6-14-2024

Machine Learning To Predict Children's Digital Maturity

Aqib Siddiqui
IE Business School, IE University, aqib.siddiqui@student.ie.edu

Konstantina Valogianni
IE University, konstantina.valogianni@ie.edu

MACHINE LEARNING TO PREDICT CHILDREN'S DIGITAL MATURITY

TREO Paper

Aqib Siddiqui, IE Business School, Madrid, Spain, aqib.siddiqui@ie.edu

Konstantina Valogianni, IE Business School, Madrid, Spain, konstantina.valogianni@ie.edu

Abstract

Over the past years, increased ICT usage among children has resulted in negative health outcomes. Studies show that prolonged use of ICTs by children poses significant concerns for their physical and mental well-being. Our approach employs a Design Science based approach that uses Deep Reinforcement Learning to identify and analyze patterns of ICT usage and Digital Maturity in children. We classify children into categories based on their digital maturity. High digital maturity reflects responsible, respectful self-learners, while moderate digital maturity denotes autonomous behavior with respect for others but limited individual growth. Low digital maturity is associated with maladaptive behaviors, cyber-crimes, and poor well-being. Our predictive model has a prediction F1 score of 96.6%. This work can help uncover digital inequalities among children and can facilitate targeted interventions to address these disparities. Additionally, it supports parents on the impact of their child's digital interactions, fostering improved family functioning. Educational institutes can employ these insights to design effective programs promoting higher digital maturity amongst children.

Keywords: Children's Digital Maturity, Deep Reinforcement Learning, Design Science, ICT Usage.

1 Introduction

In an era characterized by the ubiquitous presence of digital technologies, the influence of Information and Communication Technologies (ICTs) on various facets of life has become pervasive, particularly among the younger generation. The surge in the adoption of mobile phones, tablets, laptops, and computers has not only transformed how individuals access information but has also redefined the very fabric of societal interactions. This transformation is particularly noticeable among today's youth, often referred to as "digital natives", who grow up seamlessly navigating the digital landscape. Where regulated and mindful use of digital technologies is linked to individual well-being, impulsive, compulsive and unregulated use of digital technologies has been reported to be associated with certain negative physical and mental health problems (Rahman et. al., 2020) and social misconduct.

According to Hevner et al. (2004) the behavioral science paradigm and the design science paradigm together seek to verify and augment theories that explain, predict and extend the boundaries of human and organizational behavior and capabilities by developing innovative artifacts. Recognizing the inseparable link between technology and behavior in IS research (Hevner et. al., 2004), our study employs a design science research (DSR) approach to unravel the intricacies of children's interactions with digital technologies. At its core, the study investigates the concept of *Digital Maturity*, defined as "*the overall ability of children to assess and regulate their behavior regarding the beneficial or harmful use of digital technologies*" (Arenas and Yazdi, 2022). Digital Maturity is comprised of 10 dimensions namely - *Digital Literacy, Risk Awareness, Individual Growth, Respect Towards Others, Digital Citizenship, Support Seeking Behaviour, Autonomy Within Digital Context, Autonomy of Choice, Regulation of Aggressive Impulses and Regulation of Negative Emotions*. Through this lens, we aim to

answer the following research questions: *Are there common patterns in children's ICT usage?* and *Can we predict the digital maturity of children from their ICT usage patterns?*

2 Methodology

In accordance with the DSR paradigm, we develop an IT artifact that identifies digital maturity in children and clusters them accordingly. Following the clustering of children based on their digital maturity, we perform cluster profiling to gain a deeper understanding of each cluster's characteristics. Leveraging this knowledge, we develop a predictive model that accurately determines the maturity level of individual children. This comprehensive approach enables us to offer valuable recommendations and timely alerts to parents and educators regarding children who exhibit higher-risk levels of digital maturity. Figure 1 represents the design of our IT artifact. We identify the ill-effect of increased use of technologies by children as our primary problem. To address this problem, we build an artifact that gets inputs from children aged 11-18 years, clusters them in groups based on their ICT usage patterns and further predicts children's digital maturity. This artifact has substantial implications for parents regarding what digital maturity means for their children and consequently for schools and educators as it makes behavioral predictions based on technology usage patterns.

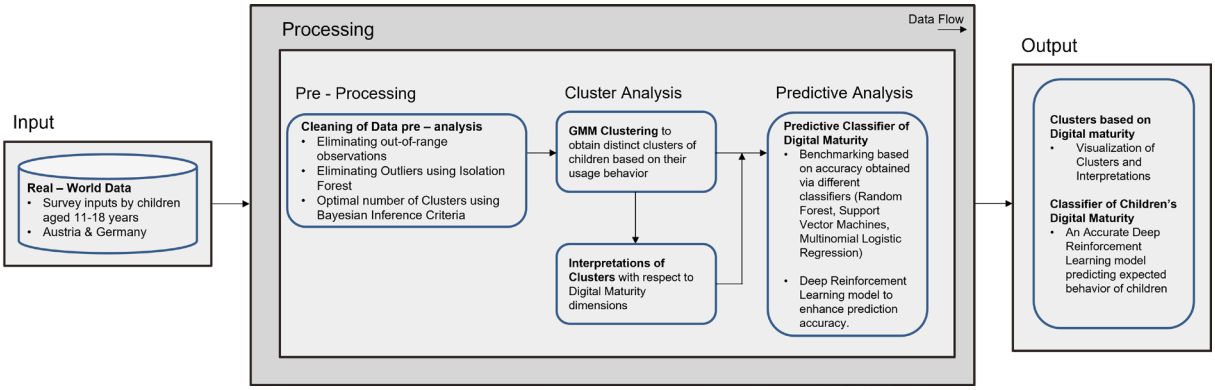

Figure 1. Design of IT Artifact.

