

# Comparison of Voice Based Virtual Assistants fostering Indian Higher Education – A Technical Perspective

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**Abstract - To meet expectations of stakeholders in Education 4.0, the inclination towards acceptance, testing, and implementation of Voice Assistants has increased at a faster pace in western universities. This study has been done to understand the present level of performance and capability of voice assistants in answering the basic queries of users from Indian Higher education sector. Three voice assistants namely Amazon Alexa, Microsoft Cortana, and Google Assistant have been considered for a survey in which 100 students participated and tested the performance of these three voice assistants by asking basic questions related to admission and examination. A set of total 14 questions has been selected to be asked by user in both the categories. Category 1 related to Admissions contained 7 little complex questions while category 2 related to Examination had 7 direct and simpler questions. Responses of the users were noted down and after careful analysis, the explanations have been deduced about performance of these voice assistants in factors considered: understanding of voice and language of user, understanding of basic meaning of the question, request to repeat the question, whether the answer was given by voice assistants and quality of the answer received. As per the results, various observations have been noted that may further help Artificial Intelligence developers and programmers to understand the success and failure of voice assistants and accordingly bring improvements in their performance level. This study also helps in knowing about huge applications, contributions and benefits these voice assistants offer to the stakeholders. Once the improvements are incorporated by the developers, marketing professionals can boost the absorption and use of voice assistants in massive higher education sector of India by convincing the important stakeholders that also paves a way to tap into more undiscovered possibilities about use of Artificial Intelligence in higher education system at global level.**

**Keywords:** Artificial Intelligence, Voice Assistants, Higher Education, Stakeholders, Education 4.0

## I. INTRODUCTION

Earlier we were trying to understand the language of technology, however voice assistants are example of one of its kind where technology is trying to understand human language and fulfil the requests received in the form of commands through user's voice only. Research on studying these aspects is limited as since the acceptance and use of voice assistants started to rise sharply in 2017 (Terzopoulos & Satratzemi, 2019). Another report by Activate Forecast (PRANGE, 2019) mentions that in United States, users have adopted Smart Speakers more quickly than even Smartphones making it among the quickest adoption of any new technology in the modern world. India too has a vast

potential to be the biggest market for voice search with an expected YoY growth of 270%, as revealed by Google. It is likely to have 9 out of 10 new internet users to be Indian Language Speakers. As per Statista 2021, it has been forecasted that by 2024, the number of digital voice assistants will surpass even the population of entire world and will reach to 8.4 billion units (Vailshery, 2021) as compared to 2.5 billion assistants in use at the end of 2018 (Juniper Research).

What makes voice assistants so popular among users is that use of these devices and smart speakers can help them in simplifying their everyday tasks such as controlling home appliance, booking an appointment with your doctor, knowing spellings, learning new recipes, playing music, or ordering something online (Optoma Corporation, 2020). Smart speakers are most used type of available voice assistants and their use in the schools and universities has just begun for educational purposes (TERZOPOULOS & SATRATZEMI, 2020).

## II. LITERATURE REVIEW

Voice Based Assistants are a subset of Virtual Assistants or Intelligent Personal Assistant. Virtual assistants can take inputs in the form of text, voice, or image. Voice Based Assistant is a virtual assistant that uses speech recognition, natural language processing and speech synthesis to take actions to help its users. The essential condition for a device to be called as voice assistant is that primary mode of input for such device must be a voice. Voice assistants should be able to have a natural two-way communication with the user and be able to confirm, clarify, and answer the user with context.

Considering their natural language capability and ease of use, Voice Assistants have a promising role to play in education industry at all levels. Youth as well as children love using voice assistants available in handheld mobile or speaker assistants. A latest survey done to study the use of voice assistants for online shopping done by CouponFollow survey of 1,038 U.S. indicates that Amazon Alexa is by far the most popular voice assistant for shopping, used by 72% of respondents. Following were Google Assistant (49%), Apple's Siri (23%), and Microsoft's Cortana (18%) and Samsung's Bixby (11%) (COUPONFOLLOW TEAM, 2009-2021) wherein respondents were allowed to give multiple preferences. There are domain specific voice assistants as well being

used in eCommerce, Travel and Healthcare or Hospitality industries.

