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The Future of Robotic-Teacher relationship in classrooms: Cooperation or Competition?

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“The Future of Robotic-Teacher relationship in classrooms: Cooperation or Competition?”

by

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Abstract (with key words)

As the realms of artificial intelligence (AI) and robotics undergo exponential growth and the issue of teacher shortage remains a concern, the potential for remarkable advancements in education with the assistance of robots becomes increasingly important. This review is conducted to understand the forthcoming role of robotics in education and its impact on teachers' role in the classroom. Currently, it is widely known that AI is evolving in a rapid way, creating a huge presence in our life, building a perception among people that it will take over the role of human in various settings in the future. Various articles and research papers, published between the years 1982 and 2024, were thoroughly reviewed to explore different types of Robots-teachers' relationships, methods or approaches used to assess such relations, the reported outcomes and acceptance level of key stakeholders. Based on the review, there was a consistency among the findings of all selected articles leading to the fact that the role of Robots demonstrates a supportive nature to teacher's role. In other words, the obtained evidence was clearly presenting Robots-teachers relationship as a cooperative connection rather than a competition, reassuring teachers that their existence in classes is paramount. However, this paper aims to shed the lights on future possibilities considering the following:

- technology is paving its way to further developments, which are ambiguous today and will unleash in the future,
- human being is indeed paving its way towards new complexities,
- Potential critical uncertainties could change the rules of the game,

Keywords:

Robots, human, teacher, relationship, classroom, cooperation, competition, future, education

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Chapter 1. Introduction

Introduction

Imagine this: 2040, two classrooms next to each other, one is a science class for grade 5 students sitting in a group of 4, highly engaged with the teacher in discussions beyond the textbook notes. A robot is keeping track of the time, distributing class sheet papers, guiding students to teachers' notes, and roaming around the groups in a timely, well-organized manner. While the teacher focusing on guiding students individually on what to focus on and discovering the hidden talent in each one of them. In the other class, the robot is running the show alone, in a highly structured and organized approach, taking over the role of human-teacher. Students are showing higher level of curiosity to what is being delivered by the robot. The concentration is on their skills and instant report are generated based on the degree of interaction each student has. In one corner, the struggle is real, as the robot is trying to calm a child who is crying and wants his parents. This prototype triggered the study of my thesis, which was further drove by teacher workload and shortage issue. In this paper, I investigate the potential of robotic integration into classrooms, knowing that technology, teachers and students are all going through phases of evolution that calls for crossing the limits and welcoming new possibilities to the world.

Statement of the problem

The Future of Robotic-Teacher relationship in classrooms, Cooperation or Competition?

In an era imposed by groundbreaking technological strides, the landscape of education, particularly teachers' role, is and will continue to undergo a transformative shift forced by different factors. One of the key factors is associated with the continuous gap in the number of teaching staff and the intensified challenges that teachers go through due to extra layers of complexities added to their role since the escalation of technology advancement and emergence of robot-assisted teachers. The integration of robots in educational classrooms, has therefore, affected the dialogue about the future of education, which has been packed with extensive considerations, ranging from possibilities of a collaborative partnership between teachers and robots, to concerns about potential competition. The two key questions to explore are:

1. What challenges will be disrupting the education sector if robots fully replaced teachers in 15 years timeline?
2. What opportunities could human-teacher unleash to be part of the educational loop system, even with the advancement of robot-teachers? And what would make teachers remain paramount and irreplaceable instructor?

Background Information

The role of teachers has evolved significantly throughout the history. 5000 years ago, they were seen as sages, imparting knowledge to small groups across various cultures. From Ancient to Middle Ages, teachers transitioned to spreading knowledge in established educational institutions. The late 19th century marked a transformative shift in teacher's role with the enforcement of education, turning teaching into a profession for larger classes with standardized curricula. The 20th century introduced psychology to education, emphasizing on the significance of understanding students' psychological and cognitive development phases. The 21st century brought technological opportunities and challenges, requiring teachers to adapt to hybrid and online learning. Indeed, with the hit of Covid-19 pandemic, more challenges have coated teachers' path and complexity of their role has further intensified, demanding teachers to handle both educational and non-educational (social and emotional) aspects of students' journeys (Education Leadership, Leadership blogs). It has been therefore, important to investigate the forthcoming future of this job, particularly with the recent development of technology, the presence of artificial intelligence in our lives and the shift in the needs and expectations of the new generation,

Project Definition and Goals

This project explores the integration of robotics into classrooms, with a focus on assessing whether these technological creatures can supplement or complement the role of educators. The aim is to offer an understanding of the evolving relationship between teachers and robots, emphasizing the potential for collaboration rather than a zero-sum competition. Currently, the role of robots is limited, where applicable to assistance nature where robot's contribution to the work of teacher is seen in translating teacher's experience with the students to a more organized, relaxed, and customized journey. Exploring teachers' and robots' roles further and digging deeper into this aspect, the research will answer the following questions:

1. What challenges are facing teachers in the current education system? And can robots contribute to solving those challenges?
2. What are the advantages and disadvantages of robot integration into classrooms?
3. What are the socio-economic impacts of integrating robots into the education system?
4. What challenges will be disrupting the education sector if robots fully replaced teachers?
5. What opportunities could human-teacher unleash to be part of the educational loop system, even with the advancement of robot-teachers? And what would make teachers remain paramount and irreplaceable instructor?

Chapter 2: Literature Review

The Literature Review will cover three main areas: teachers, students and Robots, considering that they are the key pillars for any learning process.

1 Teachers and Technology

In light of the intersection between the issue of teachers' shortage and the unprecedented technological development, the world has welcomed the intervention of technology into the education sector. From one side, the existence of teachers' gap in classrooms, called for an optimal solution, while in the other side, the dynamic evolution of innovative technology into the life of new generation presented exceptional opportunity. Such merge contributed to backing up teachers' shortage issue and welcoming a revolutionary wave into educational field. Subsequently leading to changes in both supply and demand side drivers for technology adoption, presenting technology as a crucial player in shaping the future of education.

2.1 Teachers' shortage, a global issue

In 1982, James Guthrie and Ami Zusman investigated the issue of Math and Science teacher shortage in US as not much attention was paid to this problem back then. According to a survey conducted by the Association for School, College, and University Staffing in 1981, "43 states report shortages of high school mathematics teachers, and 42 states report shortages of physics teachers". Furthermore, According to The National Education Association, 22% of all math teachers job vacancies in US were either unoccupied or occupied by uncertified

personnel. This shortage was expanded, not only reaching other scientific subjects, but even beyond the borders of the United States, affecting other developed countries. Guthrie and Zusman indeed presented statistical data to emphasize on students' perspective as well. Only 97 out of the 400,000 total students who enrolled in California's public institution, were arranging to become math teachers, while 174 were preparing to become science teacher. Such numbers reflect the severity of the issue and the importance of rectifying it as quickly as possible. Therefore, number of solutions were defined back then, most of which targeted immediate adjustments to the work condition of current teachers by providing differential pay or training and development programs, while other solutions aimed at new strategies to attract teachers from other districts, industries and/or countries. Surprisingly, technology-based solution, in particular a computer-assisted instruction was proposed as well, indicating that a transformative solution was thought of since many decades (James Guthrie and Ami Zusman, 1982). However, technology was not advanced at that time to the level that one could anticipate a technological creature to physically be present next to the teacher to either support the learning environment or even run the show alone.

Moving to recent perspective of the issue, particularly in 2018, Bosede Edwards explored the problem of teacher's shortage again. His focus was triggered by the fact that many researchers reported lack of teachers in classroom being seen as a global issue. A report published by the US Department of Education recorded a comprehensive list of areas that contributed to teachers' shortage issue, those were ranging from decline in the interest to purse a program in education to a drop-in teacher enrolment rate to be part of educational preparation courses[1] (Bosede Edwards and Adrian Cheok, 2018). According to United Nations Educational, Scientific and Cultural Organizations (UNESCO) 2015 report tackling this problem, "the issue remains a serious concern" and the urge for addressing it early is decisive. Indeed, the situation got worse post COVID-19 pandemic with teachers being imposed to intensified challenges that required adopting to new technological platforms and communicating digitally with all students with the aim to break barriers and ensure that every student, regardless of their surroundings, realized that they are acknowledged, and valued. According to the most recent UNESCO report about teacher shortage, there is an estimated need for "69 million more teachers by 2030 to achieve universal basic education, yet current trends see this deficit increasing" (Edwards, 2023). As such, innovative approaches to unleashing new intelligent solutions is an immediate need. This will highly contribute to attracting and maintaining a qualified workforce, boosting teacher's

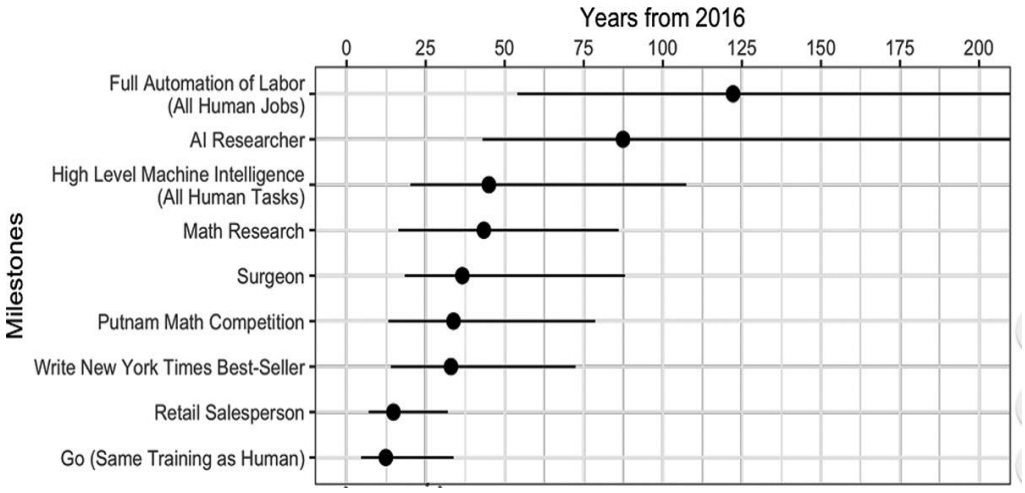
[1] Refer to the appendix – Figure A1 for further details about Teachers enrolment rate

satisfaction and wellbeing, while enhancing students learning experience through coping with the rapidly growing breakthrough-technologies.

2.2 The growing influence of technology

Elon Musk, an American visionary leader, and entrepreneur born in South Africa, who is currently the CEO and co-founder of SpaceX, Tesla, Neuralink and The Boring Company, believes that humans will have no option but to depend on intelligent machines and robots for facilitating the future workforce. He anticipates that government in future will be paying human a universal salary due to lack of jobs that human can do. Although no one shared the same perspective, the advancement of artificial intelligence and robots supports this view. A 2016 study (Grace et al. Citation2017) surveyed principal experts in AI and machine learning, raising a question about the estimated time for robots to do all human works. The survey resulted in an average of 45 years. However, there was a wide range of opinions among the experts, from less than 10 years up to 50 years. This shows how close or far we are from such reality. A recent example of human foresight in similar case presented a 2-year outcome, where the initial prediction was 12 years! This indication is reflecting how significant these values could be and proposing that the recognition of such predictions may be much closer than expected (Bosede Edwards and Adrian Cheok, 2018).

Figure 1 - Milestones of achievements in AI[2]



[2] Article "Why Not Robot Teachers: Artificial Intelligence for Addressing Teacher Shortage"

This figure supports Mask's perception of how rapid the technological development could be, turning anticipations of many years into a reality within significantly shorter time interval. While the basis of Elon Mask's thought is observed, it's worth noting that human-being is the ultimate driver for turning this perception into a reality as he is the key catalyst, continuously propelling technology to further advancements.

2. Students - Generation Alpha in particular

2.1 Characteristics of generation Alpha

According to Eurasia Science Review, generation alpha is referred to those kids born from 2010 to 2024. This generation reflects a remarkable comfort with digital technologies, with high preference laid to virtual connection. As 3 million of this generation are born on a weekly basis, all of them are raised with the existence of technologies, never feeling that smart phones, tablets and iPads are extra tools; rather they see them as indispensable parts, integrated in their lives, influencing the way they live, play, study and interact with others.

2.2 Comparison with previous generation

Comparing generation Alpha to the previous one, generation Z, born from mid 1990s till 2010, symbolizes a link between digital and analog eras. They experienced internet initiation, social media expansion, smartphone creative explosion phase. Witnessing such events, along with events from pre-digital era, contributed to shaping their mindsets and behaviors and creating a seamless connection with previous generations. It is worth noting that Generation Alpha is the only generation that is different than all previous generations, as the link to pre-digital life is missing, making this generation a unique group, with distinctive characteristics, needs and expectations. Ultimately, this fact plays a crucial role in forming exceptional trends in a world that is constantly evolving and reshaping its features.

Additionally, Eurasia Science Review indicated that generation Alpha's inclination is more towards adopting new emerging technologies such as augmented reality (AR) and virtual reality (VR) applications. In fact, after deep analysis of the difference between generations Z and alpha, Alpha reflected a greater partiality for early adoption to evolving technologies and new digital devices (Parimbekovna, 2023).

Another research published by McCrindle Research Pty Ltd, about Understanding Generation Alpha (McCrindle, 2020), implied that a shift in educational engagement is anticipated considering the current trends of virtual, multimodal education that is feeding the generation with massive amount of information that have never been accessed by any previous generations. Thus, it is anticipated that Alpha will learn more and transcend older generations in their studies. Moreover, McCrindle reflected that the school focus for Generation Alpha and the ones coming next, is expected to be based on life-long learning skills, which is totally different that the focus of Generation Z which was on exam results. It is worth noting that the shift in the outcome must be driven by a shift in the input, which is in this case both teaching and learning methods.

