

HCI in Visualisation:

Impact of Environment on Analysis of 3D Data

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Introduction

- Once data has been projected to 3D, how is it best presented for analysis?
- Study to compare the effectiveness of an immersive against a non-immersive environment for the analysis of complex 3D data.
- Synthetic datasets generated using GMMs which included 300, 350 or 400 data points.

Study Set-up

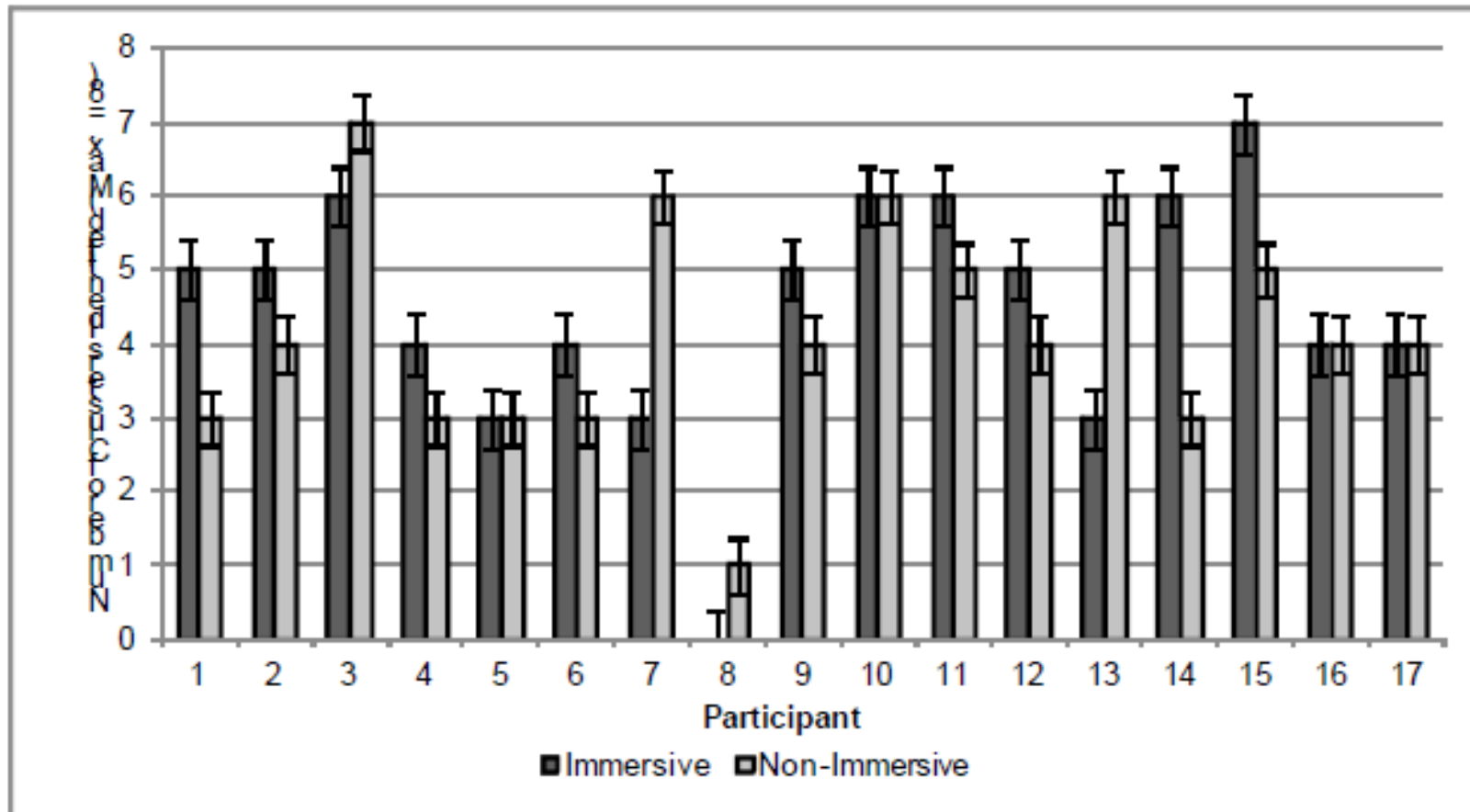
- A within-groups, counter-balanced study protocol in which each participant used both our immersive and our non-immersive visualisation environment to complete a set of prescribed tasks.
- The order in which participants were exposed to the different visualisation environments was counter-balanced to mitigate against the effects of learning – i.e., half of the participants used the immersive environment first and then the non-immersive environment, with the other half using the environments in the opposite order.
- Use of different seeds enabled us to generate non-identical datasets of similar properties.