As per Lee Mallon, founder of voice and mobile application company “Rarely Impossible”, voice assistant technology is still in the early stages and requires a learning curve. To receive consistently accurate responses, it needs a little practice in learning to phrase voice commands (Reviews.com Staff, 2020). If we look at a short history of the Voice Revolution, the chronologically important developments took place as mentioned below in the diagram. The work regarding development of voice technology had already started as early as 1950s through efforts of Bell Laboratories, US Department of Defense and IT Giant IBM. And then there was no look back. From 2010 the developments in Voice Technology skyrocketed (Silver, 2020) with the introduction of Watson by IBM that won the jeopardy. Then Apple’s Siri, Google’s Google Now, Microsoft’s Cortana, Amazon’s Alexa, Google’s Google Home, Amazon’s Echo Dot, Amazon Tap, Google Pixel phone, Google Home Bilingual and Google Assistant have been launched and available for use by massive population. Among US users, Apple’s smartphone voice assistant Siri is maintaining its position at the top capturing nearly 50% of market share consequently followed by Google Assistant, Amazon Alexa, and Samsung Bixby (Kinsella, 2020) in voice assistants market in year 2020.

These are being used in multiple devices like cars, on smart TVs, smart home components, wearables, appliances, and other connected gadgets. Voice Assistants can provide multiple fruitful benefits for users in Higher Education Industry as well. Voice assistants like Amazon’s Alexa, Google Assistant, Microsoft Cortana, etc. are being used by educators in the process of learning. Students are also using the conversational educational e-content requiring no or minimal presence of teacher. These can be carried and employed by students anywhere for facilitating interaction with educational material or to access any extra learning assistance. That is why several top ranked universities like Georgia Tech, Northeastern University and Arizona State University are already on the path of using voice assistants. Voice assistants slowly will displace traditional methods of learning in case of higher education environments. For instance, as per a podcast by Cognilytica, the Arizona State University is offering various incoming college students an Amazon Alexa as an attempt to offer solutions to all common queries of new entrants regarding campus needs to enhance their experience by giving them touch-free access to information and services tailored to campus living — and prepare some of them to become leaders in voice-technology development. Also, it will help them consistently update about the schedule and courses of each student thereby reducing the requirement for internal support as well as expense of printing college handbooks that are only temporarily used. The employment of these voice assistant systems breaks the monotony and fetches an exciting prospect for the students. The employment of this technology is expected to escalate in the coming years.

Some Engineering students at Arizona State University have chosen to take part in first-of-its-kind voice-technology program on a university campus and students powered with Alexa Echo Dot (Team, 2017) have moved to a new residence hall which is a first of its kind voice-

enabled residential community on a university campus. Once the students become familiar with their devices, the aim of the university is to motivate them to develop their own technology to create an ecosystem that supports voice technologies throughout the campus. Idea is to make it a Smart Campus equipped with the latest technologies and Artificial Intelligence, that would like to optimize operations, energy efficiency and create a highly personalized campus experience for all students, faculties, Alumni, and staff members (Seckel, 2017). Amazon is having several fellowship programs: 1. Alexa Fellowship, 2. Graduate Fellowship and 3. The Innovation Fellowship programs and start-ups launched for Graduate and doctorate level programs in collaboration with various top reputed universities like Carnegie Mellon University, Waterloo Engineering, University of Texas, University of Sheffield, MIT, Johns Hopkins, University of Cambridge, Illinois and so on. Their aim is to inspire and motivate technology entrepreneurs, faculty members and students to develop and innovate AI enabled voice interfaces.

#### Applications of Voice Assistants in Higher Education

- Provide an immersive classroom experience and encourage collaborative learning in a fun way through interaction with the learners: game like, can act as Quiz Show Host for the audience and participants.
- Put across Mock tests in the form of MCQs or guess the right answer and help in learning during the quiz or play by giving correct answers and explanation in the form of storytelling.
- Act as a knowledge hub with interdisciplinary knowledge to be produced at a command with accuracy.
- Help students in knowing their areas of strength and improvements.
- Help in knowing the performance in comparison to other students in university.
- Can help in real-time customized learning to address different needs and interest of students.
- A great tool for students in scheduling, reminding, keeping update about various activities as per their Academic Calendar.
- Can help conveniently learn spellings, language, building vocabulary, play musical instrument with daily brief lesson plans.
- Explore information about campus, departments, programs, contact persons, process flow.
- Useful in various processes like Admission, Orientation, Hostel Room Allocation, Mentoring Process, Information Desk by minimizing human bias and ensuring objectivity.