3. Robots

3.1 History of Robots

According to Robot Institutional of America, Industrial Robot is “a reprogrammable multifunctional manipulator designed to move materials, parts, tools or specialized devises through variable programmed motions for the performance of variety of tasks”, where manipulator refers to robots’ arm (Robot Institute of America, 1979). Digging into the history and study of Industrial Robots, it is important to note that the idea of robotics devises assisting human-being has been recorded in myths and stories since ancient time. One of the first automotive machines built to open temple doors back then, was invented by the Greek engineer Heron of Alexandria. In the 9th century, those documentations were collated and interpreted by the Khalif of Baghdad, while attaching a new notion to it, to enhance practicality. In the 18th century, further enhancements were applied on those machines by a Swiss craftsman who constructed human-like dolls to entertain people through music and art. Further pioneering work was presented by Nikola Tesla in the 20th century, when he introduced a remote-controlled boat that reflected the first direct correspondence between human and machines. In the same century and particularly in 1954, the first industrial robot, Unimate was built and connected in Geneal Motors Factory. It was an advanced version of robot with specific programmed arm and a magnetic container, installed to manage and repair materials. Further complexity and flexibility were injected to machines in 1970s, welcoming the birth of computer numerical controlled (CNC) assigned to more complex operations. A smarter robot “Puma” was introduced in 1980s, with the ability to learn and reflect its own practices and improve its skill afterwards (A. Gasparetto, L. Scalera, 2019). Additional features were added to robots in the 1990’s, when the

first human-robot “Honda’s P2” was developed with its capability to talk, walk the stairs, carry items, and mimic human actions. Enhancement in robotic industry continued with the launch of the first collaborative robot in 2000s which was able to work safely with human-beings without any risk of being destructive and the first cloud-connected robot that was able to access data from the net and communicate his learning with facial expressions. In 2020s, the first quantum robot, IBM’s Qiskit, was established with rapid speed and power, known for its ability to perform complicated tasks that exceeded the ability of classical computers. It is worth noting that the growth in industrial robotic field was rapid and profound, confirming that human knowledge and experience through years, played a fundamental role in expanding the functionality of robots and introducing much advanced and unconventional version of this technological creature.

3.2 Robots’ integration, a possible solution

In their article “Why Not Robot Teachers: Artificial Intelligence for Addressing Teacher Shortage”, Edwards and Cheok looked at the possibility of developing new autonomous robot teacher operating through Artificial Intelligence, as an approach to explore new solutions for lack of teachers’ issue. In fact, reduction in teacher admission rate, a drop-in job satisfaction rate and raise in students’ admission rate, were among the top factors leading to this problem. To address these issues, the authors explored the idea of turning robots into pedagogical agents injected with human-skills such as interacting socially in the classroom. This solution has been seen as a satisfactory one and only appealing to owners of educational institutions because machines do not aspire to be satisfied, recognized, or paid, which only applies to human teachers, whose genuine attributes such as attitude, irritation, fatigue force them to seek such goals (Bosede Edwards and Adrian Cheok, 2018). However, the article did not demonstrate the impact of such solution on teachers and students, which are the key stakeholders who would get affected directly by any new shift in educational landscape. One may realize that unless a robot is assembled with academic and social characteristics, filling the gap of teachers through robots only might be a challenging mission or even impossible. However, it is also important to note that the capacity of both human and robots to discover new ways to educating students is subject to further evolution and may be disrupted by many critical uncertainties anticipated to appear in the future, changing the direction of thoughts and opening the horizon to new possibilities.

3.3 The known capacity of Robots in education

Senad Orhani[3] explored the capacity of robots in Education sector, discussing the potential of them replacing or assessing teachers in the classrooms. The objective of his article was to shed the lights on the gains and limits of robots' utilization in education and to stress on the value of human teachers in student's learning journey. Additionally, the author reviewed the obstacles and prospects of robotic integration into the classroom, navigating through possible suggestions for future work. Prior further exploration of Robots key advantages, Orhani highlighted three laws of robotics written by Asimov in 1995, exhibiting ethical guidelines in relation to robotics utilization in educational settings. The three laws cluster around robotics causing no-harm, being devoted to human commands, and defending itself, considering the validity of the first two laws. Focusing on the limitations of robotics, Orhani stated that robots cannot express themselves nor create an attachment or a bond with students due to the absence of social-emotional skills, they cannot inspire students through their character nor present themselves as "role models" and finally they lack the ability to personalize lesson plans to cater the unique learning needs of each student (Orhani, 2023). These skills emphasize the strengths and incomparable values of human teachers, which in turn indicates that teachers are paramount element at students' learning journey. Indeed, Orhani pointed out the challenge that teachers may face in clarifying the degree of involvement that can be contributed by robots at a particular lesson. While humans are inherently unique with distinct attributes, it is worth noting that the expansive growth of their knowledge amplifies their role in shaping the trajectory of robot development. Indeed, as the expertise of human deepens, their contributions may not only enhance the sophistication of robotic functions but also carry the potential to influence outcomes that may unintentionally pose challenges to their own interests at later stages. In short, with further robotic development, the risk that human is working towards shutting down its own self, might turn into a reality.

Desiree Rosa Cardosa presented the key outcomes of an interview conducted in September 2023 with Professor Ilona Buchem[4] who experimented the idea of using a robot in the classroom by introducing pepper robot, to see how it can support group works, through students designing application for the use of robots. Through empathy mapping, Buchem experimented the role of robot to imagine how future learners see, feel, reflect, and respond to different aspects of life. The interviewee clarified that the role of pepper robot was beyond orchestrating the session in an organizational level, it enclosed answering questions, keeping time, sharing examples, and directing students' attention to specific task, while the teacher

[3] article "Robots Assist or Replace Teachers in classrooms."
[4] Media and communication teacher at the BHT in Berlin and the head of the Communications Lab.

herself was dedicated to do more personalized work without being worried about class control. Indeed, Buchem believes that her wellbeing was enhanced with the presence of the robot. Also, she anticipates the role of robot to be beyond classrooms, within the school environment, from being part of the concierge at school's entrance area, to collecting feedback from students on how they are feeling on daily bases. According to Buchem, further developments are planned to empower pepper robot to be able to recognize different type of sounds pertaining to emotional expression (Cardosa, Robotics and artificial intelligence (AI) in Education: using robots in the classroom. Interview with Professor Ilona Buchem (Part 2), 2023). This, again, aligns with the conclusion that more development is anticipated with the evolution of both human and robotic. However, such outcome is alerting human to be cautious about the extent to which they are willing to empower technologies and disrupt the role of the game; because how far robotic can be advanced and substitute the presence of human-being remains a big question!

Cardosa in a different article about "Personal and social robots in education" focused on integrating robotics in classrooms and teaching various subjects and verbal and social skills. The article demonstrates the role of Pepper and Nao[5]; the two robots developed by SoftBank Robotics, which play the roles of a teacher assistant and programming learning platforms in elementary to high school. Cardosa articulated that Pepper, with its emotional intelligence feature, "has been implemented in language classes in Japan and higher education in Europe", reveling its capacity to cater to individual students needs in classes, motivating students to participate and engage with each other. Indeed, the article remarks the deployment of telepresence systems, permitting distant communication between students via robot avatars (Cardosa, Personal and social robots in education , 2018). Although such examples disclosed the good side of deploying robots, Cardosa built a case to respond to the ongoing debate around robots' capacity to replace human teacher position in education. Thus, she drew readers' attention to the two sides of the coin: the advantages and disadvantages of integrating robots in student's learning journey. She indicated that robotics benefits can be seen in the increased level of collaboration and engagement among students, personalized learning journey, exposure to evolving technologies and enhancement of soft skills such as critical thinking. On the other hands, Cardosa pointed out the challenges associated with such incorporation as follow, high cost of robots could put the burden on schools with limited budget, successful integration of robots requires efficient training to upskill teachers, developing an

[5] Refer to the appendix Figures A2 and A3 – video illustration of Pepper and Nao.

assessment mechanism in robots could be a complex target which may lead to difficulty in using a fair mechanism to rate students' performance and ethical concerns pertaining to privacy and security of data could affect students interaction. With both sides examined, the author concluded that it is important to create a balance between these benefits and challenges to reach a reasonable integration of robotics in education, injecting students with new valuable skills without escalating existing discrepancies (Cardosa, 2018). Unlike the first two articles, Cardosa's reflection is compelling as it covers economic, social, and technological aspects and reasonable as it targets the need for a holistic approach to ensure an effective robotic- teacher integration in the education system.

Saira Anwar et al conducted a "Systematic Review of Studies on Educational Robotics" to explore the key drives of using robotics in K–12 formal and informal educational settings and the positive implication resulted from such execution, as well as to consolidate the key findings across the studies. Reflecting on the different studies, the authors granted a distinctive theme to her extensive review work. 45 studies underlined the advantages of robotics in school settings, 32 studies focused on the positive impact of robots on skill transfer among students, 53 studies reflected on robots' influence to boost students' creativity and motivation, 16 studies highlighted the value of robots in raising the spark of involvement among understated group of students such as minority groups, while 28 studies demonstrated the merit of robots in improving teachers' professional development (Saira Anwar, 2019). All these themed studies jointly exemplified many gains affiliated with robotics integration, ranging from expanding student knowledge and their motivation to accelerating teachers' career progress. In fact, the correlation between all mentioned concepts is obvious as they feed to the overall success of introducing robots in K-12 educational settings. Following a thorough assessment of the current use of robots, all authors emphasize that the role of robotics is still not being demonstrated beyond the cooperative role, evident by the support provided to teachers to enhance their lessons and boost students' engagement.

3.4 The unknown capacity of robots for education

In her article "Should we welcome robot teachers?", Amanda Sharkey presented four scenarios derived from a study conducted in 2015, to discuss the use of Robots in classrooms; Robot as Classroom Teacher, Robot as Companion and Peer, Robot as Care-eliciting Companion, and Telepresence Robot Teacher. The primary focus of the article was the ethical concerns accompanying the use of robots in educational classrooms, especially in terms of privacy, attachment, fraud, loss of human contact, manipulation, and liability. Consolidating an

overview of the 4 scenarios, the first one indicates that the teacher is replaced by Saya robot for specific time duration, acting as an authority figure sourcing the kids with the required knowledge. While the second scenario puts the robot in the friendship shoes, targeting an embedded teaching through peer-connection. The third scenario presents the robot as a care giving figure, with teacher's presence being imperative. The last scenario focuses on replacing human teacher by a remote, due to the availability of a telepresence robotic teacher (Sharkey, Should we welcome robot teachers?, 2016). These scenarios constitute of a range of roles for robots, differing in the degree to which the robot could serve as a full substitute or an augmentation for human teachers. The ethical concern implies to evaluating whether some scenarios generate more gains than others in the context of robot-assisted education. Thus, the author proposed taking further precautions when integrating robots in educational settings because of potential ethical issues such as students' privacy, that could generate more harm than benefit to students. In fact, in developing the scenarios, the author has missed to incorporate key elements such as current trends, weak signals and indirect factors that could affect future education. Hence, scenario planning along with a systematic thinking about each scenario would be preferable as a strategic foresight approach to consolidate all relevant perspectives and ensure proposing a solution that is accurate, intelligent, and agile.

The exploration of Edwards et al targeted the perception of students towards the introduction of robot as their new teacher and the implications of such shift into their learning outcomes. The authors presented two scenarios, Robot as teacher, where robot instructors are run by a computer and Teacher as robot, where robot instructors are run by a human (Autumn Edwards, 2016). For the first scenario "Robot as teacher", the authors stated that "the mean credibility score for the robot as teacher condition was significantly above the midpoint (4.0) on a 1–7 semantic differential scale, indicating that students perceived the robot as a credible instructor". While no concrete findings were reported on the impact of robots on student learning. For the second scenario "Teacher as robot", the authors indicated that "the mean credibility score for the teacher as a robot condition was significantly above the midpoint, and it was rated as the most credible among the two scenarios". Additionally, based on students' experience, the results reflected an effective learning outcome due to high credibility score. As a result, the conclusion was drawn reflecting that in both scenarios, students saw teacher and robot as reliable source, but the former was most credible leading to better implication on the learning outcome. The authors' findings align with what is suggested by Computers and Social Actors (CASA) paradigm (C LIFFORD NASS, 1996), which implies that people behave in the same way with a machine operated by human as they deal with direct human-beings. The

authors in a nutshell see the supporting role that robots could add to teachers work in schools and believe that such insight could direct further future studies of similar robots for higher education as well. The main point concluded is that the authors limited the basis of scenario development to two factors only, excluding new trends and potential internal and external context that could highly affect the horizon scanning approach of future foresight.

4. Main takeaways

After all, there was constituency among the findings of all reviewed articles articulating the fact that the role of Robots demonstrates a supportive nature to teacher's role. However, the key question is whether this role will remain as is with technology evolution that is anticipated in the near future. As such question is hard to respond to at this point in time due to ambiguity and lack of evidence, other questions are important to raise such as the challenges that will be disrupting the education sector if robots fully replaced teachers and the opportunities that human-teacher could take to be part of the educational loop system, even with the advancement of robot-teachers.

Reflecting on all reviewed papers, the main takeaways of the literature review are as follows:

- As time passes, the role of human (specifically **teachers**) in fulfilling life needs, gets much more sophisticated, requiring higher level of system thinking and complex capabilities to cope with new emerging challenges. In short, teachers are facing significant challenges in delivering education to students.
- As **technology** is expected to further evolve in the future, the predicted role and full capacity of robots remain ambiguous and is yet to be realized. Other factors that remain unknown are feasibility, accessibility and attractiveness. In short, robotics could offer potential solution for challenges that teacher face, especially with the workload and shortage of teachers' issue. However, robots could have limitations in some aspect such as emotional and social intervention with human-beings.
- As new **generations** are born, new trends are born, influencing a shift in key life aspects; turning the impossible into probable and changing the definition of what one day was a must. In short, new generations has exponential unique needs and expectations, that requires new ways to deal with.
- In analyzing the outcome of 2016 survey about AI and machine learning, it is not always the average responses that matters. The extreme answers of participants should be considered as some may reflect in reality sooner than expected. In other words,

uniqueness of scoring (when collecting quantitative data) can influence novelty, welcoming **new perceptions** that have never been thought of.

5. Gaps defined based on the literature review

It is crucial to acknowledge the gaps in literature review resulting from the fact that integration of robots into education is an emerging reality and still at its early stages, and the full extent of its influence is yet to be realized. Hence, we admit that the impact of this technology on education cannot be comprehensively understood at this stage. As we navigate this dissertation, we recognize the importance of anticipatory scenario development to detect potential challenges and pave the way for a balanced and cooperative future between teachers and robots in the educational landscape. We also realize that extracting feedback from direct impacted individuals is an essential step to avoid drawing conclusions based on assumptions and inferences only. According to the natural foresight framework and the ladder of inference[6], individuals tend to narrow their thinking because of the number of personal assumptions that are stored in their minds. Therefore, it is important to challenge those assumptions and figure out the actual meaning of any selected data away from the impurities of expectations and beliefs.

