Learnability Factors for Investigating the Effectiveness of Augmented Reality Smart Glasses in Smart Campus

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Learnability Factors for Investigating the Effectiveness of Augmented Reality Smart Glasses in Smart Campus

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Abstract. Augmented Reality (AR) has become an emerging platform in the field of learning either in education or industry. Wearable AR smart glasses are the example of new wearable technology devices in AR. AR smart glasses has been introduced as another alternative to enhance the user's experience in the real world rather than replacing the principle of learning. In education, AR smart glasses is seen as a possible technology to be embedded in the teaching and learning among lecturers and students for achieving smart campus environment. The effectiveness of AR smart glasses in education is a prospect for further study. Thus, this paper aims to identify the factors for investigating the learnability of students while learning using AR smart glasses. Various existing learning factors were reviewed through literature exploration and potential AR smart glasses learning factors are suggested. The results are significance for the development of the AR smart glasses learnability model that will further investigate in the future work.

1. **Introduction**

Augmented Reality (AR*)* is in the information technology industry for a long time and it has emerged from a science-fiction phenomenon to a science-based reality. AR is an insight of the real physical world where we can find that the elements present in and around us are improved and augmented by computer-generated feedback that includes audio, video, *GPS* graphics which overlays the real inputs and many more things have changed in the new digital era. Additionally, AR has become a reality. AR is available in various forms such as on the smartphones, smart glasses, head-mounted displays which will give the augmented display straight in front of the eye, Face Tracking etc. and many other AR devices. Microsoft HoloLens and Google glass may become a stream of breaking new technology of wearable devices referred to as augmented reality smart glasses which may well influence media usage shortly [1].

Informatics has digitized human beings with the contribution made by the AR in the education sectors to enhance learnability, AR is the subarea of computer science it provides us with hardware and software dedicated to present the virtual world, or cyber world onto the real world which facilitates the educational sectors and learning to a greater extent. Augmented reality has enhanced the education industry in fact it has revolutionized this industry with many unique features, for example the medical students can have a virtual body available right in front of them for practicing the surgical procedures instead of the actual body which can be difficult to have at many situations. Automatically, student experience can be increased by using AR and such experience is one of the main factor to implement smart campus [2], Thus this paper is intended to discuss about factors for investigating the learnability

of students while learning using AR smart glasses. The work is about reviewing the existing learnability factors in the Literature Review, and next identifying the initial learnability factors for AR smart glasses.

2. Literature Review

The *AR* smart glasses usage has been disclosed by many top information technology companies such as Microsoft, Facebook and Google for the future movement in mass media technology it is where it can be decide to use AR wearable glasses. According to the market predictions, it is the most expected phenomenon that these augmented reality smart glasses are predicted to be successive 'big thing' with the development of the upcoming media trends as forecasted in Technavio (2015).

Nowadays AR has emerged as a vital technology that is needed extensively in various areas and most importantly in educational smart campus environments. In recent times the AR usage has increased so extensively in the educational and training areas [3]., also due to the fact that it does not need the support of high-priced hardware and sophisticated instruments, Furthermore the employment of good and light weighted smart glasses have currently reached the masses, Moreover the advancement in augmented reality have paved the path for the adoption of this type of technology on overall basis within the educational organizations in order to enhance the learnability in the smart campus.

Factual study reveals the importance of various drivers or factors like practical advantages, simple use, individual distinction, adaptable factor, whole attitudes, and accepted behavior, though these glasses are put on equally for style fixtures and to capture numerous individual data as well, personality demonstration advantages and impending confidentiality clauses appear less probably to impact these glasses acceptance [1]. The research is from the perspective of the teaching and learning it additionally depicts the motivations to use these kinds of glasses in line with the would-be operators and its study also helps to inspire increased *AR* wearable smart glasses usage.

Philipp A. Rauschnabel [4, 15] presented a view point of would-be operators and focussed on motivators and obstacles of Smart glasses, Moreover, it also focusses on aspects such as indulgent (related to desire and pleasure) and social aspects, whereas Murat Akcayir, Gokce Akcayir [5]. The author focused on blessings and challenges related to *AR* from completely a different perspective. However, the author Apurva and others focused from the teaching aspects and based their studies for analysis by finding within the dynamics impacting of the acceptance of AR devices [6, 16]. Furthermore Bacca and other authors [7] review studies with a spotlight based on work factors like the utilizations, points of interest, restrictions, adequacy, difficulties, and choices of AR in instructional and teaching settings, In addition to all these the author Tien-Chi focused his research on the emotional effect of assimilating augmented reality in teaching [8].