In higher education, AI systems and these voice assistants have a significant role to play during the process of admission and assessment. In both the processes, it is important to minimize the human bias and increase the integrity of the process (Rangaiah, 6 Applications of AI in Education Sector, 2018), which is possible through the implementation of intelligent technology. Moreover, Voice Assistants can be very useful for educators in handling routine administrative activities to reduce the effort of teachers in non-educational activities and enabling them to utilize more time for student development. These voice assistants based on Artificial Intelligence technology can

help in arranging one-to-one discussions with parents and guardians, help in getting feedback relating to mundane issues and having sufficient time and attention to students.

### III. METHODOLOGY

For this study, 100 students (60 Male, 40 Female) were chosen (Fig. 1) and were given a set of questions (Table 1) to be asked to Voice Based Virtual Assistants namely: Amazon Alexa (AA), Microsoft Cortana (MC), Google Assistant (GA) relating to their general queries related to Admission and Examination in Undergraduate (UG) and Postgraduate (PG) courses. Out of which 50 students are enrolled in Post Graduate courses and 50 students in Undergraduate courses in well-established universities in professional courses like MBA (Master of Business Administration), BBA (bachelor's in business administration) in Delhi NCR Region. All the respondents were from the age group 18 years to 25 years of age out of which, 40 students had used voice assistants frequently users and 60 had used non-frequently. All the respondents have their native language as Hindi; however, they all can well understand and communicate in English language. Questions to the virtual assistants were asked in English language. Focus of this study is to understand the effectiveness of these available best virtual assistants in answering basic most frequently asked questions by the aspirant's seeking admission in UG and PG courses of a higher education institution in India. Also, the general queries related to examination preparation by students enrolled in UG and PG courses of well-established higher education institutions were asked.

Table1. Devices used to access each Voice Assistant to ask query

Voice Assistant	Devices
Google Assistant	Android Smart Phone
Amazon Alexa	Echo Dot 3 <sup>rd</sup> Gen
Microsoft Cortana	Windows 10 Laptop

### IV. EVALUATION AND RESULTS

The aim of this study was to test the ability of voice assistants to recognize the voice and language of the user, basic understanding of question, context of the question, answered the question asked or not as per respondents. Also, users took into consideration the quality of the answer generated for further qualitative analysis to understand the effectiveness of these voice assistants. As per the inputs received from user, the researcher has concluded the survey with these observations. In few cases, question was asked again to the virtual assistants when it was unable to give answer or requested to repeat the question.

#### a. *Observations in Category 1 questions and responses received*

In category 1, 2nd question, Alexa responded: "Sorry, I don't know that". Also, while answering 2<sup>nd</sup> question, improper answer was received by Alexa and additional details like address or distance were also told by Alexa, which were not even asked to her. This gives user the feeling of consuming extra time and more frustration. In case of answering question 2, Cortana was able to understand the question and context, however the response generated was average. In case of question 4, Cortana performed poor as it was unable to understand the language, Alexa gave average and Google Assistant Performed very good. Again 5<sup>th</sup> question was not well understood by Alexa and Cortana, and the response generated was poor, however Google Assistant responded very good. Question 6 was performed well by Cortana and Google Assistant, but not by Cortana. For some questions, Alexa neither requested to repeat the question nor gave the answer and finally responded "I don't know that". Similarly, Cortana dint request to repeat a single question and responded, "I'm sorry, but I can't help with that".

#### b. *Observations in Category 2 questions and responses received*

In category 2 Examination Preparation related queries, the questions were direct and having fewer number of words as compared to questions in earlier category 1. Here, the performance of Cortana improved with fewer instances of giving poor or average answer as compared to category 1. However, performance of Alexa was not that good as it could have been. In smaller and direct questions as well, Alexa gave average or poor response in 4 out of 7 questions. The request to repeat the question were more frequently asked by Alexa as compared to other two. Google Assistant and Microsoft Cortana understood all the questions and didn't ask to repeat the question. Alexa had issues in understanding the context of the question and even speech as well even after registering the voice before questions were asked. Also, sometimes Alexa gave responses that can make one laugh or feel sarcasm. Alexa tried to build up the conversation and asks for the feedback by the user. However, Alexa takes the subject for discussion in totally different direction and the user had to say "Alexa, Stop!" to bring it back and ask the next question.

In all the questions, Google Assistant performed very good in understanding voice, language, meaning of the question and answered correctly within the context as asked by the user. As per the results, Google Assistant was found most accurate and effective in giving the answer with explanations as per the context of user in comparison to other two voice assistants. Voice variations understanding was better in case of Google Assistant than other two and it was able to avoid and not register the disturbances in the environment because of noise in the environment created by electrical appliances like Air conditioner, Fan, TV, Laptop, Doorbell, or distant or feeble voices from children or other people.

