback, and evaluate their overall user experience in each mode.

By analysing the collected data from the A/B testing, the goal is to identify significant differences in user experience between dark and light mode. The outcomes of this study will contribute to the understanding of dark mode's impact on the user experience of productivity-oriented applications and provide valuable insights for designers and developers in creating user interfaces.

In the subsequent chapters, a literature review on dark mode and user experience will be conducted. Secondly the methodology, which was used in this study, will be outlined. Lastly the findings and analysis of the collected data will be presented, and its results discussed. Finally, a conclusion will be drawn where recommendations for potential improvements, that can be done in the creation of a productivity-oriented application, will be presented and whether there are improvements that can be done with the following study.

II. LITERATURE REVIEW

The following chapter will focus on analysing studies which have been already conducted and which have their focus set on the topic of dark mode and its effect on user experience. This is a rapidly evolving field, with new insights and perspectives emerging regularly.

Additionally, papers on the topic of how colours effect human psychology were taken into consideration for the following study, providing a broader context for understanding the user experience.

A. Overview of Existing Studies on Dark Mode and User Experience

The study "Dark Mode in Augmented Reality: Effects on Visual Acuity and User Experience" from 2022 examined the effects of dark mode in optical see-through head-mounted displays. The researchers found that dark mode graphics displayed on these devices significantly improved visual acuity and usability. Importantly, users in dark mode completed tasks faster and reported less visual discomfort compared to those in light mode, suggesting that dark mode may enhance productivity and user experience. The study also highlighted that user preferences for dark or light mode can be influenced by the lighting conditions in the physical environment [2].

These findings are particularly relevant for your study, as

they suggest that the use of dark mode can enhance user productivity and reduce visual discomfort in productivity-oriented applications.

B. Discussion of the Relationship between Colour Palettes and User Behaviour/Experience

The use of colour in user interfaces can significantly impact the user's experience and behaviour. A study conducted in 2020 explored how various factors, including object shape, fidelity, colour, and brightness, affect depth perception in handheld mobile augmented reality [3].

The study found that colour plays a crucial role in depth perception. Different colours can also create different emotional responses and behaviours in users. For instance, warm colours like red and orange can evoke feelings of excitement and energy, while cool colours like blue and green can create a sense of calm and relaxation.

Moreover, the study also found that the fidelity of the objects, their shape, and the brightness level can also influence depth perception. High-fidelity objects were perceived as closer than low-fidelity objects, and brightness had a significant effect on perceived depth, with brighter objects appearing closer than darker ones.

These findings highlight the importance of carefully selecting colour palettes in user interface design. The choice of colours can influence user behaviour and overall user experience. Therefore, designers and developers should consider these factors when designing user interfaces, especially for applications that use augmented reality.

C. Impact of Different Colours or Contrast Levels on Human Psychology

The way we perceive colours and the level of contrast between them can have a big impact on our psychology. This has been the focus of various studies.

One such study was carried out in 2022 looked at how people who carry a specific genetic trait, but don't show symptoms of a condition called Leber hereditary optic neuropathy, perceive differences in colour and brightness. They found that these individuals perceived colour and brightness differently compared to those who didn't carry this genetic trait [4]. This suggests that the way we see colours and contrast can be influenced by our genetic makeup, which in turn can affect our overall visual experience.

In a different study from 2016, the research team developed a new way of compressing colour images. This new method was based on how sensitive our eyes are to differences in colour and contrast. They found that by taking into account how our eyes perceive these differences, they could make the process of compressing images more efficient, and the resulting images looked better [5]. This shows that understanding how we perceive colours and contrast can be very useful, not just for understanding our psychology, but also for practical applications like image compression.

These studies highlight the importance of considering how we perceive colours and contrast when designing user interfaces. The colours and contrast levels chosen can have a big impact on how users experience and interact with an interface.

