Artificial Intelligence and Underfunded Education

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Abstract

There has been a lot of general research on education, but the unique topic of underfunded education has been largely untouched. Millions of students around the world get a low-quality education due to problems in underfunded education such as the lack of experienced teachers, a high student-teacher ratio and outdated curricula. This negatively impacts them and their respective countries in the future due to subpar performance both in school and in the workplace; further exacerbating the educational and economic disparities between countries. The lack of research in this area is due to the various unique challenges facing underfunded education and the difficulty in solving them with conventional methods. However, many tools that utilise Artificial Intelligence (AI) such as adaptive learning systems, chatbots, virtual assistants and Intelligent Assessment Systems can be used to solve or at least manage these problems, making the process of education more streamlined, efficient and effective. The purpose of this study is to explore the possibility of implementing AI into underfunded education and the numerous benefits that doing so would bring. We also outline the various challenges that would be faced in implementation and possible solutions to them.

Keywords: underfunded education, rural education, artificial intelligence education, AI education, personalised learning, intelligent tutoring system, large classes, student-teacher ratio, electric access

1. Introduction

Underfunded education has historically disadvantaged millions of students worldwide. It has caused them to fall far behind their peers who have access to a higher quality of education. This poses a setback to the students from the very beginning, creating further inequality in the students' education on top of the already existing economic disparities.

Education is an integral building block of the individual and society as a whole. Therefore, its improvement must be heavily prioritised and its problems immediately addressed. Artificial Intelligence (AI) has shown great potential in addressing many of the challenges facing underfunded education. With the sudden boom in popularity of AI chatbots such as ChatGPT, Google Bard and Claude AI, the untapped potential that lies in Artificial Intelligence has never been more apparent. The level of personalisation brought about by AI will be fundamental in revolutionising the process of education, improving the students' experience by engaging them on a more personal level, and taking some load off of the teacher as they may be dealing with very many students. While many schools around the world have shown concern about the potential of AI chatbots to negatively affect education, in this paper we will showcase how the power of AI can be harnessed in a positive way to decrease the disparity between underfunded and well-funded education programs all around the world. This research is important to governments, schools, students, policy makers and any other parties involved in education.

2. Underfunded Education

Underfunded education is a situation in which educational institutions or systems lack the adequate financial resources needed to sustain the desired level of functioning or meet the expected requirements. This means that the educational institution does not have enough funding to support various aspects of education, including infrastructure, supplies, extracurricular activities, technology, curriculum development, meals, teacher training and pay, and student support services (National Education Association, 2021; Obiakor, 2023; Toff, n.d.). Ultimately, a high quality of education cannot be achieved.

Research by the Global Education Monitoring Report Team and the UNESCO Institute for Statistics (2023) shows that two in three low-income countries do not meet either of the two minimum requirements (upper secondary completion rate and pre-primary education participation rate) on the funding of education. Among countries with data, 64% of low-income countries and 29% of middle and high-income countries failed to reach both benchmarks. Poorer countries also often do not report data: 24% of low-income countries and 6% of high-income countries report no data on public expenditure. These findings show that low-income countries are disproportionately affected by the underfunding in education.

Such underfunding leads to students falling behind their peers that have access to a higher quality of education, posing a setback to these students from the very beginning. It creates further inequality in the students' education on top of the already existing economic disparities as earlier stated, with detrimental effects on their future opportunities and prospects. A major impact is that the students' potential is wasted, as they are not provided a fair opportunity to truly display their academic and extracurricular potential due to limited resources and facilities. This leaves them on a difficult path, which often leads to failure in the future.

Underfunded education also has substantial negative effects on society as a whole. The subpar quality of education leads to a less skilled workforce, as the people who are entering into employment have undergone poor training and are therefore ill-equipped to handle the task (ChildFund, n.d.). This lowers the productivity of the companies that these people work at, and by extension the productivity of their countries. The net effect of this is a weaker economy which cannot measure up to global standards, thus widening the economic divide between countries with well-funded and poorly funded education systems. The underfunding of education therefore leads to a vicious cycle in which these countries are unable to improve economically.