Table 2. Questions and factors considered to find out the effectiveness of voice assistants, where Abbreviations stand: AA: Amazon Alexa, MC: Microsoft Cortana, GA: Google Assistant.

Question asked	Factors considered to find out the effectiveness of Voice Assistants				
Category 1: Admission related general most frequently asked questions	Understanding of voice and language	Understanding basic meaning of question	Requests to repeat the question	Answered the question	Quality of Answer received
1. Name the good colleges and universities for admission in MBA in Delhi?	AA: Good GA: Very Good MC: Good	AA: Very Good GA: Very Good MC: Good	AA: Yes GA: No MC: No	AA: Yes GA: Yes MC: Yes	AA: Good GA: Very Good MC: Good
2. Name the colleges and universities with affordable fee structure for MBA Program in Delhi?	AA: Poor GA: Very Good MC: Very Good	AA: Poor GA: Very Good MC: Good	AA: Yes GA: No MC: No	AA: No GA: Yes MC: Yes	AA: Poor GA: Good MC: Average
3. Eligibility criteria for MBA Program in a Business School.	AA: Very Good GA: Good MC: Very Good	AA: Very Good GA: Very Good MC: Very Good	AA: No GA: No MC: No	AA: Yes GA: Yes MC: Yes	AA: Good GA: Good MC: Very Good
4. Name MBA college and university having good placements record for MBA students in Delhi?	AA: Good GA: Very Good MC: Poor	AA: Average GA: Very Good MC: Poor	AA: Yes GA: No MC: No	AA: Yes GA: Yes MC: No	AA: Average GA: Very Good MC: Poor
5. Name various MBA institutes having good infrastructure and facilities for students in Delhi?	AA: Good GA: Very Good MC: Poor	AA: Poor GA: Very Good MC: Poor	AA: No GA: No MC: No	AA: Yes GA: Yes MC: No	AA: Poor GA: Very Good MC: Poor
6. Name the universities and colleges having hostel and accommodation facility in Delhi?	AA: Very Good GA: Very Good MC: Average	AA: Very Good GA: Very Good MC: Average	AA: No GA: No MC: No	AA: Yes GA: Yes MC: Yes	AA: Very Good GA: Very Good MC: Average
7. Name the top-ranking MBA colleges and universities in Delhi?	AA: Average GA: Very Good MC: Good	AA: Poor GA: Very Good MC: Good	AA: Yes GA: No MC: No	AA: Yes GA: Yes MC: Yes	AA: Poor GA: Very Good MC: Good
Category 2: Exam Preparation related most searched queries by users	Understanding of voice and language	Understanding basic meaning of question	Requests to repeat the question	Answered the question	Quality of Answer received
1. How to control anxiety before exam.	AA: Very Good GA: Very Good MC: Very Good	AA: Good GA: Very Good MC: Very Good	AA: No GA: No MC: No	AA: Yes GA: Yes MC: Yes	AA: Good GA: Very Good MC: Very Good
2. How to prepare for exams.	AA: Very Good GA: Very Good MC: Very Good	AA: Very Good GA: Very Good MC: Very Good	AA: No GA: No MC: No	AA: Yes GA: Yes MC: Yes	AA: Very Good GA: Very Good MC: Very Good
3. How to get good marks in exams?	AA: Very Good GA: Very Good MC: Very Good	AA: Average GA: Very Good MC: Very Good	AA: No GA: No MC: No	AA: Yes GA: Yes MC: Yes	AA: Average GA: Very Good MC: Very Good
4. How to memorize answers quickly?	AA: Very Good GA: Very Good MC: Very Good	AA: Very Good GA: Very Good MC: Very Good	AA: No GA: No MC: No	AA: Yes GA: Yes MC: Yes	AA: Very Good GA: Very Good MC: Very Good
5. How to remember answers for exams?	AA: Very Good GA: Very Good MC: Very Good	AA: Average GA: Very Good MC: Good	AA: No GA: No MC: No	AA: Yes GA: Yes MC: Yes	AA: Poor GA: Very Good MC: Good
6. How to identify important topics for exams?	AA: Very Good GA: Very Good MC: Good	AA: Average GA: Very Good MC: Poor	AA: No GA: No MC: No	AA: Yes GA: Yes MC: No	AA: Average GA: Very Good MC: Poor
7. What to carry while going for an exam?	AA: Good GA: Very Good MC: Good	AA: Average GA: Very Good MC: Average	AA: No GA: No MC: No	AA: Yes GA: Yes MC: Yes	AA: Average GA: Very Good MC: Average