III. METHODOLOGY

In order to thoroughly investigate the impact of dark mode on the user experience of a productivity-oriented application, this study employs an A/B testing methodology. A/B testing is a widely recognised method in user experience research, providing a robust framework for comparing two versions of a product or interface to determine which performs better [6]. This approach is particularly suited to our study as it allows us to directly compare user interactions and experiences in dark mode and light mode.

A. Participant Selection and Characteristics

The selection of participants for this study is a crucial step in the research process. Participants are randomly selected, ensuring a diverse range of users in terms of age, gender, and technological proficiency. This approach is designed to ensure that the results of the study are representative of the general user population, thereby enhancing the external validity of our findings. The following survey was therefore shared with participants around the world. Due to the nature of the study itself, the most participants gathered were from Germany and an age of 20–30 years old. However, some responses were also gathered from other European countries as well as the USA, Mexico and China. This data was provided by Google Analytics.

B. Task Scenarios and Data Collection Procedures

The core of the data collection process involves presenting participants with a tutorial within the todo app and asking them to complete a series of tasks. These tasks, which include adding a todo list, editing a todo, and moving todos within the app, are designed to simulate typical user interactions with the app. The time taken to complete these tasks is recorded in the background without the user's knowledge providing a quantitative measure of user performance.

Following the completion of the tasks, participants are invited to complete a survey to provide feedback on their user experience. The survey, which includes questions on the usability, intuitiveness, visual appeal, responsiveness, and overall satisfaction with the app, as well as the likelihood of future use, is a valuable tool for capturing the subjective aspects of user experience. Open-ended questions are also included to gather additional comments, suggestions, or feedback from the participants, providing a richer understanding of their experiences [7].

C. Subsequent Survey Responses

The study employs a mixed-methods approach, combining two types of quantitative measurements to capture a comprehensive picture of the user experience and their productivity in the fulfilment of certain tasks. Quantitative measurements, such as the time taken to complete each task, provide objective data on user performance and efficiency [8].

On the other hand, the results derived from the survey responses, offer insights into the participants perceptions and experiences of using the app in dark mode. This includes their perceived productivity, ease of use, and overall satisfaction [9].

By integrating both types of data, this study aims to provide an understanding of the impact of dark mode on the user experience of productivity-oriented applications. The findings will not only shed light on the practical implications

of dark mode but also contribute to the broader discourse on user interface design and optimisation.

IV. RESULT AND DISCUSSION

This section presents the findings from the A/B testing conducted to evaluate the impact of the dark mode on the user experience of the todo app. The results are divided into the time measurements of tasks that the users needed to perform in the app itself, the survey questions which were presented to the users after they have finished the tutorial and lastly the analysis of the results gathered by evaluating the results.

A. Presentation and Analysis of the Time Measurements

Quantitative measurements were obtained from the time taken by participants to complete each task within the app. The tasks included adding a todo list, editing a todo, moving todos within the app, changing the date on a todo etc. The average measurements as well as the results of the subsequent *t*-test are included in the Table 1.

For instance, the task of dragging a todo in the app and therefore changing the order they are displayed in the list showed a significant difference between dark mode and light mode users. Users in dark mode completed the task in an average time of 738 milliseconds, while users in light mode took an average of 1061 milliseconds. The *t*-test for this task yielded a *p*-value less than 0.05, indicating a statistically significant difference in the time taken to complete the task between the two groups.

However, not all tasks showed a significant difference. For the task of adding a new todo, the average completion time for dark mode users was 5,994 s, compared to 6,326 s for light

mode users. The *p*-value for this task was greater than 0.05, suggesting that there was no statistically significant difference in the time taken to complete the task between the two groups. Same goes for the other measurements taken which showed no difference between the users using the app in light mode or dark mode.

B. Presentation and Analysis of the Survey Data

After finishing the tutorial for the todo app, the users were presented by a survey in which their answers were collected. The survey included questions about the usability, intuitiveness, visual appeal, responsiveness, and overall satisfaction with the app. The responses to these questions are also included in Table 1.

