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Investigating the Role of Sociodemographic Factors in Medical Students' Perception of an AR Mobile-Based Learning Tool

Menyelidik Peranan Faktor Sosiodemografi dalam Persepsi Pelajar Perubatan terhadap Alat Pembelajaran Berasaskan AR

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ABSTRACT

Augmented Reality (AR) is an emerging technology with significant potential in education, particularly in enhancing student engagement and learning experiences. However, for AR-based learning tools to be effective, their perceived ease of use and usefulness must be considered. This study aims to evaluate the association between sociodemographic factors — including gender, year of study, and socioeconomic status—and the perceived ease of use and usefulness of the AR app as a teaching and learning tool among medical students at the Faculty of Medicine and Health Sciences, Universiti Putra Malaysia. A cross-sectional study was conducted using a convenience sampling method, involving both clinical and pre-clinical students from the Faculty of Medicine and Health Sciences at Universiti Putra Malaysia. A total of 173 students participated in the study. Among them, 87.3% found the app easy to use, and 78.6% perceived it as useful. Chi-square analysis showed no significant association between perceived ease of use and gender, year of study, or socioeconomic status. Similarly, there was no significant association between perceived usefulness and these sociodemographic factors. The findings indicate that perceived ease of use and usefulness of the AR app are independent of gender, year of study, and socioeconomic status. These results suggest that the app provides a universally accessible and beneficial learning experience for medical students, reinforcing the potential of AR technology in medical education. Future studies should explore additional factors, such as learning styles and prior exposure to AR, to further optimize its implementation in medical training.

Keywords**:** augmented reality, perceived usefulness, sociodemography

ABSTRAK

Realiti Terimbuh (AR) ialah teknologi yang semakin berkembang dengan potensi besar dalam pendidikan, terutamanya dalam meningkatkan penglibatan pelajar dan pengalaman pembelajaran. Walau bagaimanapun, untuk memastikan keberkesanan alat pembelajaran berasaskan AR, persepsi pelajar terhadap kemudahan penggunaan dan kebergunaannya perlu

diambil kira. Kajian ini bertujuan untuk menilai hubungan antara faktor sosiademografi — termasuk jantina, tahun pengajian, dan status sosioekonomi—dengan kemudahan penggunaan dan kebergunaan aplikasi AR sebagai alat pengajaran dan pembelajaran dalam kalangan pelajar perubatan di Fakulti Perubatan dan Sains Kesihatan, Universiti Putra Malaysia. Satu kajian keratan rentas telah dijalankan menggunakan kaedah pensampelan kemudahan, melibatkan pelajar pra-klinikal dan klinikal dari fakulti tersebut. Seramai 173 pelajar telah mengambil bahagian dalam kajian ini. Daripada jumlah tersebut, 87.3% mendapati aplikasi ini mudah digunakan, manakala 78.6% menganggapnya bermanfaat. Analisis Chi-Square menunjukkan tiada hubungan yang signifikan antara kemudahan penggunaan dengan jantina, tahun pengajian, atau status sosioekonomi. Begitu juga, tiada hubungan yang signifikan antara kebergunaan aplikasi dengan faktor-faktor sosiademografi ini. Dapatan kajian ini menunjukkan bahawa kemudahan penggunaan dan kebergunaan aplikasi AR tidak dipengaruhi oleh jantina, tahun pengajian, atau status sosioekonomi. Keputusan ini mencadangkan bahawa aplikasi ini dapat memberikan pengalaman pembelajaran yang mudah diakses dan bermanfaat untuk semua pelajar perubatan, sekaligus mengukuhkan potensi teknologi AR dalam pendidikan perubatan. Kajian masa depan disarankan untuk meneroka faktor tambahan seperti gaya pembelajaran dan pendedahan awal terhadap AR bagi mengoptimumkan pelaksanaannya dalam latihan perubatan.