Chapter 3 Research Methodology

Technology disruption that is affecting students learning journey, raised a question on the effectiveness of teachers' role and the type of gaps that may be filled by such technology. With the existence of artificial intelligence, it became obvious that human can supersede robots in some areas, while robots can surpass human in other areas. Will this continue to be a fact or one of the two will take over and be the ultimate teacher? If we concentrate on robots taking over considering that technology is progressing every day, what challenges will be disrupting the education sector and how the institutions will coop with robotic instead of human-teachers? What opportunities could human-teacher unleash to be part of the educational loop system, even with the advancement of robot-teachers? The following methods were used to answer these questions.

[6] The ladder of inference is a model that presents individuals thinking process by showing how they convert data into meanings, without noticing that their beliefs and assumptions are included (refer to the appendix).

3.1 Data collection and analysis

3.1.1 Teachers:

The first level of data collection was done through Knowledge and Human Development Authority (KHDA), by collecting the most up to date information and feedback from teachers working in the private schools and analysing them to assess the type of challenges that teachers are currently facing, the impact of such challenges on teachers' career journey and potential solutions to overcome them or at least to minimise their associated risks.

3.1.2 The market:

The second level of data collection considered global trends and assumptions pertaining to robotics integration in education sector and possibility of various external forces (social, technological, economic, environmental and political) that used to be seen as irrelevant, to contribute to injecting new changes into this key sector.

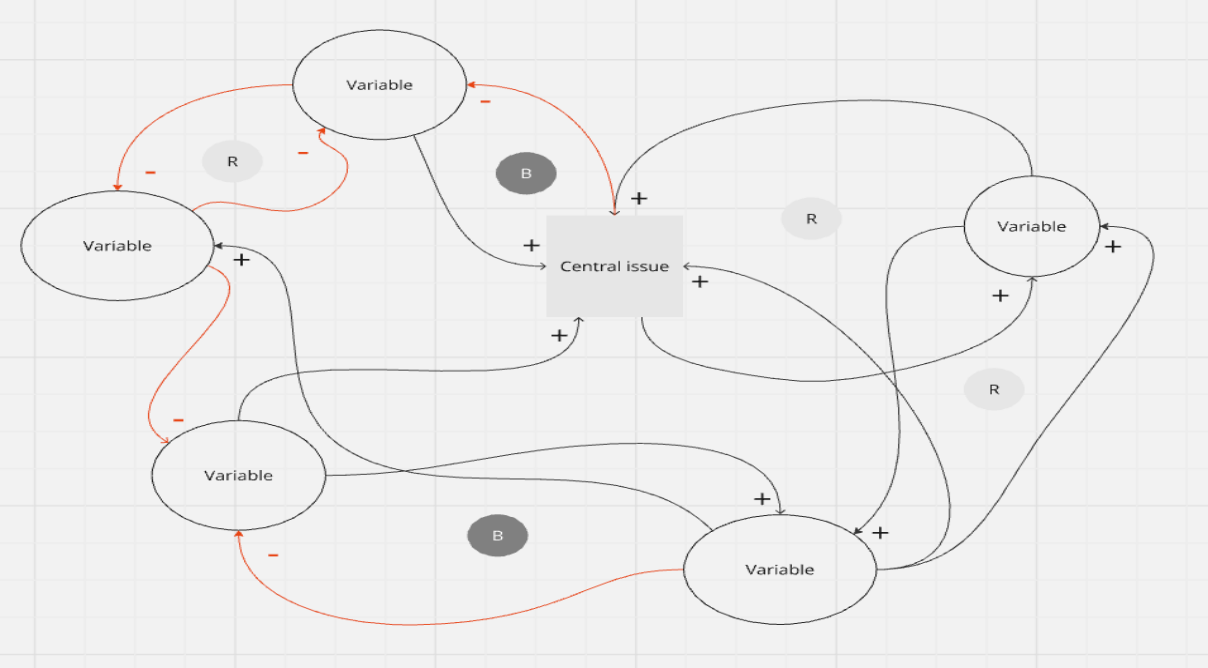
3.1.3 Students (New generations):

The third level of data collection was taken from different international students who shared their point of view about the integration of robotics or AI-teacher into classrooms, as an approach to evaluate new generation's thoughts and willingness to accept new, innovative solutions that could ease their education journey.

3.2 System Thinking

The results of data collection and analysis triggered the development of a Causal Loop Diagram, as an approach to visualize the relationships between different elements that contribute to influencing teachers' work and injecting it with great level of complexity. In fact, this step reveals the role of system thinking in expanding ones' scope of thoughts and unleashing new remarkable solutions, which may have never been considered. By focusing on the big picture of the education field, the Causal Loop Diagram presents a crucial approach to pinpoint the complexities of any system, through scanning the connection between numerous elements as shown in the figure below:

Figure 2: Causal Loop Diagram



For the purpose of this study, Causal Loop Diagram (CLD) is utilised to present the challenges of any system and emphasize on the major root causes of a central issue that key players of that system are facing; hence guiding the exploration of new solutions that simplify system's processes. Following are the key elements of this diagram:

- Central issue: the ultimate goal or issue that is under study or requires attention.
- Variables: things or state of being that may change or cause change to other elements in the system. These could be internal or external factors.
- Links: the arrows that represent the connection between two variables in any system
- Feedback loop: Positive or negative relationships between two or more variables that is displayed as reinforcing loop (R) or balancing loop (B)
    - R loop: positive relationship
    - B loop: negative relationship

The use of CLD is considered to support in clarifying the role that technology could play through robot integration, in achieving a transformational ecosystem that is sustainable

and effective for both the contributors and the receivers, i.e. teachers and students respectively. In short, the application of this diagram will not only identify key leverage points for resolving teachers' issues, but also will help in developing strategies that address the root causes of any central issue delaying improvements of students' learning process.

3.3 Trend analysis (Global trends)

A qualitative method was considered to figure out what trends are currently there in the world and serve in resolving teachers' workload issue. Researchers indicated that artificial intelligence, Cobots, mobile manipulators, digital twins and humanoid robotics are key global trends that are triggering a raise in the demand for robots to support key business operations. According to International Federation of Robotics, "The stock of operational robots around the globe hit a new record of about 3.9 million units". This demand is prompt by both various technological revolutions and the issue of human resource scarcity.

3.4 Scenario Planning

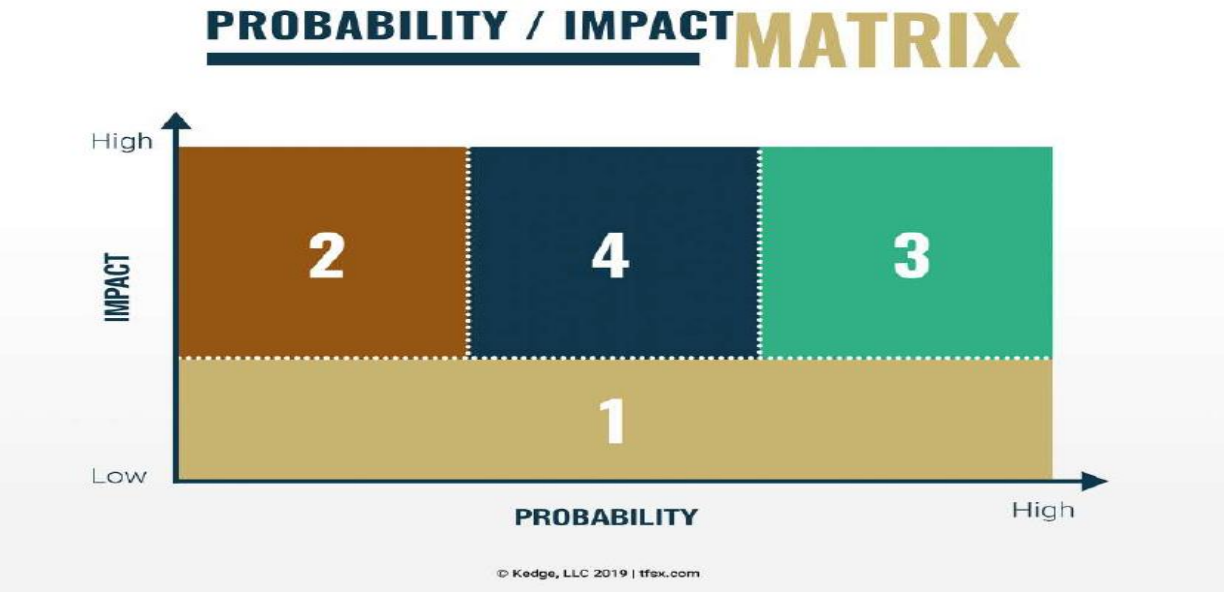
Scenario planning is a structured methodology applied to explore new future possibilities, through identifying four unique scenarios, which lead to the definition of what could a new future look like, what could be its scope, what type of changes could be disrupting it and what implications are expected to arise.

Including scenario planning approach in this study provides a strong fundamental to recognise the intricacy level of teachers' role in the Education system and explore the unlimited forces that contribute to adding new layers of complexity to this incomparable job. This approach won't only contribute to pinpointing the basis of teacher shortage issue, speaking directly to the root cause of this matter, but also will shed the light on new possibilities that expand our scope of thinking and unleash unnoticed innovative smart solutions for this particular issue.

The scenarios are built from the selection of two critical uncertainties, which are highly unlikely and are independent of each other, yet if occurred, will have a high impact. The initial extraction of the pool of uncertainties is from list of driving forces, pertaining to

social, technological, economic, environmental and political factors (STEEP analysis), as a step to think holistically and create potential links between different external factors and the issue in hand. Those forces are evaluated through Probability/Impact Matrix (PIM), reflected below.

Figure 3: Probability/Impact Matrix



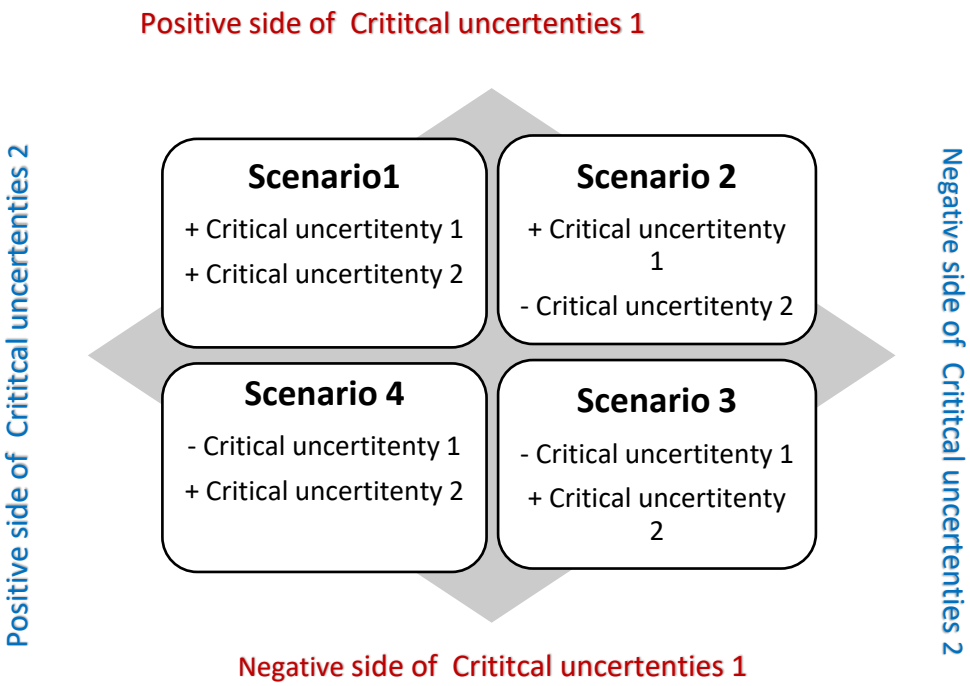
According to the Guide to Natural Foresight Framework, PIM tool can contribute to scenario development approach, by allowing the applicants to display any potential key trends and assess the chance of their occurrence along with the level of their criticality to an organization or a field. Based on it, each trend will fall under specific area which is characterised by probability and impact level.

- area one presents those trends with very low impact, that are classified as “unimportant”, and not considered in the scenario planning.
- area two reflects trends with medium to high impact, but are highly unlikely to occur, thus classified as “wildcards”. Due to their level of uncertainty, trends of area two are not always included in the planning, unless new signposts indicated the needed for otherwise.

- area three covers those trends with hight impact and high likelihood to occur. These should be considered in future forecasting but not necessarily in the scenario development phase.
- area four revels those trends and evolving issues that have medium to high impact, and medium probability of occurrence, which are called the “sweet spot”. These are the most significant ones that should be selected, analysed and assessed before developing any scenario, because their “probability is neither certain, nor uncertain, facilitating an effective evaluation of the future.

When all trends and emerging issues are positioned in the matrix, two major trends should be chosen to guide us towards identifying four new possible narratives. This approach is called 2X2 scenario matrix, which depends on two critical uncertainties to find four unique scenarios. Each scenario will reflect its unique characteristics, highlight the opportunities and challenges, and help in generating strategic actions needed to better respond to it.

Figure 4: Scenario development Matrix



Chapter 4: Findings and Data Analysis

4.1 data and findings

4.1.1 Teachers Focus group sessions.

The research applied qualitative approach, through focus groups sessions. 94 teachers working for different Private Schools in Dubai, have been invited to attend the sessions. The sessions were proposed as an approach to closely engage with stakeholders and get their perception about the challenges they face in their teaching journey and their anticipation of the future of education. (future of education in the Emirate and what role teachers are expected to play if Robots were integrated in all educational institutions' settings). To assess the perspective of the participants and ensure collecting direct feedback, 8 focus group sessions were conducted.

4.1.1A Session Questions

The sessions were based on the following question which helped to initiate the discussion and capture teachers' views clearly: What are the challenges that teachers are facing in their career and are affecting students learning journey?