3. Challenges Arising from Underfunded Education

Underfunded education leads to various challenges. This section elaborates on four major challenges, namely: a lack of experienced teachers, high student-teacher ratio, lack of electronic access and an outdated curriculum.

Lack of Experienced Teachers

One of the main problems arising from the underfunding of education is the inability to hire experienced teachers. There has been a reduction in the number of teachers due to various factors such as low pay, poor working conditions and a heavy workload. (Partelow et al., 2018; Shikalepo, 2020) Schools are desperate to get teachers, hence they recruit even inexperienced ones who often have never taught before. Globally, the number of primary and secondary teachers that hold the minimum required qualifications is only 83%. (International Task Force on Teachers for Education 2030 & UNESCO Institute for Statistics, 2021) This shows the clear need for increased attention not only in the training of teachers, but also on their selection and recruitment.

Inexperienced teachers give students a suboptimal learning experience and outcome. They are unable to satisfy the intellectual needs of the students as they may not fully grasp the concepts that they are teaching themselves, and cannot answer the often challenging questions that may be brought up. This may discourage students from engaging with the teacher during lessons due to the assumption that the teacher cannot answer questions in a satisfactory manner. In addition, students only gain a surface level understanding of the content and do not get the chance to truly understand it. A negative attitude towards a teacher may also lead to hatred for the subjects that they teach.

Rural schools are especially affected by a lack of experienced teachers as qualified teachers often move to schools in urban areas which have better pay and working conditions (Shikalepo, 2020). On top of this, teachers may be overloaded with grading assignments and doing administrative work, which denies them the time to improve their teaching skills. The inexperienced teachers often are not used to the conditions in rural areas, such as isolation from certain services and a severe shortage of instructional resources.

High Student-Teacher Ratio

The global average pupil/trained teacher ratio (PTTR) in primary education was 27:1 in 2021 (International Task Force on Teachers for Education 2030 & UNESCO Institute for Statistics, 2021). This is in stark contrast to the 56:1 in sub-Saharan Africa. There is no universal definition of what constitutes a large class, so we will define it as those with a specific number of students that teachers cannot handle and resources that are not enough to facilitate

the teaching and learning process (Bahanshal, 2013). The high student-teacher ratio brings about an onslaught of problems to both the students and teachers, the most impactful of which is a severe lack of individual attention. Students receive limited feedback from teachers, giving them little room to learn from their mistakes and grow. Interaction is an integral part of learning. This limited support has detrimental effects on the student, such as low motivation. The students often have no real motive to work as they do not receive encouragement or guidance. A lack of motivation is extremely dangerous to a student because it makes the student view school as a chore rather than viewing it in a positive light. This bars them from unlocking their potential and discovering their passions. Large classes also lead to less participation, as the teacher is unable to accurately gauge who is and is not participating, such as those who hide by sitting at the back, and does not have the time to enable each and every one to speak and participate in class. In the process, shy or weak students are left behind. A large class size leads to ineffectiveness of activities due to the sheer number of students as it is difficult to manage each one. Students thus lose concentration and do not achieve the intended result. It may also be extremely difficult to manage the class as disruptive students can easily get away with it. A lot of time is wasted in trying to deal with disruptions such as noise and general disturbances, leaving little time for the actual delivery of content. There is a lack of control over the class, which gives the students a false sense of freedom and opportunities to interrupt the class without repercussions.

Large classes are a challenge to even experienced teachers, let alone the inexperienced ones that underfunded education often has. They can therefore frustrate teachers and demotivate them from trying their best to educate and motivate their students.