## V. ANALYSIS ON RESULTS

### 1. Amazon Alexa

Amazon Alexa was unable to answer one question from category one. Alexa in comparison to other Virtual Assistants had difficulty in understanding the question and hence repeatedly responds “I don’t know”. There were quite amusing responses as well generated by Alexa for few questions asked by the user and responded either “I don’t know” or “I am still learning” or stated playing music. Request to repeat the question was done by only Amazon Alexa only

for three questions in Category I. It shows that it is more interactive and tries to clarify from the user. However, despite repeatedly asking the same question, it lacked in providing the relevant information and generated vague responses or responses from totally different domain. Alexa could give answers only one option or limited answer even when asked to tell names of few institutes or list of institutes. Also, Alexa is giving sometimes extra information, which is not even asked like addresses, location along with distance from the current location even when only name or list of institutes has been asked.

So, it is generating information which is not asked or required. Alexa terminates the conversation after giving answer for one question and making users unable to build the conversation most of the time.

## 2. Google Assistant

As per the results obtained, Google Assistant excelled in understanding the question correctly in the first attempt even through different voice modulations and able to generate the accurate response or near to accurate response for the user. Google Assistant was able to provide answers to all the questions asked from both the categories containing complex or simple questions. In terms of Quality of the answer generated as per the user, Google Assistant provided good or very good response for the user. Interestingly, Google assistant didn't ask to repeat any question and tried to generate the answer up to its best possible understanding and search.

## 3. Microsoft Cortana

Microsoft Cortana was unable to answer two questions from category I and one question from category II. In terms of Quality of the answer generated in both categories, Microsoft Cortana's performance was varying from Very good to poor as per the users. In total three questions were not answered by it from both the categories. Users received no request to repeat the question from Cortana. Cortana occasionally generated response like "I'm sorry, but I can't help with that".

## VI. DISCUSSION AND FUTURE WORK

Considering the benefits offered by Artificial Intelligence developers, many higher educational institutions are planning to enhance the use of virtual assistants to serve the students for various purposes during the process of admission, curriculum delivery, assessment, placement, counseling and many more. Anyone possessing android smart phone and a laptop with MS windows 10 or iOS has access to minimum one or two virtual assistants for their personal use. In the study, responses of all the three virtual assistants were recorded by 100 users to know their understanding of the question asked in the first attempt and accuracy of the response generated. English language was used to ask the question. Still, people have unique volume, pitch, and style of speaking the same words to ask question creating challenge for the virtual assistants in understanding the question. In the environment, few sources of noise were present while using virtual assistants to make it closer to actual scenario. Undoubtedly, artificial intelligence has come a long way since the time it has begun and still a long way is to be covered before it is used and relied upon by the users 100% in times to come. Researchers and programmers are trying various ways to bring

improvements in these voice assistants by trying different algorithms. Challenge for these voice assistants remains in to understand the context of the user and capability to build and have a human like conversation. In higher education, simpler queries can be taken by virtual assistants regarding some process with timelines and stages. However, other complex areas where mentoring, counseling is required by the students, professionals need to work hard as the little addition of complexity in the question, the performance of the virtual assistants starts declining. Programmers may combine different technologies to get desired results. Also, these virtual assistants first can build on one or two specialized area and then can build a generalist approach for answering questions. Local players can also come up in the market with option of regional languages being spoken in India. Hence, a huge potential lies in Indian Higher Education sector for these virtual assistants to assist the various stakeholders in solving their queries, guiding them, and saving time. Voice assistants can benefit users from various other industries and can be tested for their performance in other sectors and jobs as well to make them more effective in performance. Therefore, an ocean of challenges and opportunities lie ahead for the programmers as well as users respectively to take forward voice and allied artificial intelligence technologies in shouldering with and partnering the responsibilities in present demanding environment.