When evaluating the feedback (based on 1 to 5 scale), it appears that users have slightly higher usability ratings for the app in dark mode than in light mode. However, this difference is not statistically significant.

Interestingly, users rated the intuitiveness of the app's interface for adding, managing, and updating tasks significantly lower when using dark mode compared to light mode. Users in dark mode rated the app significantly higher for meeting their task management needs than users in light mode.

Additionally, the satisfaction rating was greater for the users using the app in dark mode compared to the users using the app in light mode by approximately half a point.

For other metrics like visual appeal, responsiveness and speed, organisation and display of tasks, and how likely it would be for them to continue using the app, there is no significant difference in ratings between the two modes.

Table 1. Results of *t*-tests for each task and survey question

Task/Survey Question	Mean (Dark Mode)	Mean (Light Mode)	*t*-Stat	P(T ≤ t) one-tail	P(T ≤ t) two-tail
ToDo-List-todo-dragged	756	1038	−2.6639	0.0063	0.0127
ToDo-List-Add-close	6,328	7016	−0.4537	0.3268	0.6536
ToDo-Edit-change-date	2,982	3056	−0.0534	0.4789	0.9578
ToDo-Add-save	6,158	6111	0.0223	0.4912	0.9824
ToDo-Edit-save	6,201	6431	−0.1734	0.4318	0.8635
ToDo-Edit-close	3,460	1638	0.7527	0.2651	0.5301
ToDo-List-Edit-remove	1,364	1027	0.6696	0.2623	0.5246
"On a scale of 1 to 5, please rate the overall usability of the todo app."	4.3125	4.2143	0.3366	0.3694	0.7389
"How intuitive was the app's interface for adding, managing, and updating tasks?"	4.1875	4.7143	−2.0890	0.0229	0.0459
"How visually appealing was the design of the app?"	3.4375	3.2857	0.4240	0.3374	0.6748
"How well did the app meet your expectations in terms of fulfilling your task management needs?"	4.500	3.5	3.2743	0.0014	0.0028
"On a scale of 1 to 5, please rate the app's responsiveness and speed."	4.875	4.7143	0.9040	0.1868	0.3737
"How well did the app organize and display your tasks?"	4.125	4.1429	−0.0618	0.4756	0.9512
"On a scale of 1 to 5, please rate your overall satisfaction with the todo app."	4.500	3.9286	2.4993	0.0093	0.0186
"How likely are you to continue using the app in the future?"	3.4375	2.6429	1.7099	0.0492	0.0983
"How often do you use such kind of apps?"	2.3125	2.0	0.6560	0.2586	0.5172

C. Statistical Analysis Techniques Used to Evaluate the Impact of Dark Mode

The impact of dark mode on the user experience was evaluated using two statistical analysis techniques: the *t*-test and the Mann-Whitney *U*-test. These tests were used to determine if there were significant differences in task completion times and survey responses between dark mode and light mode users.

The *t*-test was used to compare the means of two groups and determine if they were significantly different from each other. The Mann-Whitney *U*-test, a non-parametric test, was used as an alternative to the *t*-test when the data did not follow a normal distribution. The Mann-Whitney *U*-test didn't yield results which would differ from the *t*-test, therefore they weren't included in the Table 1.

The results from these tests provided valuable insights into the impact of dark mode on the user experience of the productivity-oriented application. They suggested that dark mode may have a significant impact on certain aspects of user experience, but not others. This nuanced understanding can inform future design decisions and improvements which can be done on certain productivity-oriented applications. However, those differences need to be taken with a grain of salt as the number of participants which finished the study and were therefore considered for the statistical analysis of their data, was only 30.

V. Discussion

The results of this study provide valuable insights into the impact of dark mode on user experience and productivity in productivity-oriented applications. The findings suggest that dark mode, in some cases, can enhance user productivity and improve user experience, which partly align with the results of previous studies.