4.1.1B Key Objectives

- To determine the type of challenges that are deterring teachers from providing the best quality of service to the learners.
- To determine the challenges that may result from integrating robotics into the education sector.
- To explore the perception of key parties involved in the educational process – (i.e. students).
- To assess the readiness level of current stakeholders to welcome robots in classrooms
- To discover new opportunities that could be unleashed for human-teachers considering the continuous evolution of technologies.

4.1.1C Participants

On voluntary basis and following an invitation that was shared with all teachers in the private schools, 94 teachers, of which 54 were females, from various age group, subjects, stages, nationalities and background participated in the sessions. Of the 94 participants, 46 were from Affordable schools, 18 were from Mid-range fee schools and 30 were from Premium schools. Participants had diverse experience ranging from 1 year up to 25 years in education. Prior to the start of the sessions, the participants were informed about the confidentiality of their feedback and the significance of being transparent and equitable, to ensure clear and fair reflection of their views.

Questions: What are the challenges that teachers are facing in their career and are affecting students learning journey? and how can these challenges be addressed?

Table 1: Focus group sessions details.

Group 1 Teachers from Affordable fee-range schools

46 Teachers	# of Sessions		
	Session 1	Session 2	Session 3
	10 teachers	16 teachers	20 teachers
Q1 How can we make Dubai an attractive place for teachers?	▪ Competitive compensation ▪ Teachers' **wellbeing** ▪ Professional development ▪ Diverse and inclusive environment	▪ Salary raises and compensation ▪ **Reduce working hours** ▪ Teacher recognition ▪ Discounts and offers	▪ Teaching resources and tools ▪ Attractive salary packages ▪ Health insurance packages ▪ Education for their kids ▪ Promotions and career path ▪ **Working hour restriction**
Q2 How can we enhance teacher mobility within the system while		▪ One-year contract, with two months notice period	▪ One term notice period ▪ Surplus of teachers to cover emergency situations

ensuring the quality of student education is protected? What policies should be introduced?		▪ Organization to offer schools with a pool of sub-teachers ▪ No recruitment during the academic year	/ trained teachers for each subject ▪ Restrict movement of teachers during the academic year ▪ Collaboration approach among schools for teachers hiring

Group 2 Teachers from Mid-range fees schools

18 Teachers	# of Sessions	
	Session 1	Session 2
	6 teachers	12 teachers
Q1 How can we make Dubai an attractive place for teachers?	▪ Extensive training and learning programs ▪ International community ▪ Opportunities for career growth ▪ Lifestyle, safety and tax-free salary ▪ Competitive compensation packages	▪ Cultural diversity ▪ Teaching facilities for students ▪ Quality of life ▪ Government support
Q2 How can we enhance teacher mobility within the system while ensuring the quality of student education is protected? What policies should be introduced?	▪ Investigating root causes (overwhelming **workload**, burnouts..) ▪ Pool of substitute teachers ▪ Teacher commitment ▪ Incentives and **wellbeing**	▪ Pre- defined agreements between teachers and the school ▪ Availability of teacher agency ▪ Clear labour law ▪ Proper handover process ▪ Dig into the reasons behind the movement

Group 3 Teachers from Premium schools

30 Teachers from Premium schools	# of sessions		
	Session 1	Session 2	Session 3
	5	10	15
Q1 How can we make Dubai an attractive place for teachers?	▪ Family relocation ▪ Teacher wellbeing and retention ▪ Competitive compensation ▪ Housing allowance ▪ Building social networking	▪ Flexible Visa process ▪ Standard hiring procedures ▪ Open communication ▪ **Work-life balance** ▪ Professional development ▪ Teacher empowerment ▪ Clear notice period	▪ Providing affordable cost of living ▪ More trainings ▪ Better work-life balance ▪ Competitive and international salary scale ▪ Teachers' gatherings ▪ **Less working hours**
Q2 How can we enhance teacher mobility within the system while ensuring the quality of student education is protected? What policies should be introduced?	▪ Contingency plans ▪ Substitute teacher pool ▪ School resource for supply and demand ▪ Recruitment restrictions during the academic year ▪ License for substitute teachers	▪ Substitute teachers network Proactive planning ▪ Government incentives through KHDA ▪ Proactive planning ▪ Teacher commitment	▪ Pool of teachers looking for jobs ▪ Investigate the reasons of teachers' move ▪ Contractual restrictions ▪ Teachers' forum and engagement events

4.1.1C Focus group – findings

Based on the focus group sessions, 7 out of the 8 sessions touched based on teachers' wellbeing and workload concern, indicating that almost 90% of teachers are suffering from this issue, which is escalated further due to shortage of teachers. The root causes of the shortage of teachers are getting low salary and compensation, lacking work-life balance and feeling devalued due to lack of promotion opportunities. As a result, dissatisfaction of teachers increased in different societies, leading to lower rate of new school graduates joining this career path and higher turnover rate of existing teachers. Reflecting on the research findings and linking those with the outcome of the focus group, it is worth noting that this issue has existed since decades and still existing today, negatively affecting teachers' work and role in achieving a balanced learning journey for the students.

It is also clear that old methods did not succeed in resolving this issue. Thus, there is an urgent need to resolve the root causes of it through new, exceptional and innovative approach, in order to generate the most effective impact. One of the suggested solutions can be the integration of Robots in classrooms.

4.1.2 Market trends

This section presents global trends that are related to robotics and can be explored further to unleash new ways out of the evolving issue.

Table 2: 2024 Global trends pertaining to AI and robots.

Trend	Details
Artificial Intelligence	AI is a growing trend which has been expanded through generative AI applications, exposing the world to new potential smart solutions. With the evolution of generative AI-driven interfaces, technology experts and program developers are programming robots through much easier approaches such as advanced Natural Language Processing and machine learning algorithm.
Cobots	Human-robot alliance remains a key trend in relation to robotics. Fast improvements in sensing devices, visual sense technologies and

	intelligent grippers grant robots the capability to react instantly to changes in their surroundings and thus perform their job alongside human safely. Collaborative robot applications are expanding, leading to new supportive tools that assist human in performing their work. According to the Global 50 report[7], Co-bot market is still small compared to the larger robotic industry, covering 7.5% only.
Mobile Manipulators	Mobile Manipulators refers to the automation of objects handling by merging motion with clever arms and equipping robots with cameras to enable them to perform work more efficiently.
Digital Twins	Digital twin technology presents a virtual replication of physical systems that is applied using real data to conduct pilot and anticipate possible results, without sacrificing the safety of resources. This in turn can support in better application of technologies because of the predicted outcomes. Digital twins support in building a bond between physical and virtual worlds.
Humanoid Robotics	Robotics is experiencing great progress in humanoids, constructed to execute different tasks in different environments. The design of robots that looks like human, arms and legs facilitates using robots in environments that are built for human-being. As stated by the International Federation of Robotics. “The Ministry of Industry and information Technology predicts humanoids are likely to become another disruptive technology, similar to computers or smartphones, that could transform the way we produce goods, and the way humans live”. Indeed, the Global 50 report (Dubai Future Foundation , 2024) stated that humanoid robots could be developed to have seamless interaction with human, through Neutral Networks that enables them to generate human like facial and speech expressions.

[7] Future opportunities report that is published by Dubai Future Foundation in 2024

From the above trends, it is worth emphasizing that there are always new hidden or unnoticed solutions that could be unleashed, leading to transformational shifts in our life. Thus, it is imperative to be alert to weak signals; those indicators of potential emerging trends that could help in anticipating and shaping some aspects of the future.

Based on the findings of the focus group, along with the explored trends, it is recommended to integrate robots into classrooms to support in taking over huge amount of work from teachers' plate, especially the administrative tasks.

4.1.3 Students perception

Exploring the opinion of one of the key stakeholders in the learning process, the perception of students is considered to see their acceptance level and readiness to welcome a technological replacement for their teachers. Below is the input from students from generation alpha, from across the globe, when asked about their perspectives about robots as teachers in the classrooms.

4.1.3A Taiwan

"Children thoughts of placing robots in classroom"

According to a study conducted to 167 students from grade 5, from three primary schools in Taiwan, 59% of the students agree or strongly agree to have a robot companion in class and 27% of the students disagree or strongly disagree. The main justification of why students accepted a robot companion by their sides are (1) 34% of them believe that robots could be the their teachers, one of the examples of students comment was "if I lose some important points told by teachers during class, I can ask the robots repeat those points for me" and (2) 29% of the students believe that it might be more interesting to learn from robots than human teachers. On the other side, the reasons behind students' disagreement with having robots, are (1) 53% of them think that robot might generate negative learning effects, because it might be a distracting tool and (2) 18% of students prefers dealing with a living creature. therefore, it is essential to be careful when and how robots are integrated in classrooms, to ensure injecting students' learning path with the right, positive influence (National Central University in Taiwan and Athabasca University in Canda).

4.1.3B Korea

"*Learning about, from, and with Robots: Students' Perspectives"*

According to a study conducted by Namin Shin and Sangah Kim through interviewing 85 students; 25 from elementary, 24 from middle, and 36 from high school, to understand their perception about robots and leaning most students presented negative opinion towards learning from robots. Majority of them did not prefer the notion of a robot taking over teachers' role, although they valued to some extent the value added by robot assistant in classrooms. Their criticism was based on the outcome of comparing between human and robot teacher, realising that robots lacks some key traits that human teachers have, which particularly was emotion. Following are some mentioned reasons for not preferring the idea of robot teachers: (1) a 15-year-old boy believe that robots lacking emotion means lacking passion too. (2) a 14-year-old girl sees robots lacking sense of humor. (3) a 16-year-old girl believes that robots are not caring and sympathetic, which are important human traits. (4) a 17-year-old boy thinks that robots may not be able to run the class, nor communicate with his classmates effectively.

4.1.3C United Arab Emirates

According to a study conducted by Maryam AlHashimi, Omar Mubin and Rama Baroud, "Examining the use of robots as teacher Assistants in UAE classrooms" the perspective of 20 students were gathered through a focus group after the deployment of a humanoid robot called "NAO" in their classrooms as a pilot, without any human being present in the class, except the researcher who was controlling the robot without students' knowledge. The findings of the pilot indicated that most students were grateful for the inclusion of a robot in their class as a teacher assistant. 19 out of 20 students believed that they did not feel embarrassed or shy when responding or asking a question to the robot, which might not be the case when talking to their teachers. In addition to that, students showed acceptance to robot because they believed that understanding what robot says and how fast it speaks, was far easier to track than some teachers' accents. And lastly, most students felt that a robot could be their friend and is a good companion

to have, to have some fun time with. Thus, in Arab context, it is obvious that students are more open to welcome a robot in classroom.

Analysing students' responses, it is found that there is a variation in the acceptance level among students across the world when it comes to having robots in the classroom. This is a signal of inequivalent awareness level, fear, needs and expectations among students from the new generation (generation alpha).

Considering the feedback from teachers, market research and students' responses, and corresponding to one of the main questions of this paper, it is worth noting that some challenges that could disrupt the education sector if robots fully replaced teachers, include:

- Teachers' need for individualized development plan that help them to upskill and reskill, to be ready to perform their work in a more strategic way.
- Market's need for government support to inject educational institutions with the new technological infrastructure, required to benefit from robotics and other machine learning tools.
- Students' sympathetic need for human care and presence to handle their moods and emotional fluctuations and ease their journey through emotional intelligence.

4.2 System Thinking Findings

4.2.1 Current challenges in the education system

Based on the findings of the focus group sessions analysis, various factors contributed undesirably to teachers' career, starting from the workload issue and ending towards less satisfied teachers because of absence of promotion. Therefore, figure 5 is devoted to highlighting all challenges that teachers face in their career path and create obstacles hindering them from moving towards better educational positions.

Figure5: Causal Loop Diagram presenting teachers' challenges

To elaborate, figure 5 presents promotion as a target, and locates number of factors that are influencing this target including qualifications, experience and responsibilities. Qualification refers to the highest education qualification obtained by the employee, experience refers to the number of years the employee has been applying his knowledge in practice while responsibilities refer to the amount of work and accountabilities that are assigned to an employee during his career. To analyse the interaction of these variables, the diagram reflects number of feedback loops in this system. Feedback loops are the fundamental building blocks of CLD, and they describe the interactions between different variables in the system. There are two types of feedback loops: reinforcing loops (positive loops that amplify change in the system) and balancing loops (negative loops that counteract change and maintain equilibrium). Identifying these feedback loops can help in understanding the drivers and constraints in the system. To elaborate on the main variables and constrains of career advancement system, number of reinforcing loops and a balancing loop have been identified as follow:

- The first reinforcing loop consists of teacher shortage and workload. With teacher shortage issue, less teachers are working in a school compared to the amount of work devoted to them. Thus, if teacher shortage issue is not resolved, each

teacher will continuously be assigned to more responsibilities and will be expected to deliver more outcomes. It is important to note that there are different variables including productivity, training and performance that feed into this loop, creating more complexities between the drivers.

- The second reinforcing loop consists of stress as a variable affecting wellbeing, with both having negative links, creating a reinforcing or positive feedback loop. In fact, as stress increases, wellbeing decreases, and vice versa. In other words, the more stressed a teacher becomes, the worse their wellbeing will become, and this in turn will cause even more stress, leading to a potentially exponential decline in wellbeing. For example, chronic stress can lead to physical and mental health problems, which can further worsen stress levels, creating a cycle of negative effects. On the other hand, taking steps to reduce stress, such as practicing relaxation techniques or seeking support from others, can improve wellbeing and break the cycle of stress. Conversely, if teachers' wellbeing is considered and balanced, then teachers' will be less stressed, perform better, and be satisfied with their jobs. Hence, it is very important to reduce the level of stress and increase the level of well-being to get the best results, by teachers and in turn by students.

- The third feedback loop encompasses of salary, performance, responsibilities, experience, and promotion. In this loop, as employees receive a salary increment and feel that their efforts have been valued and paid off, they become motivated to perform better and thus get more responsibilities and in turn more experience and potentially more chances to get a promotion.