## REFERENCES

- [1] *2018 Future of Marketing and AI.* (2018). Retrieved from brightedge.com: <http://videos.brightedge.com/research-report/brightedge-2018-future-of-marketing-and-ai-survey.pdf>
- [2] *About Us: toppr.* (2020). Retrieved from A Haygot Technologies, Ltd. Web site: <https://www.toppr.com/>
- [3] Adams, D. M., McLaren, B. M., Mayer, R. E., Goguadze, G., & Isotani, S. (2013). Erroneous Examples as Desirable Difficulty. In: Lane H.C., Yacov K., Mostow J., Pavlik P. (eds). In Y. K. Lane H.C. (Ed.), *Artificial Intelligence in Education. Lecture Notes in Computer Science 7926*, pp. 803-806. Berlin: Springer. doi:[https://doi.org/10.1007/978-3-642-39112-5\\_117](https://doi.org/10.1007/978-3-642-39112-5_117)
- [4] Basham, J. D., Hall, T. E., Carter Jr., R. A., & Stahl, W. M. (2016). An Operationalized Understanding of Personalized Learning. *Journal of Special Education Technology*, 31(3), 126- 136. doi:[10.1177/0162643416660835](https://doi.org/10.1177/0162643416660835)
- [5] Beal, C., Beck, J., & Woolf, B. (1998). Impact of intelligent computer instruction on girls' math self concept and beliefs in the value of math. In *Poster presented at the annual meeting of the American Educational Research Association*. San Diego.
- [6] BULGER, M. (2016). Personalized learning: The conversations we're not having. *Data and Society*, 22(1), 1-29.
- [7] Carnegie Learning. (2021). Retrieved from Carnegie Learning Inc.: <https://www.carnegielearning.com/solutions/math/mathia/>
- [7] Carnegie Mellon University. (2019, December 19).