On the social control front, the study by Caudell, T. P, & Mizell, D.W provides valued intuitions for the usage of the AR devices [9].However, smart glasses and apps ought to be able to fulfil consumer's wants the factors that are taken into consideration throughout his study are purposeful advantages, easy use, individual attention, complete attitudes, and social norms, The analysis methodology used relies on a survey done on the sample from Deutschland [9]., Though it has shown ample positive factors associated with it. However, it does have some limitations like sample restricted to the country Deutschland omitted hedonistic and social aspects and additional analysis is done on user half regarding the appliance aspect.

All the above researchers have dealt with AR wearable devices or smart glasses in areas such as adoption of AR, emotional effect of AR and tests or benefits of AR. However, not enough analysis and research is carried out within the field of effectiveness of AR technology by using the smart glasses devices. Such gap is vital in understanding how the AR smart glasses can enhance the learnability of people who use them. Yet, there is still one question remain "What are the factors to consider in measuring the people learnability on AR smart glasses". In answering the aforementioned research question, Table 1 shows the summary of factors, identified from the related existing work on AR.

Table 1. Related Work of Learning Factors with AR Smart Devices

Author	Research Scope	Factors Used
Philipp A.Rauschnabel [4].	Augmented reality smart glasses: A study comprising of technology approval factors. An investigation strategy was directed for the evaluation of the empirical model.	Functional benefits, social norms, ease use, technology innovativeness, and adoption intentions.
Murat Akcayir, Gokce Akcayir [5].	The scope is to reveal the benefits, gains and encounters related with augmented reality in the field of education with the manuscript selection process.	Allowing learners to learn by doing, provide interaction opportunity, enable visualizations of invisible concepts events, abstract concepts, and help students to understand and enhancing learning.
Apurva Adapa,Fiona Fui-Hoon Nah, Richard H. Hall, Keng Siau, and Samuel N. Smith [6].	The scope is to check the factors Influencing the adoption of smart wearable devices through the qualitative approach and through in-depth interviews with students and staff at a Midwestern technological research university.	Efficiency, time-saving, tech novelty, information accessibility, professionalism.
Bacca, J., Baldiris, S, Fabregat, R. Graf, S, & Kinshuk. [7].	The scope is augmented reality trends in education using these approaches the qualitative-exploratory-case study, Qualitative-Exploratory-Pilot study and Qualitative-Exploratory-experience survey methodology is used.	Explaining the topic, facilitating interactions, just in time information, learning gain, better learning performance, exploration, lab experience.
Tien-Chi [8].	Animating eco-education to perceive, sense, and ascertain in the AR based surroundings with the Pre-test and post-test survey method through a model developed (EDALM) on Kolb's experiential learning theory.	Learning effectively.
Caudell, T. P, & Mizell, D. W [9].	The scope is on the social control front it provides valued insights towards the usage of the AR devices.	Focused advantages, enhanced focus, easy use, individual attention, thorough attitudes, and social norms.
Jorge Martín-Gutiérrez a, Peña Fabiani a, Wanda Benesova b, María Dolores Meneses c, Carlos E. Mora [10].	The Author discussed that the augmented reality in smart campus or education will pave path towards enhancement of learning absorption.	Learning absorption, easy understanding and no repeating while explaining also the improvement of learning motivation.

As presented in Table 1, researchers have dealt with AR Wearable devices in various scope of investigation based on their choice of factors. Factors that are suitable to be used as the learnability factors for our research have been chosen and discuss in the following section.

3. Initial Learnability Factors

Table 2 presented the choice of learnability factors that we found suitable for our initial investigation on measuring the level of learnability among the students in the use of AR Smart Glasses. There are seven (7) factors: enhanced the focus, enable visualizations of invisibility of concepts, promote imaginative thinking, enhanced imagination and information accessibility, better lab experience and interaction, easy and quick understanding and better learning and performance.