3 Data, Findings and Contributions

We used survey data from Austria, Germany, Greece and Denmark as inputs for our analysis. The data comprised of 603 observations from Austria, 406 observations from Germany, 284 observations from Greece and 148 observations from Denmark. Our age of interest was 11-18 years. Our primary focus was to identify clusters of children with different digital maturity levels. We identified three clusters each for the four countries. To gain further insights into the characteristics of these clusters, we conducted a plot of the digital maturity dimension score of each cluster group against their mean z-score. The objective was to identify the unique traits and similarities among these groups. The results of this analysis are presented in Figure 2 whish is a composite graph consisting of four subplots, corresponding to the four countries, each depicting the mean z-score values of the identified cluster groups across the digital maturity dimensions. The graph provides a visual representation of the relative performance of the cluster groups across different dimensions, allowing for easy identification of clusters with above or below-average performance. Among the three cluster groups, Group 3, identified for all four countries, exhibited lower digital maturity as evidenced by scores that were much below the mean values for almost all dimensions. Conversely, Group 1 demonstrated high digital maturity as the scores of almost all dimensions were much higher than their respective averages. The remaining Group 2 demonstrated a mix of above-average and below-average scores for different dimensions, indicating an average to medium level of digital maturity when compared to the other two groups.

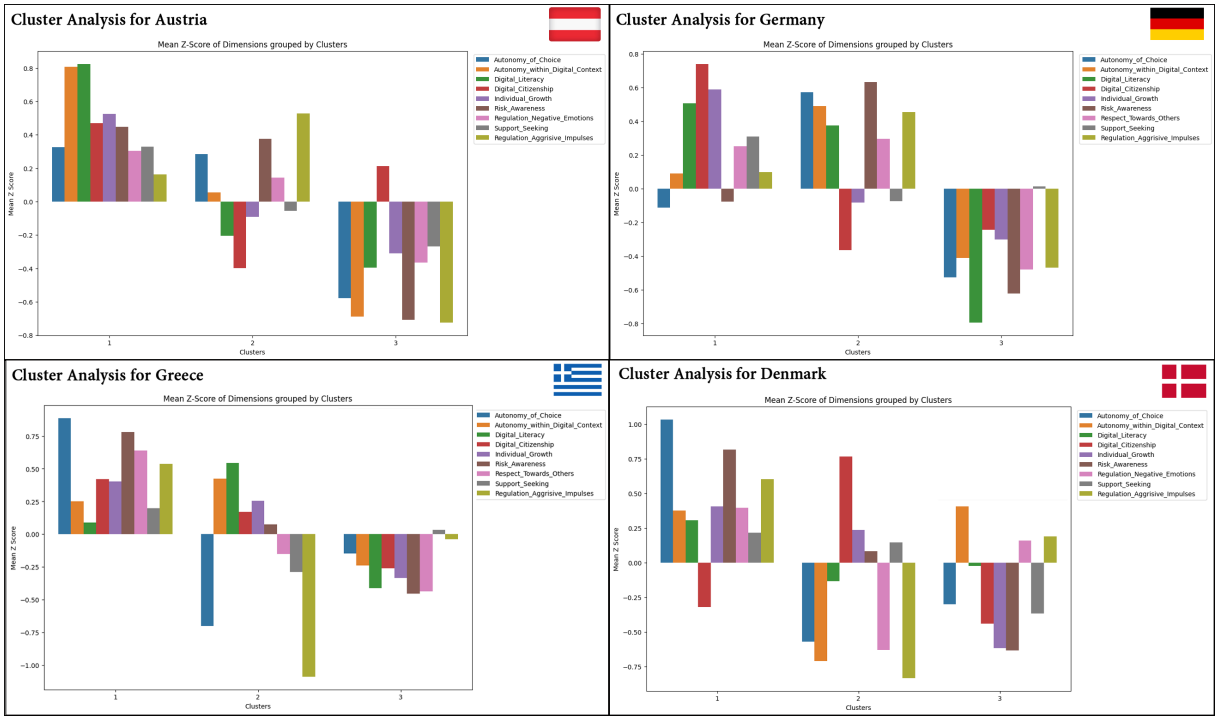

Figure 2. Clusters Obtained from Austria, Germany, Greece and Denmark.

With the results obtained from our initial clustering, we build a dynamic predictive algorithm that runs three different classifiers (Random Forest, Support Vector Machine and Multinomial Logistic Regression) and picks the best one based on the F1 Score obtained. The preliminary results indicate Random Forest performs best with the highest F1 Score of 96.6%. A deep reinforcement learning model for the above classification is being developed for more robust and accurate predictions.

This study extends the existing research on children's digital maturity and ICT usage patterns. By applying DSR, our IT artifact showcase a significant theoretical contribution, as it provides a novel and effective approach to addressing the challenges associated with understanding and predicting children's digital maturity and providing insight into the harmful effects of ICT usage. Our research also contributes to the ongoing debate around the effects of ICT usage on child development, by providing a practical tool that can be used to assess their digital maturity and identify potential areas for intervention.

References

Arenas, A. E., & Yazdi, P. (2022). Towards a model of technology usage and digital maturity in children: A grounded-theory approach. In *European Conference of Information Systems 2022,* 107.

Hevner, A. R., March, S. T., Park, J., & Ram, S. (2004). Design science in information systems research. *MIS quarterly*, 75-105.

Rahman, M. A., Hoque, N., Alif, S. M., Salehin, M., Islam, S. M. S., Banik, B., & Cross, W. (2020). Factors associated with psychological distress, fear and coping strategies during the COVID-19 pandemic in Australia. *Globalization and health*, 16(1), 95.