- [8] Retrieved from <https://stoichtutor.cs.cmu.edu/>  
Cheung, B., Hui, L., & Yiu, S. M. (2013, October 15). SmartTutor: An intelligent tutoring system in web-based adult education. *Journal of Systems and Software*, 68(1), 11-25.  
Retrieved from [https://doi.org/10.1016/S0164-1212\(02\)00133-4](https://doi.org/10.1016/S0164-1212(02)00133-4)
- [9] COUPONFOLLOW TEAM. (2009-2021). *Using Voice Assistants for Online Shopping*. Retrieved from NextGen Shopping Inc.: <https://couponfollow.com/research/voice-assistants-online-shopping>
- [10] Eliot, C., & Woolf, B. P. (1994). Reasoning about the user within a simulation-based real-time training system. *Fourth International Conference on User Modeling, Hyannis Cape Cod, Mass*, (pp. 15-19).
- [11] Freedman, R., Ali, S. S., & McRoy, S. (2000, September 1). What is an intelligent tutoring system? *Intelligence*, 11(3), pp. 15-16.
- [12] Heffernan, N. T., Turner, T. E., Lourenco, A. L., Macasek, M. A., Nuzzo-Jones, G., & Koedinger, K. R. (2006). The ASSISTment Builder: Towards an Analysis of Cost Effectiveness of ITS Creation. *Flairs Conference*, (pp. 515-520). Retrieved from <https://www.aaai.org/Papers/FLAIRS/2006/Flairs06-101.pdf>
- [13] Holmes, Wayne; Bialik, Maya; Fadel, Charles;. (2019). *Artificial Intelligence in Education: Promises and Implications for Teaching and Learning*. Boston, MA: Center for Curriculum Redesign. Retrieved from <https://curriculumredesign.org/our-work/artificial-intelligence-in-education/>
- [14] Holmes, Wayne; Bialik, Maya; Fadel, Charles;. (2019). *Artificial Intelligence in Education: Promises and Implications for Teaching and Learning*. Boston: Center for Curriculum Redesign. Retrieved from <https://curriculumredesign.org/our-work/artificial-intelligence-in-education/>
- [15] Huang, Y.-M., Liang, T.-H., & Su et al., Y.-N. (2012). Empowering personalized learning with an interactive e-book learning system for elementary school students. *Education Tech Research Development*, 60, 703-722.  
doi:<https://doi.org/10.1007/s11423-012-9237-6>
- [16] Hyper-personalization vs. Segmentation. (2017, 01 05). Retrieved from capgemini consulting and ESSEC Business School: [https://www.capgemini.com/consulting-fr/wp-content/uploads/sites/31/2017/08/hyperpersonnalisation\\_vs\\_segmentation\\_english\\_05-01-2017.pdf](https://www.capgemini.com/consulting-fr/wp-content/uploads/sites/31/2017/08/hyperpersonnalisation_vs_segmentation_english_05-01-2017.pdf)
- [17] Keleş, A., Ocak, R., Keles, A., & Gülcü, A. (2009, March). ZOSMAT: Web-based Intelligent Tutoring System for Teaching-Learning Process. *Expert Systems with Applications*, 36(2), 1229-1239.  
doi:<https://doi.org/10.1016/j.eswa.2007.11.064>
- [18] Kinsella, B. (2020, November 5). *Voice Assistant Use on Smartphones Rise, Siri Maintains Top Spot for Total Users in the U.S.* Retrieved from voicebot.ai: <https://voicebot.ai/2020/11/05/voice-assistant-use-on-smartphones-rise-siri-maintains-top-spot-for-total-users-in-the-u-s/>
- [19] Koedinger, K. R., Anderson, J. R., Hadley, W. H., & Mark, M. A. (1997). Intelligent tutoring goes to school in the big city. *International Journal of Artificial Intelligence in Education*, 8(1), 30-43. Retrieved from <https://telearn.archives-ouvertes.fr/hal-00197383>
- [20] Lajoie, S. P., & Lesgold, A. (1989). Apprenticeship training in the workplace: Computer-coached practice environment as a new form of apprenticeship. In *Machine-Mediated Learning* (Vol. 3, pp. 7-28).
- [21] McLaren B.M., L. S. (2006). Studying the Effects of Personalized Language and Worked Examples in the Context of a Web-Based Intelligent Tutor. In A. K. Ikeda M. (Ed.), *International Conference on Intelligent Tutoring Systems. Lecture Notes in Computer Science book series (LNCS*, volume 4053), pp. 318-328. Berlin, Heidelberg: Springer.  
doi:[https://doi.org/10.1007/11774303\\_32](https://doi.org/10.1007/11774303_32)
- [22] McLaren et al., B. M. (2012). To Err Is Human, to Explain and Correct Is Divine: A Study of Interactive Erroneous Examples with Middle School Math Students. In L. S.-L. Ravenscroft A. (Ed.), *European Conference on Technology Enhanced Learning. Lecture Notes in Computer Science*, vol 7563, pp. 222-235. Berlin: Springer. doi:[https://doi.org/10.1007/978-3-642-33263-0\\_18](https://doi.org/10.1007/978-3-642-33263-0_18)
- [23] McLaren, B. M., Adams, D. M., & Mayer , R. E. (2015, October 13). Delayed Learning Effects with Erroneous Examples: a Study of Learning Decimals with a Web-Based Tutor. *International Journal of Artificial Intelligence in Education*, 25, 520-542.  
doi:<https://doi.org/10.1007/s40593-015-0064-x>
- [24] Melis, E., & Siekmann, J. (2004). ActiveMath: An Intelligent Tutoring System for Mathematics. In S. J. Rutkowski L. (Ed.), *International Conference on Artificial Intelligence and Soft Computing. Lecture Notes in Computer Science book series (LNCS, volume 3070)*, pp. 91-101. Berlin, Heidelberg: Springer.  
doi:[https://doi.org/10.1007/978-3-540-24844-6\\_12](https://doi.org/10.1007/978-3-540-24844-6_12)
- [25] Melis, E., & Siekmann, J. (2004). ActiveMath: An Intelligent Tutoring System for Mathematics. In S. J. Rutkowski L. (Ed.), *Artificial Intelligence and Soft Computing - ICAISC 2004*, 3070, pp. 91-101. Springer, Berlin, Heidelberg.  
doi:[https://doi.org/10.1007/978-3-540-24844-6\\_12](https://doi.org/10.1007/978-3-540-24844-6_12)
- [26] MILETTO, E. M., SOARES , M. P., VICARI , R. M., & FLORES, L. V. (2005, November 29). CODES: a Web-based environment for cooperative music prototyping. *Organised Sound*, 10(3), 243-253.  
doi:<https://doi.org/10.1017/S1355771805000981>
- [27] Mohan, M. (2013, December 14). *the future of all education is hyper-personalized*. Retrieved from Best Engaging Communities: <https://bestengagingcommunities.com/2013/12/14/the-future-of-all-education-is-hyper-personalized/>
- [28] Nkambou, R., Mizoguchi, R., & Bourdeau, J. (Eds.). (2010). *Advances in Intelligent Tutoring Systems* (1 ed., Vol. 308). Berlin, Germany: Springer-Verlag Berlin Heidelberg. doi:<https://doi.org/10.1007/978-3-642-14363-2>
- [29] wana , H. S. (1990). Intelligent tutoring systems: An overview. *Artificial Intelligence Review*, 4(4), 251-277.  
doi:<https://doi.org/10.1007/BF00168958>
- [30] Optoma Corporation. (2020). *Voice Assistant: Optoma Corporate Marketing*. Retrieved from Optoma Corporation Web site: <https://www.optoma.com/235-2/>
- [31] PRANGE, S. (2019, 1-8). *Study: Standalone Voice Assistants One of Fastest Adopted Technologies in U.S. History*. Retrieved from SLANG LABS: <https://www.mediaplaynews.com/study-standalone-voice-assistants-one-of-fastest-adopted-technologies-in-u-s-history/>
- [32] Rangaiah, M. (2018, June 21). 6 Applications of AI in Education Sector. Retrieved from <https://www.analyticssteps.com/blogs/4-major-applications-artificial-intelligence-education-sector>
- [33] Rangaiah, M. (2021, June 21). 6 Applications of AI in Education Sector. Retrieved from <https://www.analyticssteps.com/blogs/4-major-applications-artificial-intelligence-education-sector>
- [34] Reviews.com Staff. (2020, October 28). *The Best Voice Assistants*. Retrieved from Reviews.com: <https://www.reviews.com/home/smart-home/best-voice-assistant/>
- [35] Rouhiainen, L. (2019, October 14). How AI and Data Could Personalize Higher Education. Harvard Business Review. Retrieved from <https://hbr.org/2019/10/how-ai-and-data-could-personalize-higher-education>
- [36] Schiaffino, S., Garcia, P., & Amandi, A. (2008, December). eTeacher: Providing personalized assistance