Task Definition

- Participants were shown the first dataset and asked to identify – by entering the reference for the centre point – as many clusters as they believed were present. Described, in free text, the clustering within the dataset.
- Also asked to identify – again by reference – as many outliers as they believed were present in the data.
- It was left up to the participants to define/interpret what constituted a cluster and an outlier.
- Repeated for a second dataset.
- Participants also asked to identify changes between two datasets from four choices.
- Completed a paper-based NASA TLX1 questionnaire to reflect on the workload associated with the visualisation environment.
- 24 participants: 17 valid records.
- No difference in outlier detection.

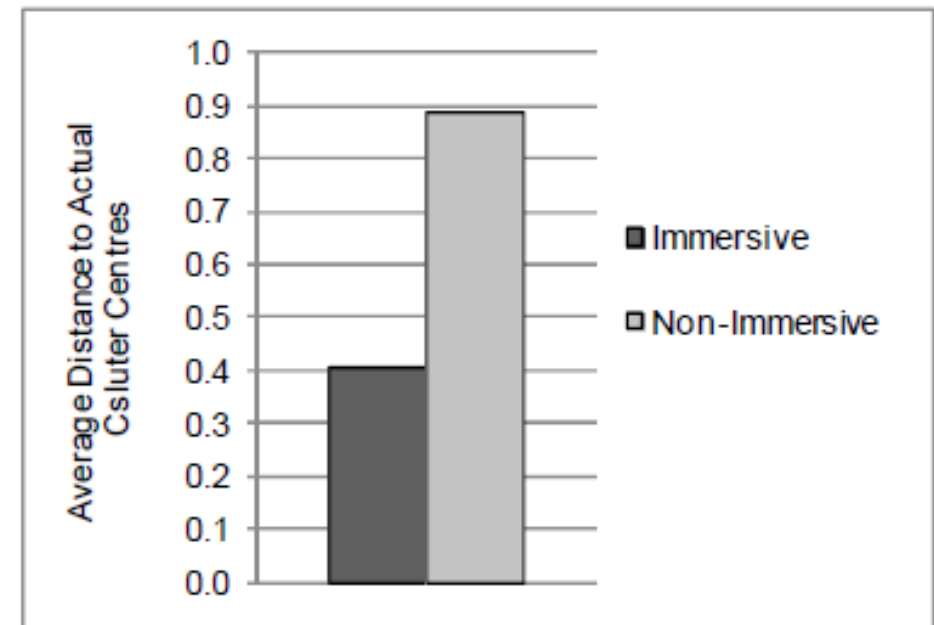
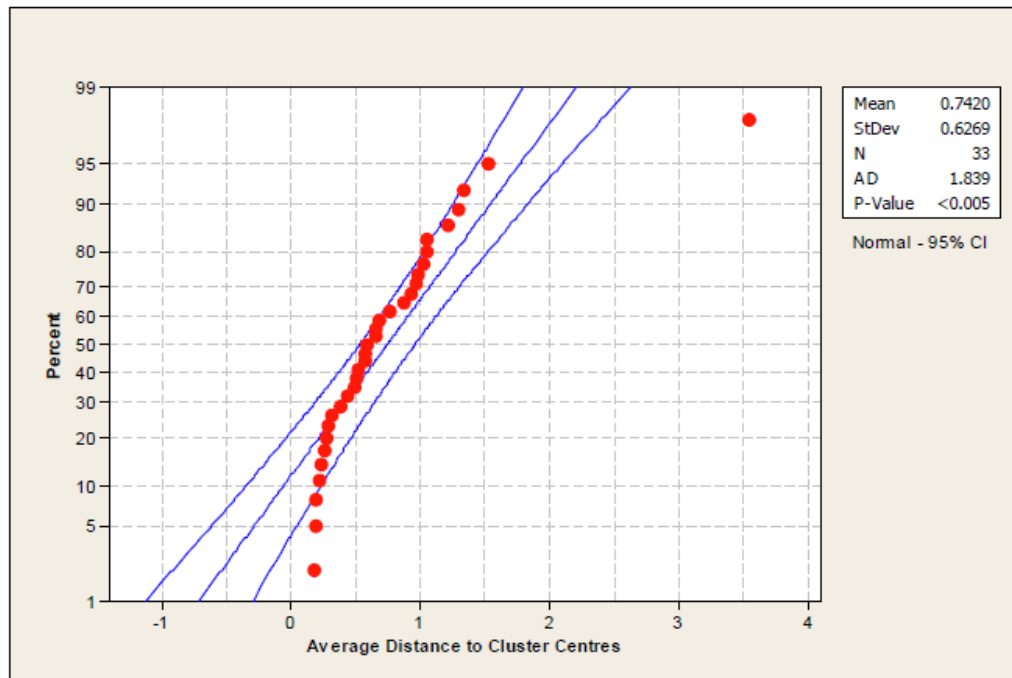
Cluster Identification