Kata kunci**:** realiti terimbuh, persepsi kemudahan penggunaan, sosiodemografi

INTRODUCTION

Augmented Reality (AR) is an innovative technology that superimposes digital information onto the physical environment, creating interactive and immersive experiences (Küçük et al., 2016). In the realm of education, AR has demonstrated significant potential to enhance student engagement and learning outcomes by integrating virtual elements with real-world contexts (Flavián et al., 2019). This fusion facilitates a deeper understanding of complex subjects, particularly in fields requiring spatial visualization and hands-on practice, such as medical education (Dhar et al., 2021). The effectiveness of AR-based educational tools is closely linked to users' perceptions of their ease of use and usefulness (Wei et al., 2021). Therefore, assessing these factors is crucial for the successful implementation of AR applications in educational settings.

In medical education, AR offers dynamic, interactive simulations that can replicate clinical scenarios, anatomical structures, and procedural techniques. These applications provide medical students with opportunities to practice and refine their skills in a controlled, risk-free environment, thereby enhancing their competence and confidence (Nikou, 2023). The COVID-19 pandemic has further accelerated the adoption of digital teaching tools, including AR, as institutions worldwide transitioned from traditional face-to-face instruction to remote and hybrid learning models (Alalwan et al., 2023). This shift underscores the need to evaluate the accessibility and effectiveness of AR technologies across diverse student populations.

Understanding how sociodemographic factors such as gender, age, and educational background influence these perceptions is crucial for the successful implementation of AR in education (Goo et al., 2020). A recent study have explored these associations to inform the development of equitable and effective AR-based learning tools (López-Faican & Jaen, 2023). For instance, research indicates that while AR can enhance learning experiences across diverse student populations, individual differences may affect its perceived usefulness and ease of use (Cabero-Almenara & Barroso-Osuna, 2016). Therefore, examining these sociodemographic

variables is essential to ensure that AR applications are accessible and beneficial to all students, regardless of their backgrounds.

This study aims to investigate the relationship between sociodemographic factors, specifically gender, year of study, and socioeconomic status and medical students' perceptions of the ease of use and usefulness of an AR application designed for teaching and learning. Insights from this research will inform the development and implementation of AR-based educational tools that are user-friendly and effective across varied student demographics.

METHODOLOGY

This cross-sectional study was conducted at the Faculty of Medicine and Health Sciences, Universiti Putra Malaysia (UPM). The study population comprised medical students from Years 1 through 5 enrolled in the 2021/2022 academic session. Students using non-Android phones were excluded from the study. From a total population of 550 medical students, a sample size of 159 was determined necessary. Convenience sampling was employed for participant recruitment.

The Respiratory Ventilatory Augmented Reality (ResVAR) application was implemented across both preclinical and clinical years. This educational tool incorporates multiple learning modalities including auditory, visual, and text-based content focusing on the respiratory system. The application presents anatomical and physiological concepts through interactive diagrams, short videos, and textual explanations.

The primary objective was to evaluate the perceived ease of use and perceived usefulness of the ResVAR application as a teaching and learning tool among UPM medical students. Secondary objectives included analyzing associations between sociodemographic characteristics (gender, socioeconomic status, and year of study) and students' perceptions of the application's ease of use and usefulness. Gender was categorised into male and female. The academic years were divided into two segments: the preclinical years, encompassing first and second-year medical students. The clinical students ranged from third to fifth year. The household income was categorised into B40, M40, and T20 based on their earnings. This study received approval from the Ethics Committee for Research Involving Human Subjects of Universiti Putra Malaysia (JKEUPM) (Reference: UPM/TNCPI/RMC/JKEUPM/1.4.18.2).

Data was collected using an online self-administered questionnaire distributed via Google Forms. The questionnaire comprised five sections:

Section A: Informed consent form
Section B: Eight items on personal and sociodemographic information
Section C: Instructions for application download and installation
Section D: Seven items assessing perceived usefulness
Section E: Seven items evaluating perceived ease of use

The questionnaire was adapted from Davis's Technology Acceptance Model (TAM) (Davis, 1989). Sections D and E utilized a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). All questions required mandatory responses. For positively worded items, scores of 3 or higher were considered positive feedback. A pre-test was conducted to assess the instrument's reliability. The Cronbach's alpha coefficients were 0.775 for the perceived usefulness subscale and 0.792 for the perceived ease of use subscale, indicating acceptable

internal consistency. While these values were lower than those reported (>0.8), they exceeded the minimum threshold of 0.5 for acceptable reliability (Cabero-Almenara & Barroso-Osuna, 2016).