- The balancing loop, defined in the diagram, reflects the relationship between teachers' wellbeing and number of leave days; where the increase in leave days leads to a boost in teachers wellbeing, as he/she can take more time off to rest and recharge. However, this increased time off may also lead to decreased productivity, as the teacher is working fewer hours. This reduced productivity could lead to increased stress, as teacher feels pressure to meet his/her work targets within a shorter amount of time. As stress levels rise, a teacher may feel

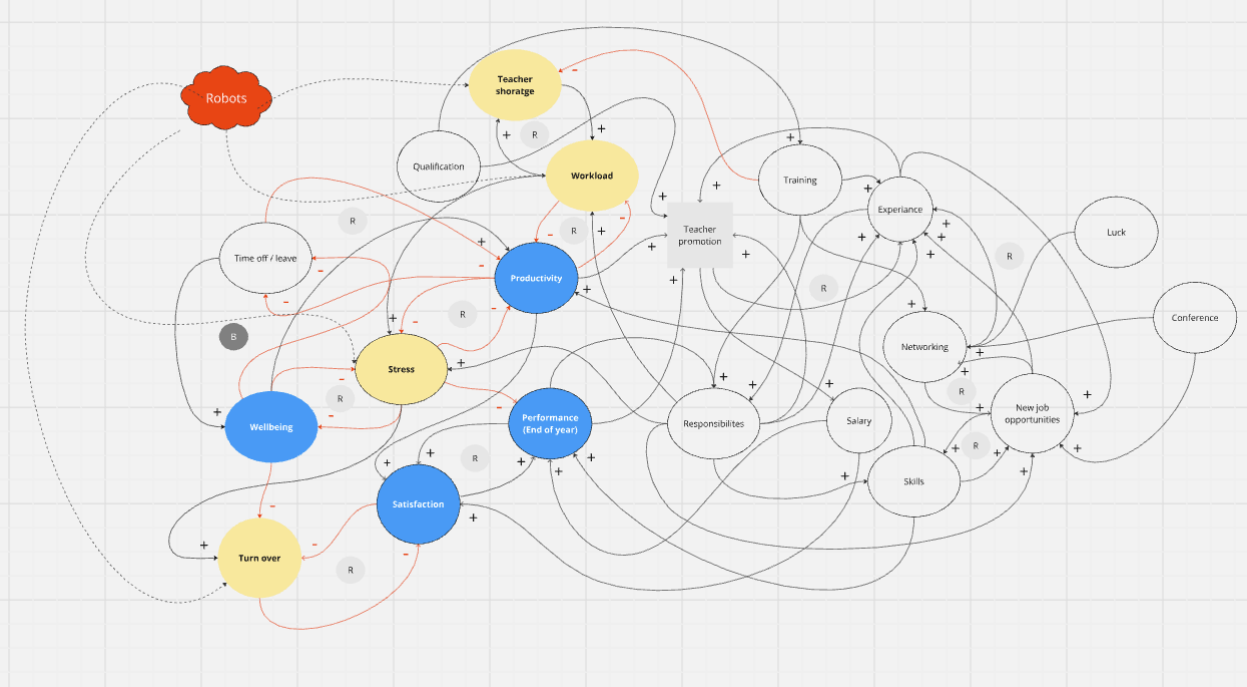
the need to take even more leave days to address his/her wellbeing. This increased time off could lead to even lower productivity levels, further increasing stress, and the cycle continues, creating another reinforcing loop.

In a nutshell, it is essential to introduce an idea that could stand as a turning point devoting a solution to workload, turnover and teacher shortage problems. Unless those are tickled, teacher promotion could remain a painful challenge.

4.2.2 Transformational shift through robotic integration

Integrating robotics into teachers teaching journey presents a remarkable shift in the education system. After analysing the current challenges and recognizing the level of concern that coats teachers' career, this section will reveal how robotics could support in uplifting teachers through handling key administrative tasks and allowing teachers not only to focus on delivering their expected work but also to improve their skills in other strategic areas, which will raise their eligibility to be promoted. The below diagram presents a snapshot of partial impact of robot if integrated in classrooms with teachers, indicating that the challenges highlighted in yellow will decrease while the challenges highlighted in blue will increase leading to efficiency and effectiveness of the conducted work.

Figure 6: Causal Loop Diagram presenting robot implications on teachers' challenges



Here is the list of positive implications of robot integration on teachers' career:

1. Improvement of teachers' Well-being and job satisfaction

- With robots handling repetitive and administrative tasks, teachers will be less tensioned and more focused on strategic objectives, rather than operational work, leading to skills improvement and strategic thinking boost.
- As a result, teachers will feel valued and have a bigger purpose to focus on, raising their level of satisfaction and enhancing their Work-Life Balance

2. Enhancement of teachers' productivity and work efficiency

- Raise of work efficiency: allocating the repetitive tasks and key operational work to robotics can lead to quicker results and repetition of any information won't be time consuming as teacher will be focusing on other aspects of the learning plan, while robot will be providing some illustrations and explanations to make the lessons easier.
- When the administrative tasks are taken over by robots, teachers will have more time to spend in thinking outside the box and looking beyond the limits, which in

turn contributes to improving their level of creativity, raising student engagement level and improving their progress and attainment in the given subject.

3. Reduction of Teachers' stress level

- As robots take on boring and pressuring tasks, teachers will be less stressed, specifically regarding repetition of tasks and missing to cover further deadlines as per learning plans.
- On the other hand, the integration of robotics may conversely lead to more stress or worry among assistant teachers who are mainly accountable of assisting subject teachers with admin work.

4. Further development of skills and competencies

- With the assistant of the robotics in classrooms, teachers can emphasis on upskilling and/or reskilling through building new capabilities such as creativity, entrepreneurial ship, and future-oriented skills, which can cause prosperity and growth at both personal and professional levels.
- Reliving teachers from uninteresting tasks empowers teachers and push them to step into more complex, yet valuable activities.

4.3 Scenario Planning Findings

In this section, the focus is on scenario development, which starts by analysing different external factors including their implications, then assessing the possibility and impact, followed by selected the most critical ones, and finally, discovering the future scenarios that could emerge.

4.3.1 STEEP Analysis

Table 3: external driving forces and some implications

What are the external driving forces?	What are the implications pertaining to them?

Social	• Change in the **demographics**, birth rate and aging population • Change in parents' preference for private education • Change in residency location, • Change in society's perception towards education • Change in values that may lead to the need to **change curriculum/ teaching methods** • Change in **the needs and expectations of the new generations** • Change in the way we live, eat, connect and socialize, to evolutionary **gaming system**	○ New generations will have new needs & expectations ○ Existing education models may not meet new generations' needs ○ Private sector might be less attractive ○ Short focus span will lead to drop in students' performance, leading to less high performers at national level, thus less competition globally ○ Parents will be dissatisfied with the learning progress of their kids. ○ Introduction of robots could impact teacher's position/value
Technological:	• Digital transformation and advancement in e-learning • Online education and the raise of **virtual classrooms** • The **role of Artificial Intelligence** in educational processes and learning	○ Shift towards digital life due to the evolving role of AI and machine learning ○ Focus on virtual world and online connections all the time ○ Challenge to sectors that resist changing to digital mode ○ New opportunities for sectors that are adopting to the changes ○ New players entering technology market and possibly taking the lead over existing

	• Metaverse and the shift towards virtual schools • The Rapid evolution of technology and communication modes. • The evolution of robotics with advanced features that could be substituting human role.	ones who might be slower in reflecting the change ○ Big data will require significant enhancement to the current infrastructure
Economic:	• Change in the standard of living – parents income level and affordability for private education • Change in the **investment level** and the interest of investors to invest in education • Change in the market, targeting **vocational education** and new types of jobs • Change in **Dubai's position** as a key city attracting international investments / foreigners • Perceiving quality education as an expensive element of life	○ Parents could invest in life-long learning opportunities to expand the skills of their kids ○ New investors could be interested in expanding to vocational education to meet market needs
Environmental:	• Change in the level of **understanding of environmental risks** and the importance of sustainable practices	○ Involvement of generation alpha in volunteer work related to sustainable practices

	• Change in the students' behaviour towards global issues such as climate change • Shift towards becoming contributors to find solutions for environmental issues rather than listeners • Shift in the world awareness level post Cop28 event	○ Students raising their voice to defend global issues ○ Involve students in global issue discussion summits, due to their mindset and mature level of thinking
Political:	• Government regulations, polices and laws pertaining to education • Government support to the growth of education sector, example, incentives for education providers who deliver the best quality • Collaboration between private and public sectors (federal authorities) • Political stability affecting educational activities	○ Bold steps by the government, introducing new policies pertaining to education, will encourage people to follow it and adopt the change ○ Leading a new era in education sector, and encouraging world view to be part of it

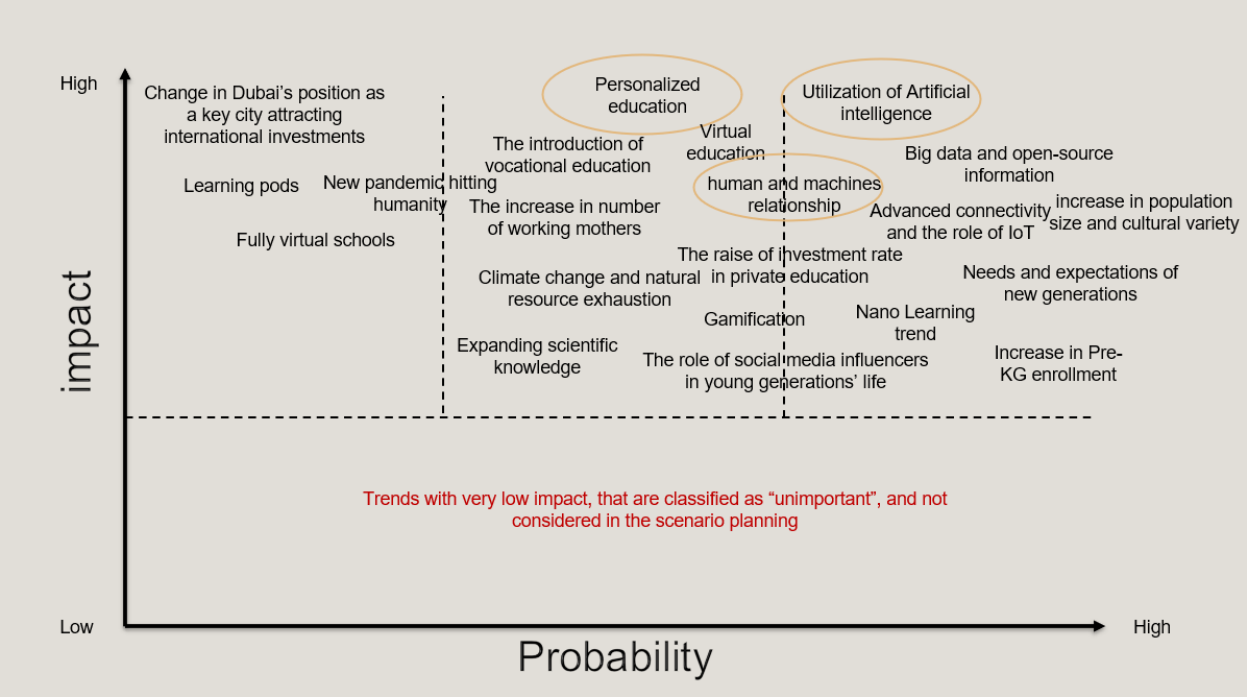
After analysing the above external factors and considering the findings of robotic integration through causal loop diagram, it is found that the level of complexity is very high due to the high number of interconnections that exist among different driving forces. It is therefore essential to assess the impact of those factors and take into account those elements with the highest impact level, to predict how the future will look

like, and what is needed to prepare for it. Indeed, it is expected that different factors will influence a transformational shift in the world view of education field based on the direction of some trends and assumptions that key educational stakeholders are experiencing or will experience.

4.3.2 Probability/Impact Matrix

Following the STEEP analysis, key trends are plotted into the Probability/Impact Matrix to assess its likelihood to occur along with the anticipated level of impact. This step is imperative to guide the selection of the critical uncertainties needed to develop the scenarios in the next section.

Figure 7: PIM



4.3.3 Critical Uncertainties

Anticipating future scenarios entails the selection of two critical uncertainties that are independent with high impact, as mentioned in Figure (3), especially those sweet spots that fall in area 4 of the PIM figure.

Based on the findings of the research methodologies and in order to answer the subject question of this research paper and foresee the potential of robots to collaborate or

compete with human-teachers, the two selected critical uncertainties are the utilization of Artificial Intelligence and the shift towards a personalised education. These were selected due to their potential role in shaping the future of education.

Critical uncertainty 1: The utilization of Artificial Intelligence

The two parameters that present this uncertainty are AI-driven vs Human-driven education.

- AI-driven education: this could be through advanced AI applications or full robotics integration in the education sector, which will be leading the educational process. It is anticipated that the expansion of robot role, will result in further values that will optimistically boost teachers' confidence and align with new generation's needs.
- Human-driven: this aspect could be applied through either teacher alone (replicating the existing educational condition) or through Teacher and robotic assistant. Focusing on teacher alone, teachers have always been the key contributors in the education cycle since ancient times and this has always brought great outcomes to students, however, with the increased degree of complexity and the new type of challenges that are appearing in teachers' journey, they may not be able to fully provide their services to students, leading to gaps in the learning outcomes. Hence, teachers working with assistant robots that support in the administrative work and class time management, will definitely bring positive results into the teaching process.