- 8 clusters: average identified in immersive was 4.5; non-immersive was 4.2.



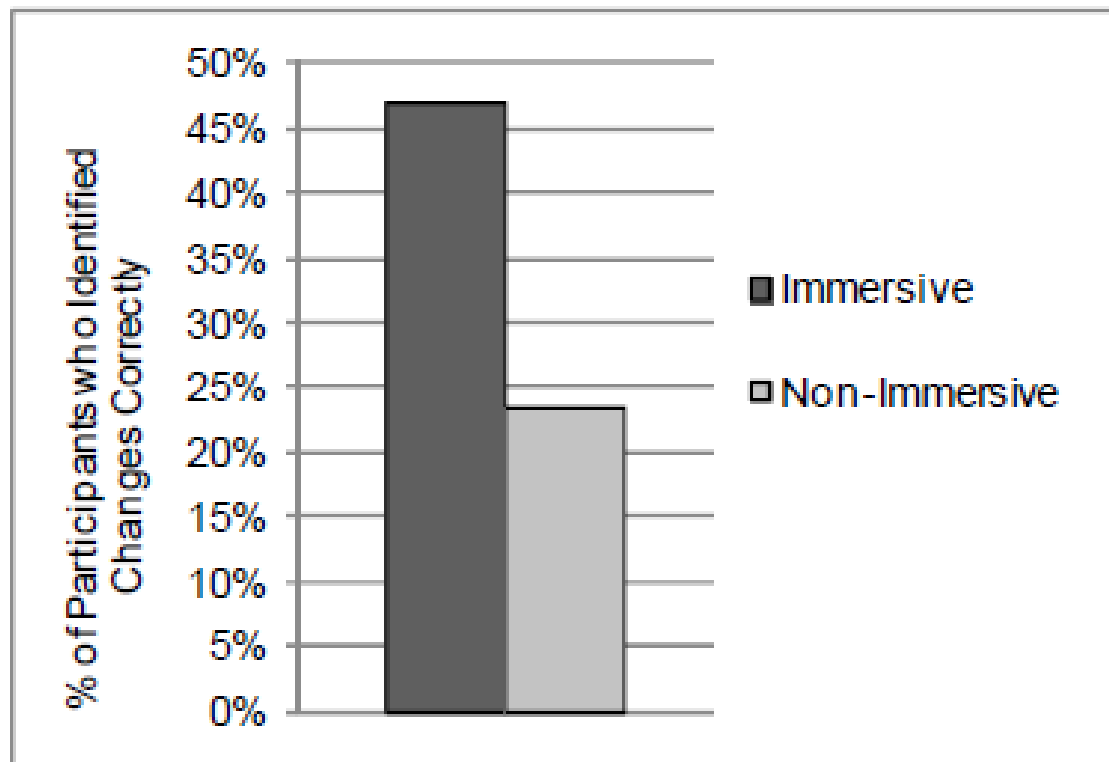
Cluster Identification Accuracy

- Next considered average distance to cluster centre.
- Excluded outlier – rest has a normal distribution.
- Two-sample t-test was significant ($p < 10^{-4}$).
- Being able to immerse oneself within a complex dataset increases one's ability to accurately identify data points relative to the spatial location of clusters.