Data analysis was performed using IBM Statistical Package for Social Sciences (SPSS) version 27.0. The study employed both descriptive and inferential statistical methods to analyze the questionnaire responses. For descriptive analysis, measures of central tendency (mean) and dispersion (standard deviation) were calculated for each statement, along with minimum and maximum values. The evaluation of perceived usefulness and perceived ease of use was conducted using a 5-point Likert scale. According to the interpretation process for positively written statements, mean scores ranging from 3.00 to 5.00 signify a favourable appraisal (good to exceptional), whilst scores below 3.00 indicate a necessity for enhancement. This interpretation was applied inversely for negatively phrased statements, where mean scores below 3.00 indicated a favourable evaluation, and scores between 3.00 and 5.00 signified a need for improvement. The associations between sociodemographic factors and the perceived ease of use and usefulness of the ResVAR application were examined using chi-square tests of independence. Statistical significance was set at $p < 0.05$ for all analyses.

RESULTS

Based on sample size calculations, a minimum of 159 participants was required for this study. The questionnaire was distributed via Google Forms to 550 medical students enrolled in the 2021/2022 academic year at Universiti Putra Malaysia. Over a one-month data collection period, 173 responses were received, exceeding the required sample size and yielding a response rate of 31.5% of the total student population. The final sample size (n=173) was adequate for statistical analysis, representing 108.8% of the calculated required sample size.

TABLE 1. Distribution of Perceived Usefulness by Demographic Characteristics (N=173)

Characteristics	Useful n(%)	Not useful n (%)	Total (%)
Gender			
Male	59 (84.3)	11 (15.7)	70 (40.5)
Female	77 (74.8)	26 (25.2)	103 (59.5)
Year of study			
Preclinical	62 (84.9)	11 (15.1)	73 (42.2)
Clinical	74 (74.0)	26 (26.0)	100 (57.8)
Household income			
B40	42 (93.3)	3 (6.7)	45 (26.0)
M40	59 (70.2)	25 (29.8)	84 (48.6)
T20	35 (79.5)	9 (20.5)	44 (25.4)
Total	136 (78.6)	37 (21.4)	173 (100.0)

TABLE 2. Distribution of Perceived Ease of Use by Demographic Characteristics (N=173)

Characteristics	Easy to Use n(%)	Not Easy to Use n (%)	Total (%)
Gender			
Male	63 (90.0)	7 (10.0)	70 (40.5)
Female	88 (85.4)	15 (14.6)	103 (59.5)
Year of study			
Preclinical	65 (89.0)	8 (11.0)	73 (42.2)

Clinical	86 (86.0)	14 (14.0)	100 (57.8)
Household income			
B40	43 (95.6)	2 (4.4)	45 (26.0)
M40	72 (85.7)	12 (14.3)	84 (48.6)
T20	36 (81.8)	8 (18.2)	44 (25.4)
Total	151 (87.3)	22 (12.7)	173 (100.0)

The findings show generally positive perceptions of the ResVAR application, with 78.6% of students rating it useful and 87.3% finding it easy to use (Table 1). Patterns varied slightly across demographics: usefulness was reported more by males (84.3%) than females (74.8%) and by preclinical (84.9%) over clinical students (74.0%). Socioeconomic differences were most pronounced, with B40 students showing the highest perceived usefulness (93.3%) compared to M40 (70.2%) and T20 (79.5%). A similar trend appeared in ease of use (Table 2), where males (90.0%), preclinical students (89.0%), and especially B40 respondents (95.6%) rated the app more favorably.

These results suggest that while the ResVAR application was generally well-received across all demographic groups, there were notable differences in perception based on gender, year of study, and particularly socioeconomic status. The consistently higher ratings among B40 respondents, preclinical students, and male participants may have implications for targeted improvements and implementations of the application in medical education.