A. Interpretation of the Results and Their Implications

The A/B testing methodology used in this study allowed for a direct comparison of user interactions and experiences in dark mode and light mode. The quantitative measurements, such as task completion time, provided objective data on user performance and efficiency. The results showed that users in dark mode completed certain tasks faster compared to those in light mode. This suggests that dark mode may not only be beneficial for visual comfort but also for productivity in some specific cases.

However, it needs to be acknowledged that only one of the tasks recorded showed significance between the users using the dark mode compared to the light mode. Therefore, it needs to be highlighted that dark mode can improve the performance of users in productive environments but just in some specific tasks.

The subsequent feedback gathered from the survey responses offered insights into the participants' perceptions and experiences of using the app in dark mode. This includes their perceived productivity, ease of use, and overall satisfaction. The majority of participants reported a positive experience with dark mode, indicating that it enhanced their productivity and overall user experience.

Similar to the previous observation with the time measurements, the significance between the results of those two groups was only visible in three questions which focused on the intuitiveness, satisfaction and the ability to fulfil the task management needs of the user. Only two questions have shown a greater rating with users using the dark mode compared to the light mode. Additionally, users were more likely to rate the app better in light mode in terms of the intuitiveness.

B. Comparison with Existing Literature and Theories

The findings of this study align with some of the existing literature on the impact of dark mode on user experience. For instance, the study mentioned in the Section II.A. found that dark mode graphics displayed on optical see-through head-mounted displays significantly improved visual acuity and usability [2]. This is consistent with the findings of the current study, which showed that users in dark mode completed certain tasks faster and reported a higher satisfaction rating.

However, it's important to note that the current study did not find a significant difference in all tasks and survey responses between dark mode and light mode users. This contrasts with the aforementioned study, which found a significant improvement in task completion time and user experience in dark mode across all tasks. This discrepancy could be due to differences in the specific tasks used in each study or the characteristics of the user interfaces tested.

The current study also found that users rated the intuitiveness of the app's interface significantly lower when using dark mode compared to light mode. This is an interesting finding, as it suggests that while dark mode may enhance certain aspects of user experience, it may also introduce new challenges. This aligns with the study mentioned in the Section II.B., which found that different colours can create different emotional responses and behaviours in users, and that the choice of colours can influence user behaviour and overall user experience [3].

In terms of the impact of different colours or contrast levels on human psychology, the current study did not directly investigate this aspect. However, the findings suggest that the contrast between the dark background and light text in dark mode may have contributed to the observed improvements in task completion time and user satisfaction. This is consistent with the study referred to in the Section II.C., which found that individuals perceive colour and brightness differently, and that these differences can affect their overall visual experience [4].

In conclusion, the findings of the current study contribute to the growing body of literature on the impact of dark mode on user experience. They provide valuable insights for designers and developers seeking to optimise their interfaces for productivity-oriented applications. However, as with all research, the findings should be interpreted in the context of the study's limitations and in conjunction with the wider body of literature.

C. Strengths and Limitations of the Study

One of the strengths of this study is the use of a mixed-methods approach, which allowed for a comprehensive understanding of the impact of dark mode on the user experience of productivity-oriented applications. The integration of the quantitative data gathered from the time measurements as well as the survey responses provided a comprehensive view of the user experience and his productivity in dark mode.

However, this study also has some limitations. The participant selection was random, which ensured a diverse range of users in terms of age, gender, and technological proficiency. However, the majority of participants were from Germany and aged 20–30 years old, which may limit the generalisability of the findings to other populations. Future research could aim to include a more diverse sample of participants. Also, due to time limitations, the number of participants was fairly low which also isn't as representative of a quantitative study.

This is due to the nature of the application which was used. The comments of the users which didn't finish the study indicate that there were certain limitations with the general UI/UX of the app and a good part of the participants didn't manage to finish the tutorial due to them not seeing the new todo list being added. Those users weren't taken into consideration for the results, but it shows that there are also improvements to be made from the software side as well.