Table 2. The Chosen Learnability Factors and Description

Learnability Factors	Description
Information accessibility	Wearable smart glasses are like computers as they provide in time information access whenever and wherever needed [6].
Better lab experience	With the help of additional images video and audio in front of the user's eye this whole experience gives a better lab experience for the students and the users as it makes understanding easier and lab hours more fun.[7]. It also brings in additional functional benefits with AR smart glasses [4].
Better learning and performance	The usage of AR smart glasses gives just in time information which will give better learning performance [7]. AR smart glasses increases the learning performance of the user [4, 11, 12].
Enhanced focus	AR increases the focus of the users [9]. It also raises the level of engagement in users [13]. AR facilitates the learnability of the users in a smart campus.
Easy and quick understanding	AR smart glasses makes the understanding easy for the users [14]. As with the help of AR smart glasses one can see things happening so it becomes lot easier to understand by seeing it happen live.
Promote imaginative Thinking	AR smart glasses makes imaginary theories possible in Augmented reality through the smart glasses [5]. Therefore, with the help of AR smart glasses one can bring our imagination into reality which helps enhance the ability of imagination and thinking in a person.
Enable visualization of invisible concepts	AR allows imagining of unseen theories, events, and abstract concepts [5]. The exploration of imagination will make learning effective and quick to understand.

These factors have been chosen due to the connectivity of the factors to achieve the learning outcome as well to increase the learning performance in education.

4. Conclusion and Future Work

In the literature exploration, we found a gap linked to the effectiveness of AR devices specifically to AR smart glasses in increasing the student experience for learning in smart campus. Thus, this study reviewing the potential learnability factors in measuring the effectiveness of the AR smart glasses usage. We found seven (7) suitable learnability factors. These initial finding will be further investigated in the next work. A survey will be designed to a group of students in two (2) universities to understand the learnability influence with and without AR smart glasses based on the chosen learnability factors.

References

[1] Philipp A. Rauschnabel and Young K. Ro Augmented reality smart glasses: an investigation of technology acceptance drivers, Int. J. Technology Marketing, **11** (2) (2016).
[2] Muteeb Alahmari, Tomayess Issa, Theodora Issa, S. ZaungNau, Faculty awareness of the economic and environmental benefits of augmented reality for sustainability in Saudi Arabian universities in Journal of Cleaner Production, **226**, (July 2019) 259-269.
[3] Billinghurst, M. Augmented reality in education, new horizons for learning, (2002).
[4] Rauschnabel, P.A., Brem, A. and Ivens, B.S. 'Who will buy smart glasses? Empirical results of two pre-market-entry studies on the role of personality in individual awareness and intended adoption of Google Glass wearable's', Computers in Human Behaviour, **49 (**8) (2015) 635–647.
[5] Murat Akcayir, Gokce Akcayir, Advantages, and challenges associated with augmented reality for education (2016).
[6] Apurva Adapa, Fiona Fui-Hoon Nah, Richard H. Hall, Keng Siau, and Samuel N. Smith Factors influencing the adoption of smart wearable devices, (2018).
[7] Bacca J., Baldiris, S., Fabregat, R., Graf, S., & Kinshuk. Augmented reality trends in education. (2014).
[8] Tien-Chi Huang, Chia-chen chen,Yu-Wen Chou, animating eco-education, Computers and education, (May 2016).
[9] Caudell, T. P, & Mizell, D. W. Augmented reality: An application of heads-up display technology to manual manufacturing processes, in proceedings of the twenty-fifth Hawaii international conference on system sciences. (1992).
[10] Jorge Martín-Gutiérrez a, Peña Fabiani a, Wanda Benesova b, María Dolores Meneses c, Carlos E. Mora Augmented reality to promote collaborative and autonomous learning in higher education.(Dec 2014).
[11] El Sayed, N. A., Zayed, H. H., & Sharawy, M. I. ARSC: augmented reality student card an augmented reality solution for the education field. Computers & education, **56** (4), 1045e1061. (2011).
[12] Huizenga, J. J., Admiraal, W. W., Akkerman, S. S., & Ten Dam, G. Mobile game-based learning in secondary education: Engagement, motivation, and learning in a mobile city game. Journal of Computer Assisted Learning, **25** (2009) 332–344.
[13] Liu, P.-H. E., & Tsai, M.-K. Using augmented-reality-based mobile learning material in EFL English composition: An exploratory case study. British journal of educational technology. (2013).
[14] Chiang et al. An Augmented Reality-based Mobile Learning System to Improve Students' Learning achievements and motivations in natural science inquiry activities (2014).
[15] M Abdul Majid, U Aickelin, PO Siebers, Human behaviour modelling: an investigation using traditional discrete event and combined discrete event and agent-based simulation, University of Nottingham (2011).
[16] BA JNR, MA Majid, A Romli, Sustaiable adoption and implementation in collaborative enterprise: A systematic Litraure review, Journal of Theoretical & Applied Information Technology 95 (9) (2017).

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