Critical uncertainty 2: The shift towards personalised education

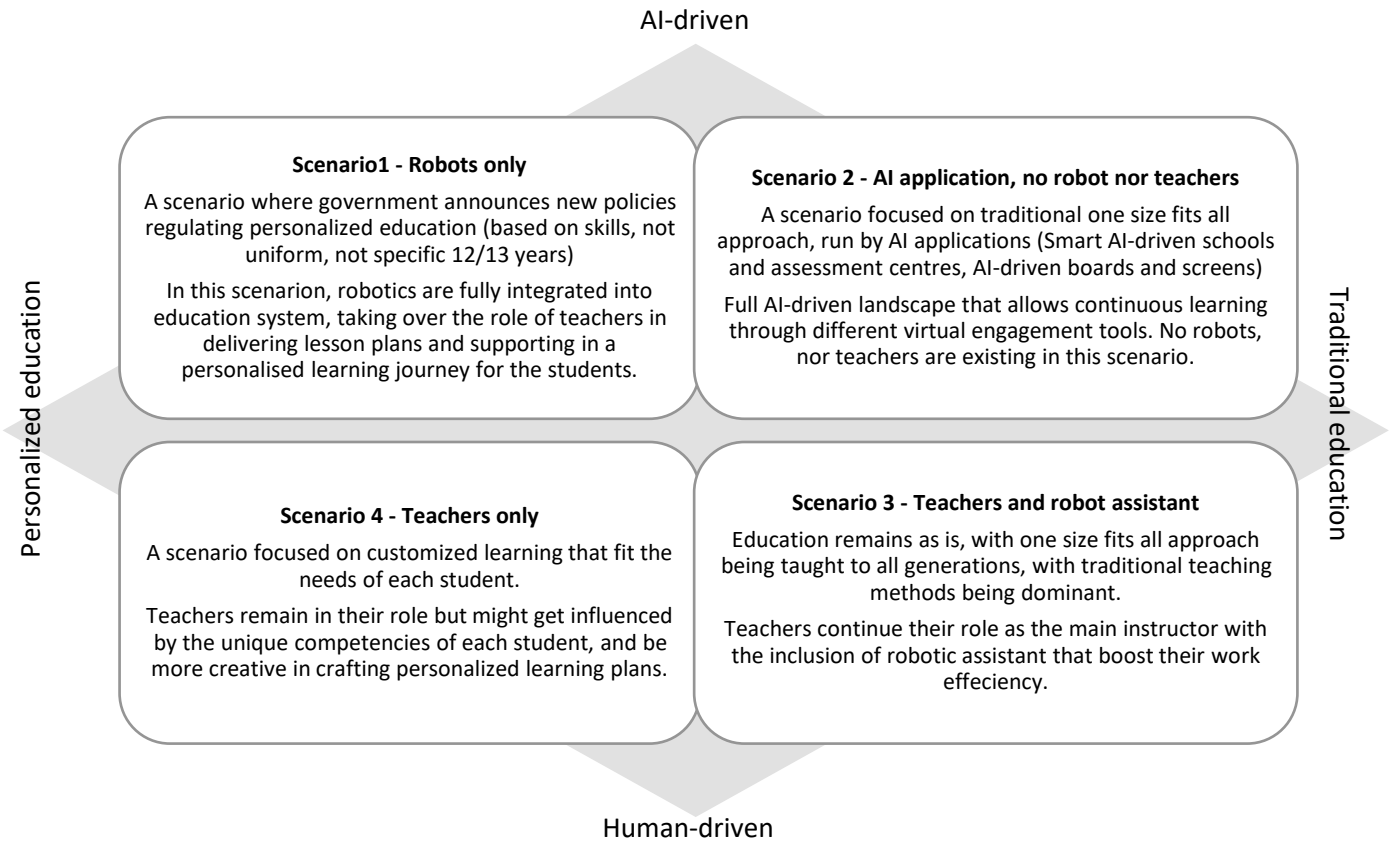
The two parameters that present this uncertainty are personalised vs traditional education

- Personalised education: one size fits all approach may not fit the new generation (i.e generation alpha), considering that they are growing with new needs, expectations and mindset that are totally different than previous generations (Z, baby boomers). Therefore, a personalised skilled-based approach might result in better alignment with the needs of this generation.

- Traditional education: this represents the existing method of teaching, which depends on one size fits all approach, with one curriculum, leaning plan and textbooks, that are delivered to all students at the same time, expecting that all students have the same level of understanding and intelligence.

4.3.4 2X2 Scenario development Matrix

Figure 8: Four future scenarios



Scenario 1: Personalized learning method, with *Robots only* running the show

Opportunities	Challenges
• Students will be highly engaged as lesson plans are targeting their individual skills.	• Teachers will be overridden by robots, losing their valuable position in the education circle.

• AI-driven tools used for teaching and assessment • Teachers will get new opportunities outside the classrooms, potentially contributing at higher level. • Market will open the doors for construction field to develop new school building designs that fit robotics presence. • Government will have a strong source of data (machine learning records in comparison to human) which can support in building an eco-system that connects all sectors together – health, tourism, travel and education.	• Investors will need to invest heavily in technological infrastructure and always be prepared with back up plans for robot teachers in case of technology failure.

Scenario 2: Traditional learning method, with *AI applications only*, no robot nor teachers.

Opportunities	Challenges
1) Students will save their travel time, which could be utilized for other learning purposes. 2) Teachers will be free to explore new job opportunities. Thus, government must support in creating new futuristic job profiles that can be filled by teachers. 3) Market will be exploring new AI-driven tools for teaching and assessment. 4) Investor might explore re-constructing the schools to utilise the buildings for other business opportunities.	1) Students will be connecting to school via online channels, which might lead to less engagement and potential distraction from their own surroundings. 2) Students will be linked virtually, will lead to less social connections with their peers and less emotions due to lack of human connections. 3) Teachers will be less valued but may contribute behind the scenes with discussions about students' outcomes

	4) Investors might have to sell their schools as students will depend on online channels to connect.

Scenario 3: Traditional learning method, driven by Teachers and assistant robots.

Opportunities	Challenges
1) Students will be less hesitant to ask the robot assistant about lesson repetition, thus might result in better performance among students in general. 2) Teachers will remain valuable asset in the educational settings, with more focus on higher level work, while robot assistant will reduce the pressure, by taking over administrative work and time control. Thus, teachers' confidence will be boosted, because of their involvement in strategic discussions, innovative solutions and creative approaches that best fit students' learning cycle. 3) Investors will be providing a much happier work environment to teachers whose productivity will increase (additional revenue) due to improvement of their wellbeing.	1) Students will be studying through consistent and uniformed old practices, which might will not target their individual needs and expectations 2) Teachers will need to be trained to deal with robotics assistant and guide it to a smoother arrangement of the class. 3) Investors will need to inject their schools with robot assistant (additional cost),

Scenario 4: Personalized learning method, driven by Teachers only.

Opportunities	Challenges
1) Students will be studying through consistent old methods, which might be	1) Students needs will not be focused on, as the traditional method focuses on one size fits all approach

easier to be guided by colleagues and siblings from previous generations. 2) Teachers continue to be key players in education cycle and will follow stable education practices, which might be convenient to most parents 3) Investors will need productivity (additional revenue) will go up due to improvement of their wellbeing.	2. Old approaches will result in similar old results. In other words, students might be less prepared for future market needs/jobs. 3. With the increase in population size and decrease in graduates' interest to join teaching field, teachers' shortage issue and workload will remain a concern.

Chapter 5 Discussion

This section presents a discussion of the findings pertaining to the key questions raised in this paper and the main objectives listed in the introduction. The discussion will highlight the integration of robots into classrooms and the potential of this technological creature to compete or cooperate with human-teachers. As reflected in the literature review, teacher shortage issue is existing since 1982. Many efforts have been put to find out new ways to resolve it, but none succeeded fully. According to the statistics about the new generation, almost 3 million babies are born worldwide every week. This number reflects a rapid growth in population size, which requires readiness of the key sectors including education sector to accommodate their needs. Hence, teachers' gap is not something that can remain as is. Yet, new directions should be taken to figure out new outcomes.

5.1 Restatement of research aim and objectives

The key objective of this study was to investigate whether robots, if integrated in classroom, will compete or cooperate with teachers. The main questions were targeting the challenges that will be disrupting the education sector if robots fully replaced teachers in 15 years timeline along with the opportunities that human-teacher could unleash even if robot-teachers were advanced.

5.2 Analysis of key findings

5.2.1 Current challenges and potential solutions

Based on the findings of teachers' focus group sessions, the results indicated that there are number of challenges that educators are currently encountering and need an urgent attention to resolve them. These challenges include workload issue resulting from shortage of teachers, which in turn result from low salary rate, absence of work-life balance and feeling devalued because of absence of promotions. These concerns contributed to building a pool of unsatisfied teachers whose perceptions reflected negatively on the image of this job in the society. Hence, discouraging new school graduates from entering this path.

Following the analysis of new market trends, it is found that the world is going through various technological evolution of which AI and machine learning are positioned at the top. Hence, such technological advancements are influencing the exploration of exceptional solutions, calling for new shifts in human life. Thus, robotics and AI-driven tools are suggested not only to support in resolving key issues faced by teachers, but also to seize opportunities related to the growth in technology and human preparation for the upcoming future.

5.2.2 Challenges if Robot teacher were partially or fully integrated

After analysing the findings of teachers' focus group sessions, market trends and students' perceptions about robots, the results indicated that there are number of challenges that education sector would encounter if robots fully replaced teachers. The key challenges included lack of development plans for teachers to upskill into next job scale of their career, lack of technological infrastructure in schools to integrate robots, lack of financial support to invest in robotics and AI-driven tools in every school, lack of guidelines and laws pertaining to robotics being teachers, and lack of social and emotional traits in robots that may lead students to resist such change. While if partially incorporated, challenges might be less concerning because human teacher could substitute the missing traits including social and emotional features that robots lack.

5.2.3 Opportunities if Robot teacher were partially or fully integrated

The findings also indicated that many opportunities could result from robot integration and contribute to the development of human-teachers. If partially integrated, robots will help in enhancing teachers' wellbeing, raising the job satisfaction level, reducing stress and thus the turnover rate, and developing their skills and capabilities beyond the usual limits. As a result, teachers will have bigger chances to expand their horizon of thinking, away from daily operational work, towards more strategic and creative ideas. However, if fully integrated, robots may negatively affect teachers' life, taking over their status as educators who have been paramount asset in the education history since ever. On the other hand, robot could positively influence the world to welcome new line of jobs that matches future-oriented education system, where students lead their learning, guided by robots and mentored by teachers – the future mentors. The role of mentor will require new competencies and mindset that teachers should adjust to, in order to deal with students as mentees through two-way communication approach, where each side contribute to the learning process.

5.3 Evaluation of the findings

Evaluating the findings of this paper in light of the broader study literature, it is worth highlighting the following:

5.3.1 Consistent results:

Because new jobs are still not discovered for teachers if robots fully took over their role, educational institutions are not sufficiently prepared for robotic integration in classrooms, and students are still not ready to accept a non-human creature to be their tutor, the results of my study are consistent with the outcomes of the literature review, which indicates that robots could be a partial addition to educational settings, reflecting a collaborative role besides human teachers.

5.3.2 Inconsistent results:

However, some aspects of my study are inconsistent with the findings of the literature review because one scenario anticipated a future where robots could

evolve further, playing a competitive role against human teachers. Taking a turn towards this direction might be caused by the need to do so because:

- teachers' shortage and workload issue are global concerns that require an immediate attention,
- rapid growth of technology and the evolution of robotics over the history proves that developmental aspects are still uncertain, but once revealed, will hit strongly.
- generations alpha is born with technology and has exceptional needs and expectations that are unconnected with previous generations.

Chapter 6 Conclusions

6.1 Conclusion

The study targeted exploring the likelihood of robotics to collaborate or compete with teachers in classrooms, considering the optimization of artificial intelligence and advanced technologies to resolve one of the substantial concerns in the world pertaining to education. Number of gaps have been identified following the review and analysis of existing research, influencing the thoughts to follow the ladder of inference[8] and consider perceptions rather than assumptions to reach out to conclusions. Hence, the perspectives of relevant stakeholders including students, teachers and worldview were considered to guide us through the development of possible future scenarios and paths. As a result, four scenarios were anticipated, depending on the selected critical uncertainties. As such, it is hard to be definite in confirming that robots will be cooperating or competing with teachers because the criticality of these uncertainties will change in the future affecting the direction of the sector and because of the existence of other limitations (specified below) that need further consideration.

6.1.2 Summary

The research strategy was based on data collection and future development methods that were utilized to anticipate new possibilities. The methodology was based on collecting data about:

- Teachers: through focus group sessions and the casual loop diagram, the study explored the complexity that teachers are undergoing, which in turn contributed to

[8] Refer to figure 1A - appendix

discovering other factors beyond the direct, obvious ones affecting the system. This step resulted in listing the challenges that are affecting teachers' role.

- Market and global trends: through exploring new trends that the world is going through and some weak signals that might need to be zoomed in, the study assessed the probability and impact of those trends and selected the most critical ones to guide in the development of new possible future scenarios.
- Students: through interview results, the perception of students from different age groups was analysed, emphasizing on the overall excitement of generation alpha to deal with robots in classrooms. This step helped in defining the level of acceptance and readiness of this generation to have a robot tutor.

Following data collection, the study focused on different approaches including Causal Loop Diagram, STEEP analysis, Probability/Impact Matrix and Future Scenario Development Matrix where two independent critical uncertainties were evaluated and selected to support the formation of four new scenarios. The challenges and opportunities of each scenario were stated accordingly.

6.1.3 overall findings

With the great progress and advancement that artificial intelligence and robotics are experiencing and considering the importance of finding a solution for teacher shortage issue, it was important to consider an innovative yet supportive method for education field to help resolving this matter. As such, this paper covered a study about the anticipated role of robotics in education and the impact it could have on teachers' role in the classroom. Based on the review of different articles that were published between 1982 and 2024 focusing on Robots-teachers' relationships, the findings revealed a consist outcome indicating that Robots displays a collaborative rather than a competitive role to teachers when integrated in classrooms. However, the paper focused on future possibilities considering the ambiguity versus clear development of technology, the complexity versus simple work of teachers, and the certain versus uncertain aspects of the future. Hence, unique scenarios were identified envisioning four futures, in which teachers, robots, both or none of them will be operating the education journey. The exploration of these scenarios sparked other ideas that are reflected in the below sections.

6.2 Recommendations to address the limitations

Further to the highlighted gaps mentioned in the literature review section, it is worth emphasizing on some limitations that have been identified throughout the research study after analysing the data. Following is a list of limitations with some recommended future work to address them:

1. The perception of students about robot integration was a result of either a short duration of contact with robot(s) or based on their assumptions. Therefore, it is highly recommended to incorporate new approaches in educational settings to guide future readiness. One of the recommendations could be to select two equivalent lesson plans, which have the same level of difficulty and requires almost similar duration of teaching. One session to be assigned to a robot-teacher and the other to be run by human teacher for at least one week. This pilot should be then followed by a quiz to assess students' level of understanding, engagement, progress and preference. In short, having a mini scenario of what one future could look like could better guide in capturing a clear and realistic perception of all relevant stakeholders. This approach will help in assessing the suitability of integrating robots in classroom as a solution for teacher workload issue, or dig into other innovative solutions, that are yet to be investigated.
2. Teachers' feedback about robots' incorporation in classroom was not collected, assuming that their emotions might contribute to their point of view, generating a feeling of being substituted by a technological creature rather than being supported. Therefore, it is recommended that differentiated job profiles with clear roles and accountabilities for both teachers and robots be developed and published by the education authorities, to ensure having an inspiring education community that is based on clarity and fairness and run by satisfied and happy educators. Following that, collecting the perception of teachers about the success of robotic intervention into their zone.
3. Market analysis of the affordability of robots was not explored, to evaluate the practicality of incorporating robots into societies that suffer the most from teacher shortage and need to be given the priority to apply such solution.