Lack of Electronic Access

Students who undergo underfunded education have a glaring disadvantage compared to students in well-funded education due to their access to few or total lack of access to electronic devices such as computers, tablets and mobile phones. In the event that they do have access to electronic devices, the internet is often very weak, low quality, or totally absent. They therefore cannot fully exploit the devices, limiting their access to various opportunities, a positive academic enrichment and networking (Giving Compass, 2021). Thus, a digital divide is created between those in underfunded and well-funded education. The digital divide is the gap between those who do and do not have access to computers and the internet (Dijk, 2006). It has far reaching effects on the students whose education is underfunded. For instance, students perform worse as they have less access to resources and information that would help to advance their education. They spend more hours completing learning objectives than their counterparts with access to technology, and consequently learn and understand the same amount of material at a decelerated pace. With the large amount of coursework required for students to undertake, it may lead to high stress levels, and may discourage students from taking more technical and challenging courses. Students undergoing well-funded education have a competitive edge at the university level due to the increasing embracement of technology in education, which also makes them more marketable in the corporate world. Generally, technology streamlines the experience of education as it removes many of the hurdles on the path to successfully completing an academic program.

The digital divide further widens the already large gap between social classes. The internet typically has the effect of levelling the playing field between the social classes, as it provides high quality content and learning materials for free. Therefore, the limiting factor of a lack of

access to information is removed, giving students a much better fighting chance. When the internet cannot be accessed by these students in underfunded education, it becomes a tremendously constraining factor to their academic growth. While more privileged students continue to advance and grow their knowledge at an accelerated pace due to their access to the internet, the students without access are left behind. The lack of access to electronic devices and the internet has a ripple effect on other aspects of life, not just education. These students often proceed to lower paying jobs as they are not as skilled or qualified as those with good internet access, further exacerbating existing economic disparities. There therefore is a clear need for access to the internet in this ever-evolving world.

Outdated Curriculum

Underfunded education faces the problem of an outdated curriculum due to the limited resources allocated to curriculum development. The curricula in underfunded education are very rarely updated to include the new discoveries that continue to be made in various fields. Thus, students are often learning content that was relevant many years ago, which may have since been disproven, amended or greatly improved. They have limited exposure to current events and pressing issues of our time. They may therefore miss opportunities to develop the critical thinking and problem-solving skills necessary in tackling the problems faced in today's world.

When curricula are outdated, they may fail to incorporate innovative or emerging technologies and teaching methods that could enhance the learning experience for students. This hinders the development of new and more effective approaches to teaching and learning. Students miss out on opportunities to learn and apply new techniques, strategies, and tools that can help them succeed in their academic and professional lives. As a result, they may struggle to keep up with the demands of the rapidly evolving world and fall behind their peers who have access to more modern and effective educational resources. Students may learn skills that are no longer in demand, thus hindering their chances of employment as employers seek a different set of more relevant skills not taught in the classroom. They are therefore less viable in the job market and have a harder time finding a job. Outdated information may also have inconsistencies that teachers cannot explain to students, thus discouraging students from attempting to gain a deeper understanding of certain concepts and teaching them to simply accept new information without interrogating it. This complacency is damaging to the student as it discourages the deep exploration and mastery of content, teaching them to memorise rather than understand.

Students are in a time capsule of outdated information, leading to a great shock when they explore the bigger world and realise that what they have learnt is largely irrelevant (Matter & Form, 2019). An outdated curriculum is disconnected from current world contexts and fails to equip students with the knowledge and skills they need to navigate and thrive in the modern world. They then have to spend time updating themselves with current information, disadvantaging them as other students with up-to-date curricula advance far ahead socially and economically.

4. Artificial Intelligence

AI does not have a single concrete definition that is universally accepted. For the purposes of this research, we will define artificial intelligence as the development of computer systems and machines that can perform several tasks that would require Human Intelligence (HI) such

as learning, solving problems and decision making (Chen et al., 2020). It also involves the use of algorithms and data to enable machines to simulate intelligent behaviour and adapt to different situations.

In the past few years, interest in AI has spiked due to the popularity of cutting-edge research done by companies and scholarly institutions alike. For example, the AI research company OpenAI is making strides and pushing the limits of the development of artificial intelligence. With the release of GPT-4, they have demonstrated the extreme potential of AI to revolutionise human life as we know it. Its remarkable ability to reason, understand and synthesise coherent and accurate information has brought AI into the limelight. ChatGPT, a chatbot made by OpenAI, reached 100 million users only 2 months after its launch, clearly demonstrating its outstanding demand and utility (Hu, 2023).