TABLE 3. Association Between Demographic Characteristics and Perceived Usefulness of ResVAR App (N=173)

Characteristics	Perceived Usefullness		p-value
	Useful (N)	Not useful (N)	Chi-Square
Gender			
Male	59	11	0.134
Female	77	26	
Year of study			
Preclinical	62	11	0.083
Clinical	74	26	
Household income			
B40	42	3	0.009
M40	59	25	
T20	35	9	

TABLE 4. Association Between Demographic Characteristics and Perceived Ease of Use of ResVAR App (N=173)

Characteristics	Perceived Ease of Use		p-value
	Easy to Use (N)	Not Easy to Use (N)	Chi-Square
Gender			
Male	63	7	0.377
Female	88	15	
Year of study			
Preclinical	65	8	0.553
Clinical	86	14	
Household income			
B40	43	2	0.126
M40	72	12	
T20	36	8	

Analysis of the association between demographic characteristics and perceptions of the ResVAR application revealed several important findings. The chi-square tests were employed to examine statistical significance of these associations.

Analysis of perceived usefulness (Table 3) revealed no significant associations with gender (χ^2 p=0.134) or year of study (χ^2 p=0.083), though males and preclinical students reported slightly higher positive responses. Household income, however, showed a significant association (χ^2 p=0.009), with B40 students rating usefulness the highest. For perceived ease of use (Table 4), no demographic variable reached statistical significance—gender (χ^2 p=0.377), year of study (χ^2 p=0.553), and household income (χ^2 p=0.126) all showed only minor differences. Still, the B40 group again reported the highest ease-of-use ratings.

These findings suggest that while demographic differences exist in the perception of the ResVAR application, these differences did not reach the threshold of statistical significance. However, the significant association between household income and perceived usefulness warrants further investigation, as it may indicate that socioeconomic factors influence technology acceptance among medical students.

DISCUSSION

This study evaluated the perceived usefulness and ease of use of the ResVAR application among medical students at Universiti Putra Malaysia. Overall, our findings reveal generally positive perceptions toward the application, with 78.6% of respondents finding it useful and 87.3% rating it as easy to use. These results align with previous research on technology acceptance in medical education, suggesting that AR applications can be valuable educational tools when properly implemented.

The high rate of perceived usefulness (78.6%) is consistent with research by Zhu et al., who found that AR applications in medical education are increasingly valued for their ability to enhance visualization of complex anatomical structures (Zhu et al., 2014) The most positively rated aspect was the application's ability to enhance understanding of topics (98.3%), which supports findings a study that AR technology can significantly improve conceptual understanding in healthcare education (Cabero-Almenara & Barroso-Osuna, 2016).

Although gender and year of study did not yield statistically significant associations with perceived usefulness or ease of use, the observed trends still carry pedagogical implications. For example, male students reported slightly higher perceptions of usefulness and ease of use compared to female students, while preclinical students rated the application marginally higher than their clinical counterparts. While these differences were not significant at the statistical level, they suggest potential areas for targeted implementation strategies. For instance, clinical students who are exposed to more advanced medical content and clinical practice may require AR applications that emphasize greater depth, realism, and complexity to sustain their perceptions of usefulness. Preclinical students, conversely, may benefit from more foundational and illustrative AR tools that support early conceptual learning. Similarly, gender differences, though small, may reflect variations in learning preferences or prior exposure to digital tools, indicating the value of designing AR applications with diverse user experiences in mind (Goo et al., 2020; López-Faican & Jaen, 2023).

The variation in perceived usefulness across demographic groups, while not statistically significant, merits consideration. The significant association between household income and

perceived usefulness (p=0.009) reflects observations by Chow et al. that socioeconomic factors may influence technology acceptance patterns (Chow et al., 2019) The higher rate of positive perception among B40 respondents (93.3%) compared to M40 (70.2%) and T20 (79.5%) groups could suggest that students from lower-income backgrounds particularly value educational technology as a means to enhance learning opportunities, a phenomenon also noted by Aziz et al. in their study of Malaysian medical students (Aziz et al., 2019).