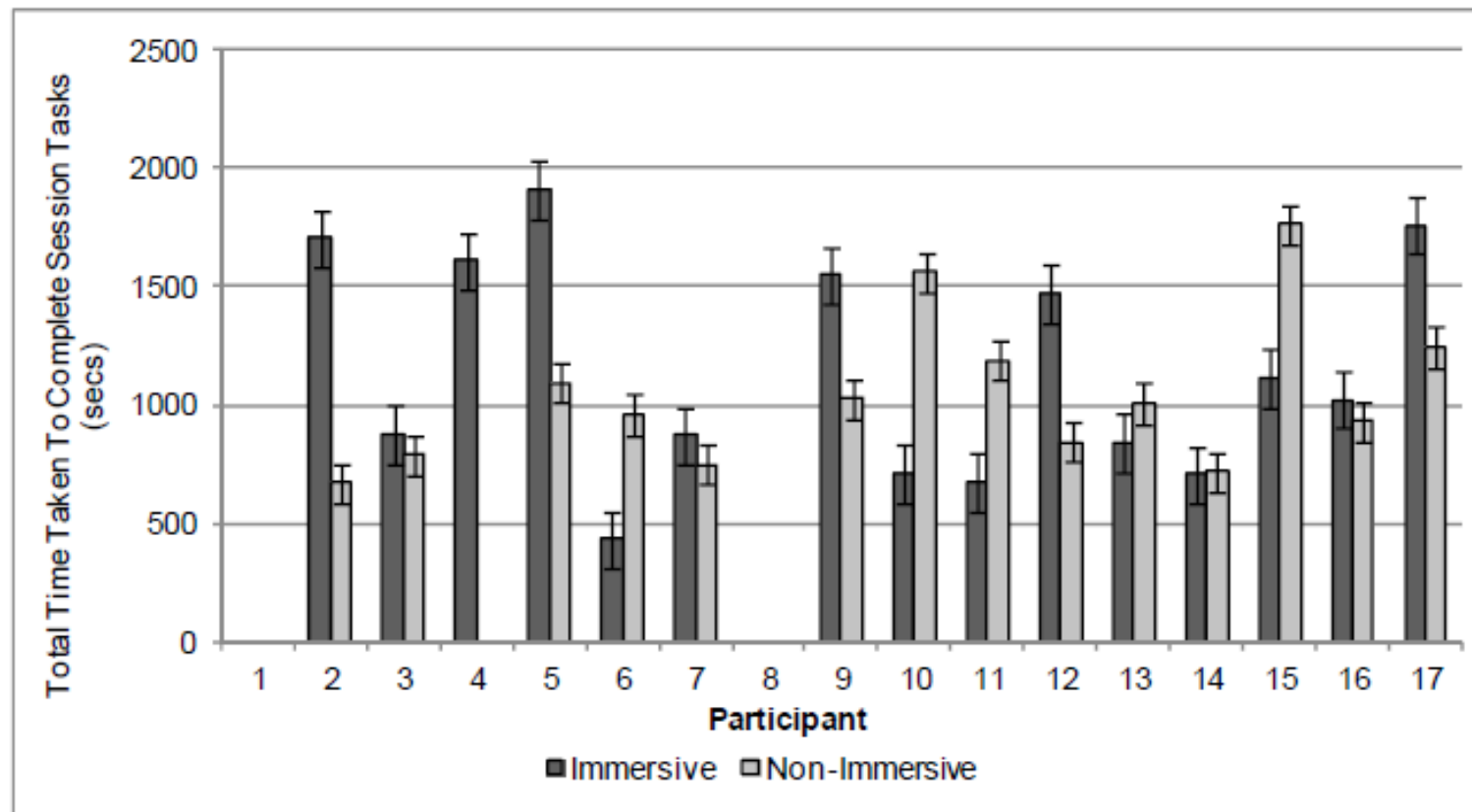
Dataset Changes

- Almost half (47.1%) of the participants using the immersive environment could accurately detect the changes in a dataset compared to less than one quarter (23.5%) of participants using the non-immersive environment.