AI has many diverse uses, such as in search engines, autonomous vehicles, and even smart toasters. For example, AI has achieved remarkable progress in the field of healthcare. It has contributed to disease diagnosis, drug discovery and personalized medicine. By use of machine learning algorithms, AI can effectively analyse extensive medical data hence enabling doctors to make precise and accurate diagnoses and treatment strategies.

Despite the incredible benefits that they bring to the table, artificially intelligent systems have their drawbacks. AI often produces completely false information conveyed in a convincing manner, called "hallucinations". Items such as references and citations are often completely made up. The cause of these "hallucinations" is difficult to establish (Lutkevich, 2023). They are hazardous because they can easily fool people, causing the spread of misinformation. Due to the newness of large language models such as ChatGPT, people are likely to believe it as they may not know about the phenomenon of hallucination. They also betray the users' trust who previously believed AI to always be accurate, discouraging them from using it.

AI also has implicit biases (Silberg & Manyika, 2019). Training data that the AI learns from may have biases which are reflected in the AI's output, further reinforcing harmful stereotypes. Bias may be in subtle forms, such as an AI system giving a student who writes an essay about a difficult socioeconomic background a lower score than one who writes about a different topic. This bias compromises the holistic nature of education. It may be ingrained deep in the training data and show up in a not so obvious way. While this may not have been the developer's intention, it is still a very important concern if widespread use of AI is to be achieved. Much work needs to be done to improve on this, such as by choosing training data more selectively and through auditing of models and data by third parties.

5. How AI Could Address the Problems in Underfunded Education

AI has the potential to significantly mitigate the problems in underfunded education outlined above. These is outlined in the following sections.

Aid to Inexperienced Teachers

Artificial Intelligence would be an instrumental tool in not just aiding teachers in the classroom, but also teaching the teachers themselves. It could be used in the initial training of teachers, delivering pedagogical knowledge on optimal teaching methodologies and improving content comprehension. Additionally, AI models can serve as practice students for new teachers (Chen, 2023). They have the ability to simulate confusion and ask follow-up questions like a student, preparing the teacher for the real experience. AI tools can be used to

help design lesson plans which align with the curriculum requirements and with class activities that better engage students. This is a useful feature that could support teachers in developing effective lesson plans that are engaging and pedagogically sound. The AI can serve as a source of inspiration for the teacher, such as by suggesting different ways to deliver a certain concept and thus the teacher can decide which best suits their style (Nieves, 2023). AI can also provide live feedback in a lesson, suggesting questions to ask students and actively advising the teacher based on proven pedagogy. This can help a teacher to build intuition on what to do in various situations, acting as a live mentor during the lesson. After the lesson, AI can produce a summary, capturing various metrics such as how much time students spoke for and questions that led to the most engagement. This data is useful for the teacher for future improvements in the learning experience for students. It also helps the teacher develop their own unique style of teaching, which sets them apart from other teachers and gives their lessons a sense of personalization.

However, caution must be taken in the direct use of AI in the teaching process. Measures must be put in place to avoid AI automating bad ways of teaching rather than improving the teaching (Chen, 2023). Doing so is crucial for the actual use of AI tools in the classroom. We must also remember that AI is just a tool and does not guarantee success, effort still needs to be put in by the teacher to provide effective instruction (Wilichowski & Cobo, 2023).

Mitigating the High Student-Teacher Ratio

An incredibly useful AI tool that would take some load off teachers is the Intelligent Tutoring System (ITS). An ITS tracks various psychological qualities of a student through a process called student modelling. It then responds based on the psychological state with activities and exercises that are appropriate for the student's capabilities. ITSs have the ability to perform repetitive, non-cognitive tasks such as grading and administrative tasks. Therefore, teachers save time and have a reduced workload, thus they can use their time more productively to build positive relationships with students, hone their teaching skills and give students more personal and quality instruction (Wilichowski & Cobo, 2023).