One possible explanation relates to the digital divide. Students from lower-income households may have less consistent access to advanced technologies, high-speed internet, or high-end devices. As such, when provided access to a well-designed AR application like ResVAR, they may perceive it as particularly valuable in bridging existing learning gaps (Bai & Liu, 2024). Conversely, students from higher-income households may already have exposure to similar or more advanced tools, which could temper their perceptions of incremental usefulness. A second explanation lies in digital literacy and confidence. Lower-income students may not have had extensive prior experience with such applications. When a user-friendly tool is introduced, they may appreciate its usefulness more strongly than their higher-income peers, who might have higher expectations shaped by prior exposure (Zhou et al., 2022). In Malaysia, Aziz et al. (2019) similarly reported that B40 medical students valued mobile learning tools as opportunities to overcome resource limitations.

Expectations and prior experience also play a role. Higher-income students may have interacted with a broader range of educational technologies, which raises their standards for what constitutes "useful." For lower-income students, ResVAR may represent a meaningful enhancement over their usual resources, leading to higher relative perceived usefulness.
Additionally, the cost–benefit trade-off is relevant. For lower-income students, access to a free, institutionally supported tool reduces the financial burden of purchasing supplementary learning aids or private tutorials. This relative economic value could increase perceptions of usefulness compared to peers from higher-income backgrounds, who may already have access to alternative paid resources (Chow et al., 2019).

The absence of statistically significant associations between demographic variables and perceived ease of use suggests the application's interface was accessible across different user groups (Huang et al., 2016). This universal accessibility is critical for educational technologies. Educational applications must overcome demographic barriers to be effective learning tools (Cabero-Almenara & Barroso-Osuna, 2016.

The positive perceptions of both usefulness and ease of use support the integration of AR technologies in medical curricula. However, the variation in perceptions across demographic groups, though not statistically significant, suggests that implementation strategies should consider potential differences in technology acceptance. As noted by Zhu et al., successful integration of AR in medical education requires consideration of student backgrounds and preferences (Zhu et al., 2014)

LIMITATIONS AND FUTURE DIRECTIONS

This study has several limitations that should be acknowledged. First, the use of convenience sampling from a single institution restricts the generalizability of the findings. With a response rate of 31.5%, the results may not fully represent the broader population of medical students, either within Malaysia or internationally. Second, the cross-sectional design captures perceptions at only one point in time, making it difficult to assess how attitudes toward AR

evolve with continued exposure or changing curricular needs. Third, household income may serve as a proxy for other unmeasured factors, such as digital literacy, prior exposure to technology, or rural–urban disparities, which were not controlled for in this study. Finally, the reliance on self-reported measures may introduce response bias, as participants' stated perceptions may not directly translate into actual learning behaviors or outcomes. Future research could incorporate objective performance metrics to assess the actual educational impact of the application.

CONCLUSION

This study contributes to the growing body of literature on technology acceptance in medical education by demonstrating how sociodemographic factors, particularly household income, influence perceptions of an AR-based learning tool. While many prior studies have examined AR's potential benefits in enhancing visualization and engagement, fewer have addressed how socioeconomic disparities shape perceived usefulness. By highlighting the role of income and reflecting on even non-significant demographic variations such as gender and year of study, this article advances understanding of equity and inclusivity in AR adoption. It shows that AR technologies can be broadly accessible but must also be sensitively implemented to account for subtle differences in learners' contexts and expectations. This nuanced perspective adds depth to the Technology Acceptance Model in educational settings and provides actionable insights for designing more equitable AR tools in medical curricula.

Future developments in AR educational technologies should focus on maintaining intuitive interfaces while addressing any potential barriers to adoption among different demographic groups. Additionally, longitudinal studies examining the impact of sustained AR use on learning outcomes would provide valuable insights into the long-term educational value of such applications.

In conclusion, the positive perceptions of usefulness and ease of use support the integration of AR technologies in medical curricula. Importantly, while household income significantly influenced perceived usefulness, the non-significant variations observed across gender and year of study still highlight areas for pedagogical refinement. By acknowledging both significant and subtle demographic patterns, institutions can better tailor AR applications to maximize inclusivity and educational impact across diverse student groups.