- to e-learning students. *Computers & Education*, 51(4), 1744-1754. Retrieved from <https://doi.org/10.1016/j.compedu.2008.05.008>
- [37] Schroer, A. (2020, March 25). 12 companies using AI in education to enhance the classroom. Retrieved from <https://builtin.com/artificial-intelligence/ai-in-education>
- [38] Seckel, S. (2017, August 17). ASU News. Retrieved from Arizona State University: <https://news.asu.edu/20170817-asu-news-asu-amazon-dots-tooker-house>
- [39] Shneyderman, A. (2001, September). *Evaluation of the Cognitive Tutor Algebra I Program*. Miami: MIAMI-DADE COUNTY PUBLIC SCHOOLS OFFICE OF EVALUATION AND RESEARCH. Retrieved from <https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.693.8250&rep=rep1&type=pdf>
- [40] Silver, S. (2020, August 21). *A History of Voice Technology*. Retrieved from KEY LIME INTERACTIVE: <https://info.keylimeinteractive.com/history-of-voice-technology>
- [41] Team, A. P. (2017, Aug 28). aws. Retrieved from AWS Public Sector Blog: <https://aws.amazon.com/blogs/publicsector/arizona-state-university-brings-voice-technology-program-to-campus/>
- [42] Terzopoulos, G., & Satratzemi, M. (2019). Voice assistants and artificial intelligence in education. *Proceedings of the 9th Balkan Conference on Informatics*, 34, pp. 1-6.
- [43] doi:<https://doi.org/10.1145/3351556.3351588>  
TERZOPoulos, G., & SATRATZEMI, M. (2020). Voice Assistants and Smart Speakers in Everyday Life and in Education. *Informatics in Education*, 19(3), 473-490. doi:[10.15388/infedu.2020.21](https://doi.org/10.15388/infedu.2020.21)
- [44] Vailshery, L. S. (2021, 1 22). *Number of digital voice assistants in use worldwide 2019-2024*. Retrieved from statista: <https://www.statista.com/statistics/973815/worldwide-digital-voice-assistant-in-use/>
- [45] VanLehn K. et al. (2002). The Architecture of Why2-Atlas: A Coach for Qualitative Physics Essay Writing. In G. G. Cerri S.A. (Ed.), *International Conference on Intelligent Tutoring Systems. Intelligent Tutoring Systems Lecture Notes in Computer Science book series (LNCS, volume 2363)*, pp. 158-167. Berlin, Heidelberg: Springer. Retrieved from [https://doi.org/10.1007/3-540-47987-2\\_20](https://doi.org/10.1007/3-540-47987-2_20)
- [46] Walsh, K. (2019, December 3). Intelligent Tutoring Systems (aDecades-old Application of AI in Education). In C. Fade, W. Holmes, & B. Maya, *Artificial Intelligence In Education: Promises and Implications for Teaching and Learning* (p. 242). EmergingEdTech. Retrieved from EmergingEdTech: <https://www.emergingedtech.com/2019/12/intelligent-tutoring-systems-application-of-ai-in-education>.