6.3 Future work

The study triggers the need for the following future works to gain a better understanding of students', teachers and market acceptance and readiness level to welcome robots whether fully or partially to the education sector and benefit extensively from their presence:

1. **Assessment of students' perceptions based on holistic approach:** in-depth evaluation of the perspectives of students about robotics as teachers, considering all criteria that could trigger a change in their point of views, such as student's age, selected subject, school curriculum and teaching method.
2. **New career opportunities for teachers:** additional research is required to explore list of strategic job positions whether existing or newly emerging, that could efficiently align with the qualifications and experience that teachers have and support an easy transition plan, subject to minor elevation of skills and competencies.
3. **Feasibility analysis to introduce a robot for each child:** extensive research is required to discover the potential of a robot for each child, to contribute to personalized education approach that is trending across different sectors and might be the next direction for education sector as well.

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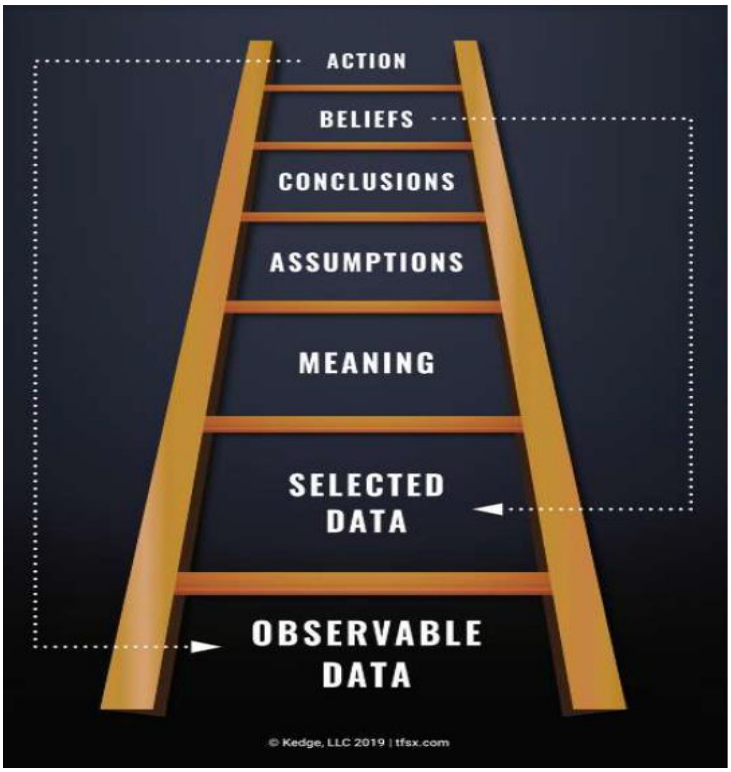
Appendices

Figure A1: the ladder of inference model



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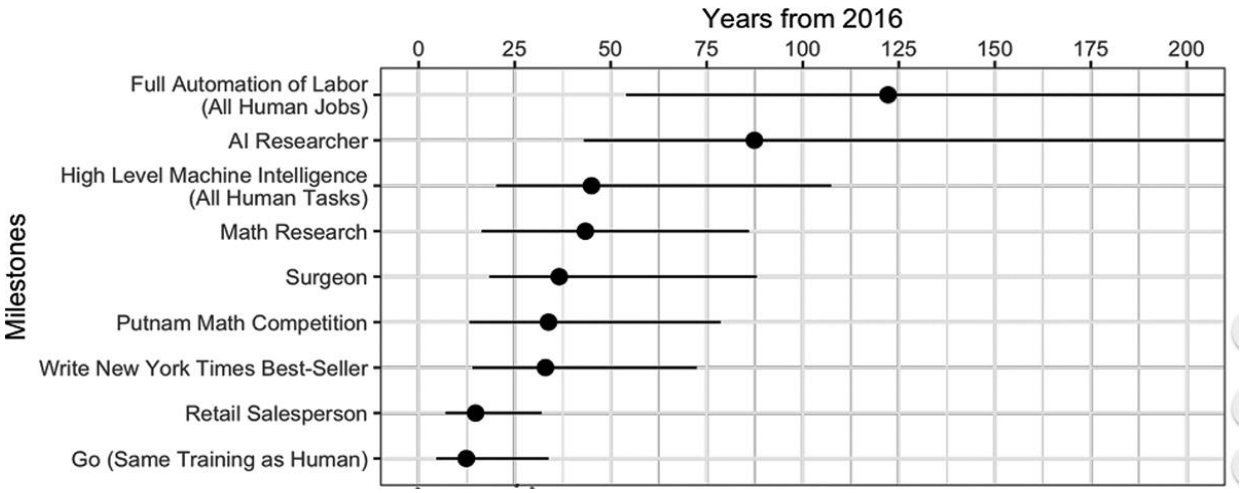


Figure 2: Causal Loop Diagram

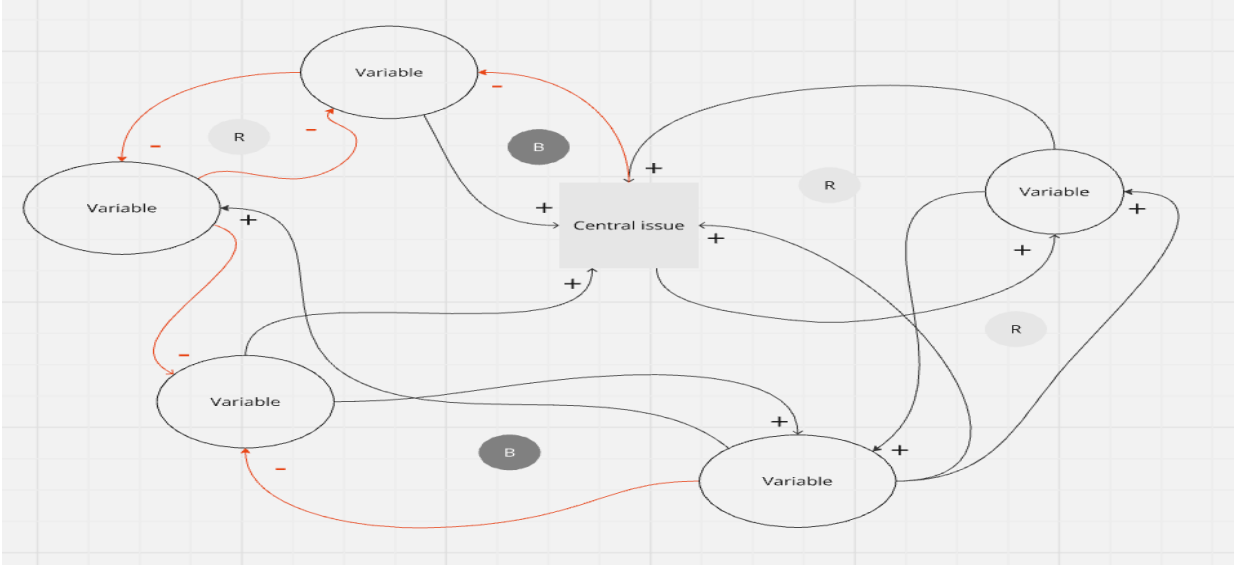


Figure 3: Probability/Impact Matrix

Figure 4: Scenario Development Matrix

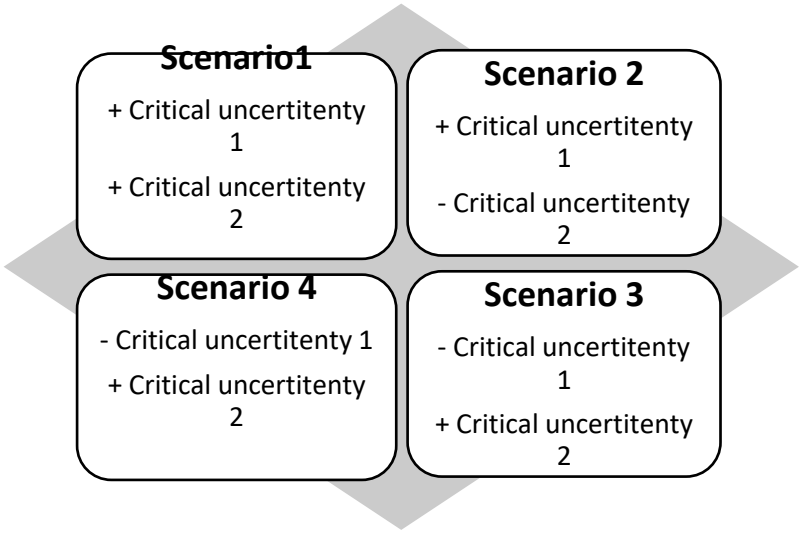


Figure 5: Causal Loop diagram presenting teachers' challenges

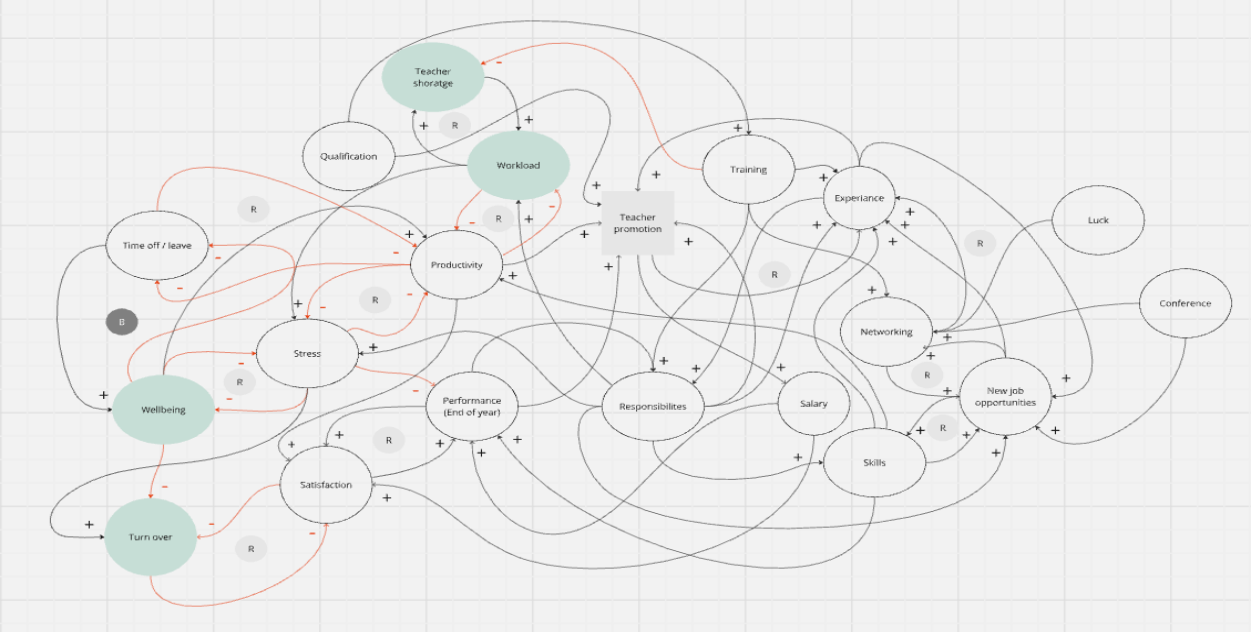


Figure 6: Causal Loop Diagram presenting robot implications on teachers' challenges