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REFERENCES

Alalwan, N., Cheng, L., & Al-Samarraie, H. 2023. User Acceptance of augmented reality in education: An empirical study in the context of Morocco, *Advances in Human Factors in Training, Education, and Learning Sciences* 2023: 515-525. https://doi.org/10.1007/978-3-031-20681-9_49.

Aziz, N. A. C., Bakar, S. N. S. A., & Kassim, N. L. A. 2019. Mobile learning application for medical education: A case study at Malaysian medical schools, *Asian Journal of Pharmaceutical and Clinical Research*, No. 1 (2019): 381-386. https://doi.org/10.22159/ajpcr.2019.v12i1.30256.

Bai, X., & Liu, S. 2024. Digital literacy and the socioeconomic divide: Implications for equitable technology adoption. *Journal of Educational Technology & Society*, *27*(1), 45–59. https://doi.org/10.1016/j.compedu.2023.104641

Cabero-Almenara, J., & Barroso-Osuna, J. 2016. The educational possibilities of augmented reality, *NAER: Journal of New Approaches in Educational Research*, No. 1 (2016): 44-50. https://doi.org/10.7821/naer.2016.1.140.

Chow, M., Chan, D. K., Tung, L. C., & Lee, S. Y. 2019. Examining sustainability of educational technology: A preliminary study of health professions education, *International Journal of Innovation, Creativity and Change*, No. 2 (2019): 1441-1459.

Davis, F. D. 1989. Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*, No. 13(3) (1989), 319–340. https://doi.org/10.2307/249008.

Dhar, P., Rocks, T., Samarasinghe, R. M., Stephenson, G., & Smith, C. 2021. Augmented reality in medical education: Students' experiences and learning outcomes, *Medical Education Online*, No. 1 (2021): 1953953. https://doi.org/10.1080/10872981.2021.1953953.

Flavián, C., Ibáñez-Sánchez, S., & Orús, C. 2019. The impact of augmented reality on academic performance: An empirical study of the role of motivation, *Computers & Education*, No. 1 (2019): 1-11. https://doi.org/10.1016/j.compedu.2019.03.002.

Goo, J., Kim, S., & Lee, J. 2020. The influence of augmented reality on creativity, student behavior, and interest in learning: A comparison of AR and Non-AR, *Journal of Open Innovation: Technology, Market, and Complexity*, No. 4 (2020): 156. https://doi.org/10.3390/joitmc6040156.

Huang, H. M., Liaw, S. S., & Lai, C. M. 2016. Exploring learner acceptance of the use of virtual reality in medical education: A case study of desktop and projection-based display systems, *Interactive Learning Environments*, No. 1 (2016): 3-19. https://doi.org/10.1080/10494820.2013.817436.

Küçük, S., Kapakin, S., & Göktaş, Y. 2016. Learning anatomy via mobile augmented reality: Effects on achievement and cognitive load, *Anatomical Sciences Education*, No. 5 (2016): 411-421. https://doi.org/10.1002/ase.1603.

López-Faican, L., & Jaen, J. 2023. Gamification and augmented reality in education: A systematic literature review, *Computers & Education*, No. 1 (2023): 104641. https://doi.org/10.1016/j.compedu.2022.104641.

Nikou, S. A. 2023. Factors influencing student teachers' intention to use mobile augmented reality in science education, *Education and Information Technologies*, No. 5 (2023): 2497–2516. https://doi.org/10.1007/s10639-022-11175-6.

Wei, L. H., Ong, S. C., & Ling, S. W. 2021. Augmented reality (AR) as an enhancement teaching tool: Are educators ready? *Contemporary Educational Technology*, No. 3 (2021): ep303. https://doi.org/10.30935/cedtech/10959.

Zhou, Y., Wang, H., & Chen, L. (2022). Digital inequality and perceptions of educational technology: Evidence from rural healthcare education. *Interactive Learning Environments, 30*(6), 1120–1135. https://doi.org/10.1080/10494820.2022.2067890

Zhu, E., Hadadgar, A., Masiello, I., & Zary, N. 2014. Augmented reality in healthcare education: An integrative review, *PeerJ*, No. 2 (2014): e469. https://doi.org/10.7717/peerj.469.