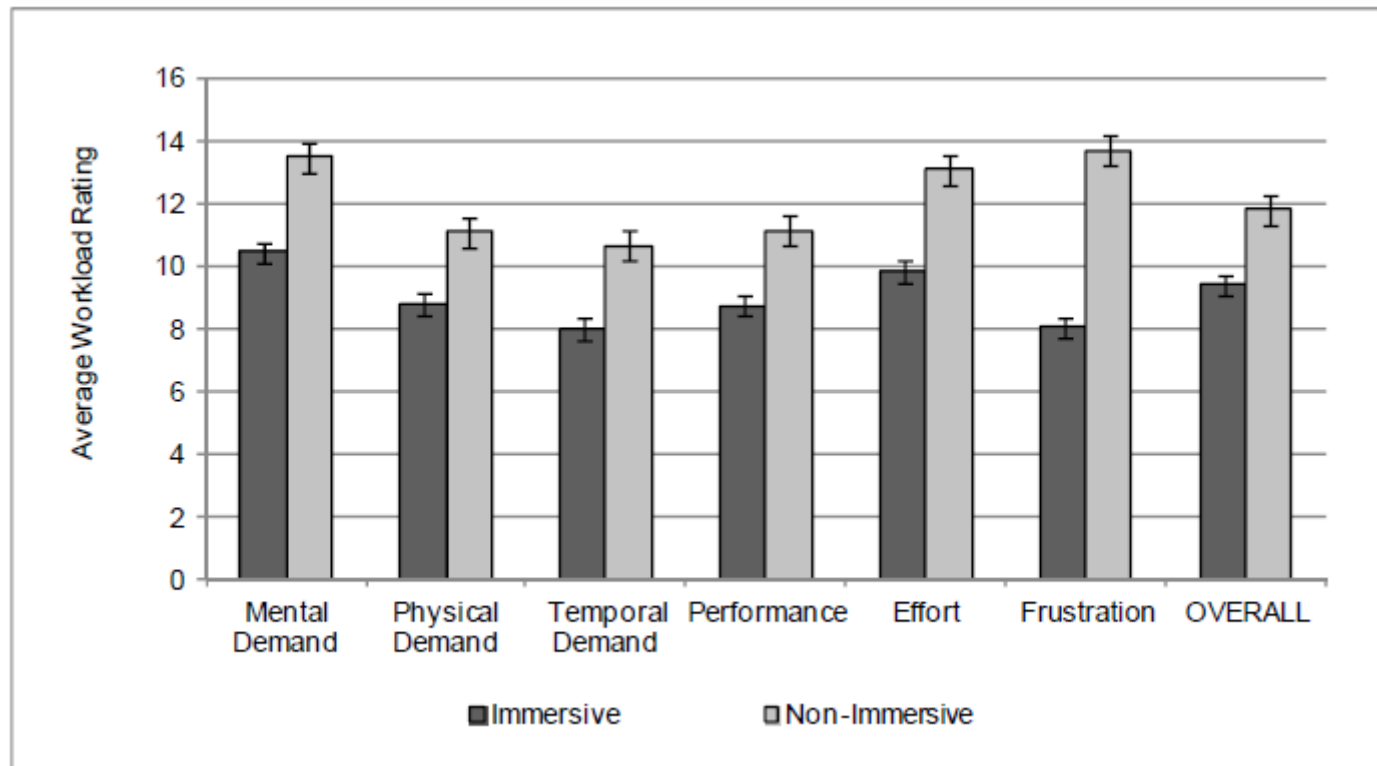
Speed of Analysis

- Took slightly longer to complete tasks using the immersive environment (average of 1117s compared to an average of 1039s), but this was not statistically significant ($p=0.622$).