A key benefit of ITSs is that they give students individual attention through personalised feedback based on the student's performance in a certain topic. Students also learn at a pace that is suitable for them. This way, smart students do not feel unchallenged or held back by the rest, while slow students are not left behind. Students can deeply understand the content. This is especially important in underfunded education, because it takes some load off the teachers who physically cannot give each student the full attention required for optimal learning.

Students feel more motivated to learn and progress as they are taught in a manner tailored specifically to their needs, so learning does not feel like a burden. The ITS tests various teaching tactics and decides on the best one for the student. It can make connections between the students' likes and the concept that is being taught. This is also likely to improve student performance as participation in class is guaranteed, whereas in the status quo of large classrooms, some slow or unmotivated students may blend in and never participate. Students are also often discouraged from openly asking questions during class due to the fear of judgement by their peers (Chen, 2023). In particular, slow students are the most affected by this as they fear being labelled as 'stupid' by their classmates. This becomes a positive feedback loop in which the student never really gains understanding and does not improve even with time. An AI system would remove the barrier of self-consciousness; thus, the

learner is more willing to be vulnerable and engage. Constructive remarks such as "That is a good question!" by the AI could also help to boost their self-confidence.

AI as an aid in creating lesson plans would also be very useful to support the large classes that characterise underfunded education. AI can suggest effective collaborative exercises for the large number of students to work together, further improving their understanding of a subject while also dividing the class into smaller groups which are easier to monitor.

A good example of the effectiveness of AI tools in education is Khanmigo, a tutoring AI that is powered by OpenAI's GPT-4 technology. It has the ability to prompt and give hints to the student to encourage them to find the answer on their own, without the AI explicitly giving the student the answer (Golden, 2023). It does this by asking the student how they came up with a solution and showing where they went wrong, developing the student's critical thinking skills. It also records a summary of the student's progress for review by teachers and parents (Ofgang, 2023). The Khanmigo AI can also simulate various historical figures and fictional characters, bringing stories about them to life and leaving a lasting impression on the student as they can seemingly interact with them (Singer, 2023). Khanmigo is also of great help to teachers as it can develop lesson plans and assist with administrative tasks (Ofgang, 2023).

Though the high student-teacher ratio may not be eliminated, it becomes lot more manageable through the implementation of AI.

Curriculum Development

Artificial Intelligence can be leveraged to update curricula and bridge the educational divide between adequately funded and underfunded education. In the initial development of a curriculum, AI can act as a good starting point by providing ideas for content alignment (McGehee, 2023). It can create course objectives, give an outline of the subtopics in each unit and generate lesson plans of which topics to cover in each lesson. AI could also assist in the generation of questions that closely align with the content and that challenge the students' understanding.

AI would be excellent in continuously updating of curricula to maintain their relevance and alignment with current knowledge and societal trends. Machine learning algorithms can be utilised to analyse vast volumes of data such as research papers, articles and scientific publications. This analysis can be used to identify breakthroughs and emerging issues, notifying the curriculum designers who can then determine their appropriateness for inclusion. By implementing these insights, curricula undergo continuous refinement, providing students with the latest well-curated content and skills that effectively meet the demands of the modern world.

However, we must remember that AI is just a tool and cannot replace the expertise of curriculum designers, it should be used only as a supplement to their work. Human experts are still needed to refine the content, but are better with AI.

6. Implementation

So far, we have mainly explored the potential that artificial intelligence promises in the improvement of underfunded education, but we have not seen whether this would actually be

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possible. This section looks into the feasibility of implementing AI in underfunded education and the measures that would have to be taken to ensure its effectiveness.