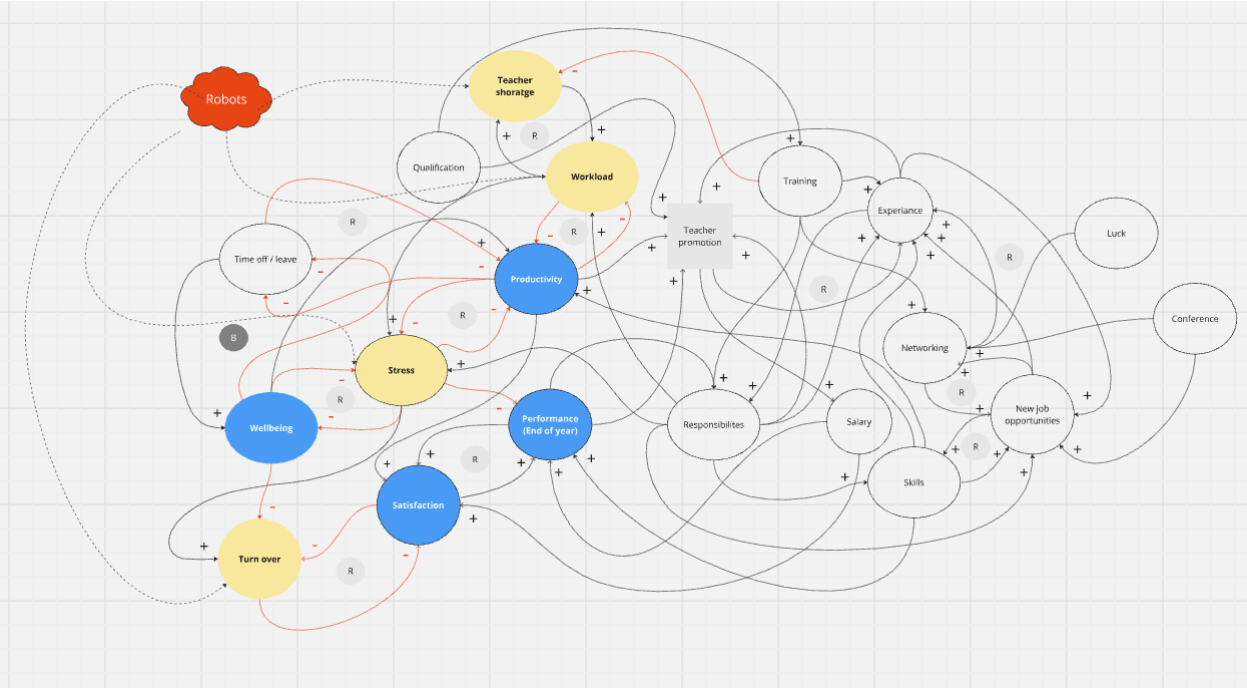


Figure 7: PIM

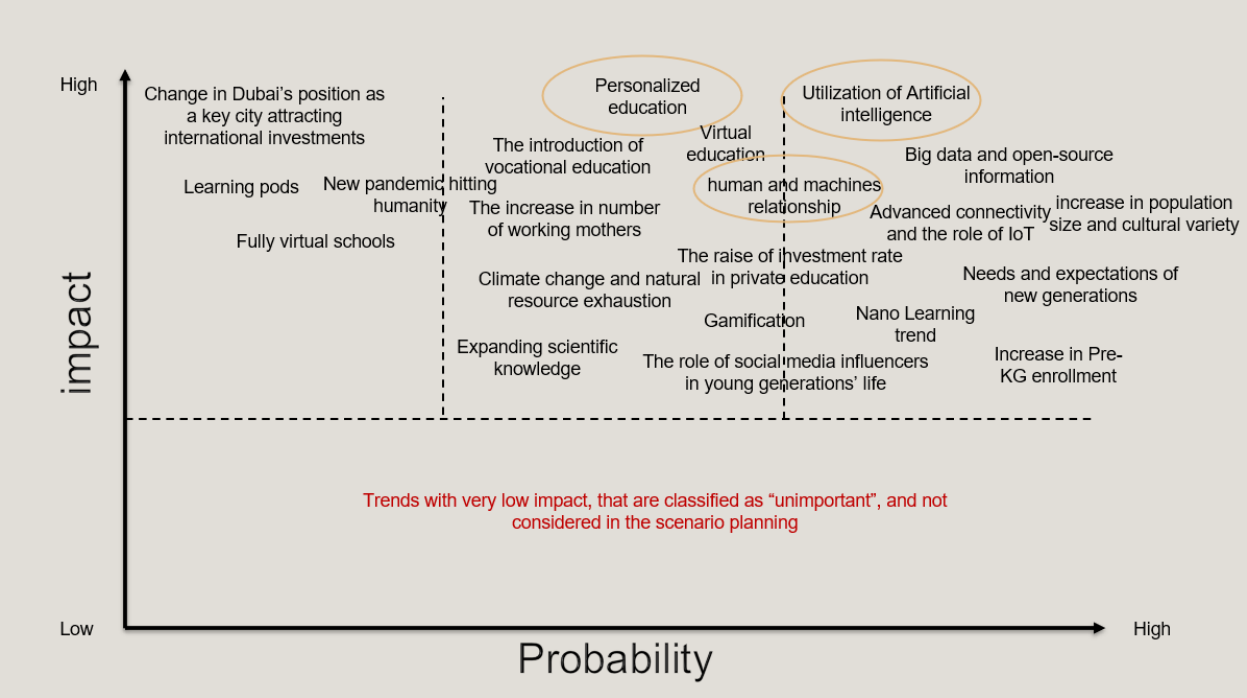
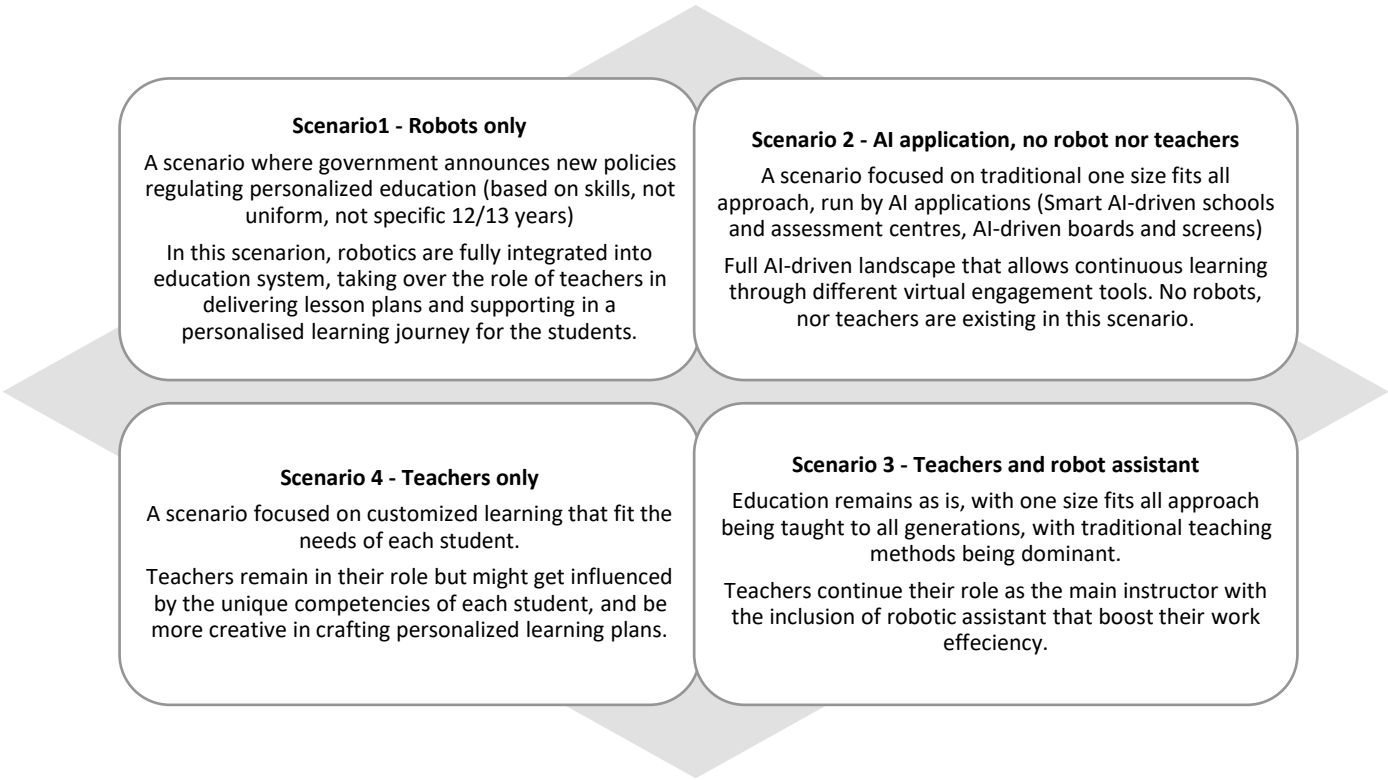


Figure 8: Four Future Scenarios



List of Tables

Table 1: Focus group sessions details

T1.1 Group 1 Teachers from Affordable fee-range schools

46 Teachers	# of Sessions		
	Session 1	Session 2	Session 3
	10 teachers	16 teachers	20 teachers
Q1 How can we make Dubai an attractive place for teachers?	▪ Competitive compensation ▪ Teachers' wellbeing	▪ Salary raises and compensation ▪ Reduce working hours	▪ Teaching resources and tools ▪ Attractive salary packages ▪ Health insurance packages ▪ Education for their kids

	▪ Professional development ▪ Diverse and inclusive environment	▪ Teacher recognition ▪ Discounts and offers	▪ Promotions and career path ▪ Working hour restriction
Q2 How can we enhance teacher mobility within the system while ensuring the quality of student education is protected? What policies should be introduced?		▪ One-year contract, with two months notice period ▪ Organization to offer schools with a pool of sub-teachers ▪ No recruitment during the academic year	▪ One term notice period ▪ Surplus of teachers to cover emergency situations / trained teachers for each subject ▪ Restrict movement of teachers during the academic year ▪ Collaboration approach among schools for teachers hiring

T1.2 Group 2 Teachers from Mid-range fees schools

18 Teachers	# of Sessions	
	Session 1	Session 2
	6 teachers	12 teachers
Q1 How can we make Dubai an attractive place for teachers?	▪ Extensive training and learning programs ▪ International community ▪ Opportunities for career growth ▪ Lifestyle, safety and tax-free salary	▪ Cultural diversity ▪ Teaching facilities for students ▪ Quality of life ▪ Government support

	▪ Competitive compensation packages	
Q2 How can we enhance teacher mobility within the system while ensuring the quality of student education is protected? What policies should be introduced?	▪ Investigating root causes (overwhelming workload, burnouts..) ▪ Pool of substitute teachers ▪ Teacher commitment ▪ Incentives and wellbeing	▪ Pre- defined agreements between teachers and the school ▪ Availability of teacher agency ▪ Clear labour law ▪ Proper handover process ▪ Dig into the reasons behind the movement

T1.3 Group 3 Teachers from Premium schools

30 Teachers from Premium schools	# of sessions		
	Session 1	Session 2	Session 3
	5	10	15
Q1 How can we make Dubai an attractive place for teachers?	▪ Family relocation ▪ Teacher wellbeing and retention ▪ Competitive compensation ▪ Housing allowance ▪ Building social networking	▪ Flexible Visa process ▪ Standard hiring procedures ▪ Open communication ▪ Work-life balance ▪ Professional development ▪ Teacher empowerment ▪ Clear notice period	▪ Providing affordable cost of living ▪ More trainings ▪ Better work-life balance ▪ Competitive and international salary scale ▪ Teachers' gatherings ▪ Less working hours

Q2 How can we enhance teacher mobility within the system while ensuring the quality of student education is protected? What policies should be introduced?	▪ Contingency plans ▪ Substitute teacher pool ▪ School resource for supply and demand ▪ Recruitment restrictions during the academic year ▪ License for substitute teachers	▪ Substitute teachers network Proactive planning ▪ Government incentives through KHDA ▪ Proactive planning ▪ Teacher commitment	▪ Pool of teachers looking for jobs ▪ Investigate the reasons of teachers' move ▪ Contractual restrictions ▪ Teachers' forum and engagement events

Table 2: 2024 Global trends pertaining to AI and robots.

Trend	Details
Artificial Intelligence	AI is a growing trend which has been expanded through generative AI applications, exposing the world to new potential smart solutions. With the evolution of generative AI-driven interfaces, technology experts and program developers are programming robots through much easier approaches such as advanced Natural Language Processing and machine learning algorithm.
Cobots	Human-robot alliance remains a key trend in relation to robotics. Fast improvements in sensing devices, visual sense technologies and intelligent grippers grant robots the capability to react instantly to changes

	in their surroundings and thus perform their job alongside human safely. Collaborative robot applications are expanding, leading to new supportive tools that assist human in performing their work. According to the Global 50 report[9], Co-bot market is still small compared to the larger robotic industry, covering 7.5% only.
Mobile Manipulators	Mobile Manipulators refers to the automation of objects handling by merging motion with clever arms and equipping robots with cameras to enable them to perform work more efficiently.
Digital Twins	Digital twin technology presents a virtual replication of physical systems that is applied using real data to conduct pilot and anticipate possible results, without sacrificing the safety of resources. This in turn can support in better application of technologies because of the predicted outcomes. Digital twins support in building a bond between physical and virtual worlds.
Humanoid Robotics	Robotics is experiencing great progress in humanoids, constructed to execute different tasks in different environments. The design of robots that looks like human, arms and legs facilitates using robots in environments that are built for human-being. As stated by the International Federation of Robotics. “The Ministry of Industry and information Technology predicts humanoids are likely to become another disruptive technology, similar to computers or smartphones, that could transform the way we produce goods, and the way humans live”. Indeed, the Global 50 report stated that humanoid robots could be developed to have seamless interaction with human, through Neutral Networks that enables them to generate human like facial and speech expressions.

[9] Future opportunities report that is published by Dubai Future Foundation in 2024

Table 3: external driving forces and some key implications

What are the external driving forces?		What are the implications pertaining to them?
Social	• Change in the **demographics**, birth rate and aging population • Change in parents' preference for private education • Change in residency location, • Change in society's perception towards education • Change in values that may lead to the need to **change curriculum/ teaching methods** • Change in **the needs and expectations of the new generations** • Change in the way we live, eat, connect and socialize, to evolutionary **gaming system**	○ New generations will have new needs & expectations ○ Existing education models may not meet new generations' needs ○ Private sector might be less attractive ○ Short focus span will lead to drop in students' performance, leading to less high performers at national level, thus less competition globally ○ Parents will be dissatisfied with the learning progress of their kids. ○ Introduction of robots could impact teacher's position/value
Technological:	• Digital transformation and advancement in e-learning • Online education and the raise of **virtual classrooms** • The **role of Artificial Intelligence** in educational processes and learning • Metaverse and the shift towards virtual schools	○ Shift towards digital life due to the evolving role of AI and machine learning ○ Focus on virtual world and online connections all the time ○ Challenge to sectors that resist changing to digital mode ○ New opportunities for sectors that are adopting to the changes

	• The Rapid evolution of technology and communication modes. • The evolution of robotics with advanced features that could be substituting human role.	○ New players entering technology market and possibly taking the lead over existing ones who might be slower in reflecting the change ○ Big data will require significant enhancement to the current infrastructure
Economic:	• Change in the standard of living – parents income level and affordability for private education • Change in the **investment level** and the interest of investors to invest in education • Change in the market, targeting **vocational education** and new types of jobs • Change in **Dubai's position** as a key city attracting international investments / foreigners • Perceiving quality education as an expensive element of life	○ Parents could invest in life-long learning opportunities to expand the skills of their kids ○ New investors could be interested in expanding to vocational education to meet market needs
Environmental:	• Change in the level of **understanding of environmental risks** and the importance of sustainable practices • Change in the students' behaviour towards global issues such as climate change	○ Involvement of generation alpha in volunteer work related to sustainable practices ○ Students raising their voice to defend global issues ○ Involve students in global issue discussion summits, due to their

	• Shift towards becoming contributors to find solutions for environmental issues rather than listeners • Shift in the world awareness level post Cop28 event	mindset and mature level of thinking
Political:	• Government regulations, polices and laws pertaining to education • Government support to the growth of education sector, example, incentives for education providers who deliver the best quality • Collaboration between private and public sectors (federal authorities) • Political stability affecting educational activities	○ Bold steps by the government, introducing new policies pertaining to education, will encourage people to follow it and adopt the change ○ Leading a new era in education sector, and encouraging world view to be part of it