Subjective Response

- Of those that responded, 82.6% stated a preference for the immersive environment,
- 73.9% stated that the immersive environment was more enjoyable,
- 90% stated that the immersive environment was more effective than the non-immersive environment.

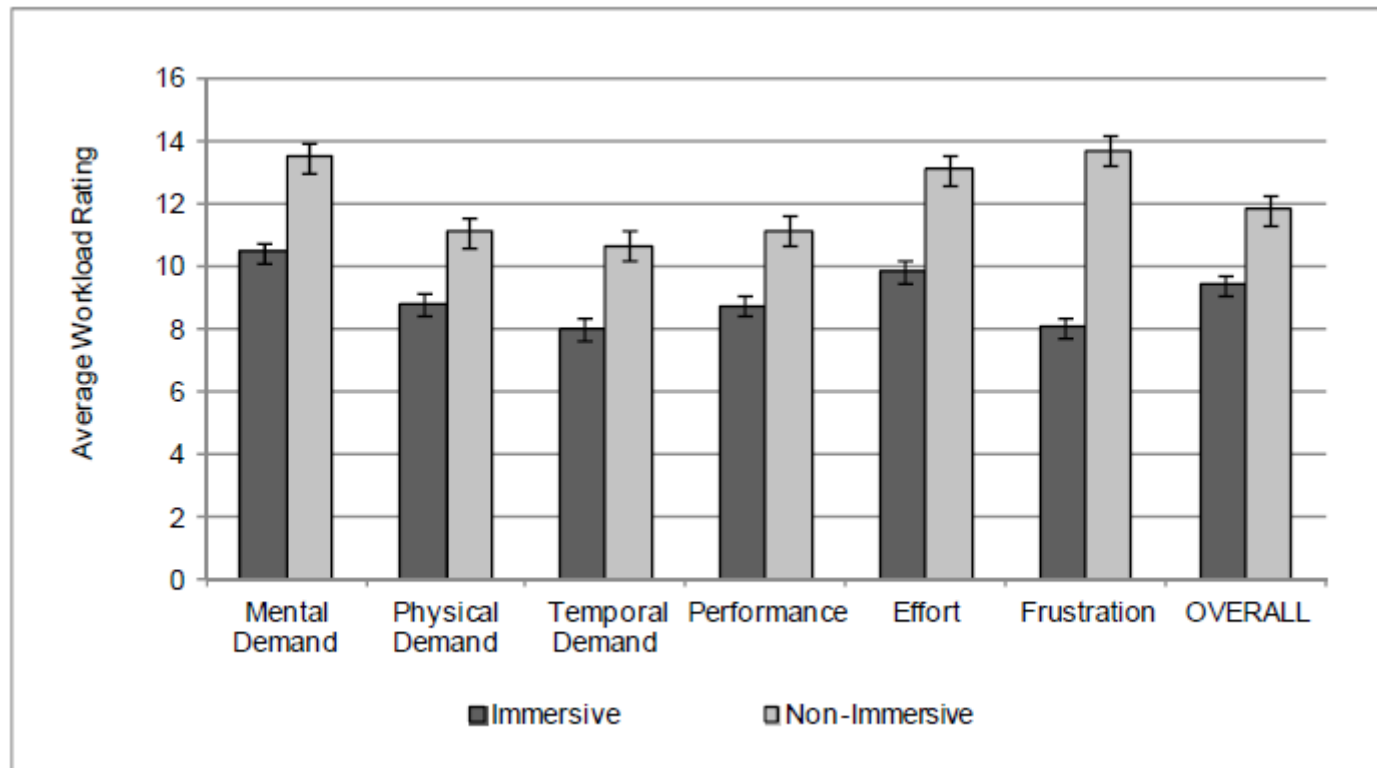


Conclusions

- Immersive environment does not reduce the time taken to analyse complex sets of 3D data.
- It does show potential for supporting users to
 - achieve increased accuracy in data point identification/selection
 - increased ability to visually record and retain dataset patterns and to then accurately identify changes in the data.
- It also shows potential for
 - reducing the workload associated with complex 3D data analysis activities
 - eliciting a better subjective response from users – an important factor in attaining user acceptance and adoption of a technology.

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