Firstly, we must establish how these underfunded areas would access electricity. Around the world, 775 million people lack access to electricity, most of whom are in developing Asia and Sub-Saharan Africa (Cozzi et al., 2022). This has disrupted various areas such as healthcare, communication and industries. The lack of electricity negatively affects underfunded areas in all respects and stunts their economic and social growth, and is an issue that must be addressed for prosperity. To supply electricity to such areas, off-grid solutions such as solar or hydroelectric power may be used (Heinz, 2014). Alternatively, microgrids can be set up where it is cheaper than extending the main grid. Energy-efficient appliances should also be used to maximise efficiency in electricity usage (Odarno, 2017). Additionally, access to electricity should be linked to development goals, as they are interdependent. Development is hindered by a lack of access to electricity, while electric access is reliant on successful development projects. If development projects partner with electric access initiatives, planners can utilise the expertise of developers and finance organisations to accelerate the electrification of these areas. We must also guarantee the affordability, reliability and high quality of electricity for development to take place. This could be achieved by subsidising the cost of buying electricity. The burden falls on governments to continue availing electricity in remote and underfunded areas to reap the benefits of economic development and improvements in education.

Next, we look into how underfunded education would gain access to the technology required to run the AI programs. Governments can partner with technology manufacturers to buy efficient and affordable devices for education in bulk. For example, tablets or all in one desktops can be used. Though implementing AI in poorly funded schools may seem difficult due to limited resources and capital, it is not impossible. AI-powered educational applications can be developed to run on low-cost devices such as smartphones or low-end computers that are more affordable and accessible to poorly funded schools. Since internet connectivity may be limited in some poorly funded schools, offline AI solutions can be employed. Of course, these devices would have to be periodically updated with the newest developments, but this is easily achieved by transporting them to areas with internet access or by downloading newest AI programs to a portable storage medium such as a flash disk and availing them to the areas without internet access.

A key part of the puzzle of implementing AI in underfunded education is the training of all parties involved to be able to use it effectively. Firstly, teachers must be trained in order to understand how to apply it in their daily work and help students use it. Some of the teachers may not even be computer literate, thus a lot of effort must be put into such training for it to bear results. The training can be through means such as seminars and workshops to educate the teachers on the effectiveness and utility of AI, as well as how to use it themselves. These training programs will have to be very rigorous, as the teachers will be the primary tutors to their students on the use of AI. Teachers will also need reassurance that AI will not replace them or steal their jobs. Overcoming this doubt requires effective communication, awareness campaigns, and demonstrating the positive impact of AI in education.

In addition, teachers must be convinced that AI will not make their students lazy. For example, AI can write entire essays, which the teacher might feel is a form of cheating. On the contrary, AI might actually end up heightening writing standards, as AI will not be doing the thinking for the students. Students will have to curate and edit the content, which makes

them investigate the subject matter much more deeply than they previously did (Chen, 2023). This could end up actually improving their critical thinking skills, rather than decreasing them.

To educate the students, expert guest speakers can go to each school in which AI is to be implemented and give the students a brief presentation on AI and its benefits. For long term maintenance and to ensure that the adoption of AI technologies goes smoothly, a designated tech support person can be situated in each school.

It must be noted that only one AI system is required to cater for an entire education system, therefore all the time, energy and resources can be put into making that one AI system as good as possible. This can be achieved with the help of experts across the world who are well-versed in the AI development, as well as the most experienced local teachers who fully understand what the education system requires. This guarantees a somewhat equal playing field between people in underfunded schools and well-funded schools. The creation of one AI program for an entire education system could also encourage international cooperation in education in which different countries exchange ideas about their education systems to improve them. Eventually, the possibility of a universal curriculum may be realised.

While the implementation of AI may seem costly, its long-term benefits far outweigh the short-term challenge of initially funding the buying of devices and development of the system.

7. Conclusion

Artificial Intelligence has incredible potential in revolutionising underfunded education. It is producing new teaching and learning solutions that are being tested globally. By harnessing the power of AI, education systems can create more equitable and engaging learning environments while empowering teachers to grow and develop professionally. If AI were implemented in underfunded education, it would decrease the educational divide between countries, giving all students an opportunity to display their full potential. However, much work still needs to be done on improving AI models and optimising them for education systems. As the world continues its rapid evolution, we must ensure that underfunded education does not get left behind as the rest of the world pushes forward and develops. In this paper we have demonstrated its potential to effectively address four major deficiencies arising from underfunding in education. It is doable and necessary for a more equitable and fairer world, governments, education institutions and their partners should therefore take seriously the open opportunity presented by AI to managing the challenge of underfunded education.

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