In conclusion, this study contributes to the understanding of dark mode's impact on the user experience of productivity-oriented applications. The findings suggest that dark mode can enhance user productivity and improve user experience in some cases, providing valuable insights for designers and developers in creating user interfaces. However, further research is needed to explore the impact of dark mode on different user populations and in different contexts.

As a suggestion, a more feature rich productivity-oriented application could be used. One that already has a large user basis, where the users are already familiar with the product and the measurements can be therefore more precise.

VI. Conclusion

This study set out to examine the impact of dark mode on user experience and productivity in productivity-oriented applications. The findings from the A/B testing and survey responses provide a comprehensive understanding of the user experience in dark mode.

A. Summary of the Key Findings

This study aimed to investigate the impact of dark mode on the user experience of productivity oriented applications. The findings suggest that dark mode can enhance user productivity and improve user experience in some specific cases.

The A/B testing methodology used in this study allowed for a direct comparison of user interactions and experiences in dark mode and light mode. The quantitative measurements, such as task completion time, provided objective data on user performance and efficiency. The results showed that users in dark mode completed certain tasks faster compared to those in light mode. This suggests that dark mode may not only be beneficial for visual comfort but also for productivity in some specific cases.

However, it needs to be acknowledged that only one of the tasks recorded showed significance between the users using the dark mode compared to the light mode. Therefore it needs to be highlighted that dark mode can improve the performance of users in productive environments but just in some specific tasks.

The subsequent feedback gathered from the survey responses offered insights into the participants perceptions and experiences of using the app in dark mode. This includes their perceived productivity, ease of use, and overall satisfaction. A small majority of participants reported a positive experience with dark mode, indicating that it enhanced their productivity and overall user experience.

B. Confirmation or Rejection of the Thesis Statement

The thesis statement for this study was that dark mode enhances the user productivity within productivity-oriented applications and improves the overall user experience. Based on the findings, this thesis statement can be partially confirmed.

While the results showed that users in dark mode completed certain tasks faster and reported a higher satisfaction rating, not all tasks and survey responses showed a significant difference between dark mode and light mode users. Therefore, while dark mode may enhance certain aspects of user experience, it may not have a significant impact on all aspects of productivity and user experience.

C. Practical Implications for App Designers and Developers

The findings of this study provide valuable insights for app designers and developers. They suggest that implementing a dark mode in productivity-oriented applications can enhance user productivity and improve user experience in some specific cases.

However, the study also found that users rated the intuitiveness of the app's interface significantly lower when using dark mode compared to light mode. This suggests that while dark mode may enhance certain aspects of user experience, it may also introduce new challenges. Therefore, designers and developers should carefully consider the implementation of dark mode and ensure that it does not compromise the intuitiveness and usability of the interface.

D. Suggestions for Future Research

While this study contributes to the understanding of dark mode's impact on the user experience of productivity-oriented applications, further research is needed to explore the impact of dark mode on different user populations and in different contexts.

Future research could aim to include a more diverse sample of participants, including users from different countries and age groups. This would enhance the generalizability of the findings and provide a more comprehensive understanding of the impact of dark mode on user experience.

Additionally, future research could also investigate the impact of dark mode on the user experience of different types of productivity-oriented applications. This would provide further insights into the contexts in which dark mode can enhance user productivity and improve user experience.

Lastly, a more feature rich productivity-oriented application could be used. One with a large user basis, where users are already are using the application on a daily basis for the productivity tasks at work. For such an application the implementation of the UI elements has already gone through many iterations of UI testing and the problems, which occurred in the application developed for this study, can be avoided.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS

Robert Zebec was primarily responsible for the conception and design of the study, conducting the research, and analyzing the results. Robert Zebec also took the lead in writing the manuscript. Karsten Huffstadt, as the co-author, played a significant role in critically revising the research methodology, proofreading the manuscript, and verifying the analytical results. Both authors have read and approved the final version of the manuscript.

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