



AI-Driven Ergonomic Assessment and Optimization of Classrooms and Offices at Public Sector University

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ARTICLE INFO			ABSTRACT
Article History:			<i>With more AI in classrooms and workplaces, public universities now have new ways to deal with ergonomic issues. It analyses 65 studies focused on using AI to review and boost ergonomics in both learning and working environments. The purpose was to understand whether using AI such as machine learning, computer vision and neural networks, can improve physical, mental and environmental ergonomics for everyone in the school. Analysis found that most of the main outcome areas had moderate to good effect sizes: pain was reduced (Hedges' $g = 0.58$), productivity was raised ($g = 0.47$), being in the classroom was more engaging ($g = 0.51$) and environmental quality was increased ($g = 0.63$). Significant differences were found in the data ($p < 0.01$) and the amount of heterogeneity remained low to moderate (between 30% and 42%) among different institutional and geographical groups, proving that AI works similarly everywhere. AI tools were able to promptly highlight ergonomic tips, handle environment-related work processes and adapt to new learning requirements at work. Although the results were in favor of bone marrow transplantation, it was apparent that many studies didn't use controls for participant blinding and concealing the patient's group allocation which made the research less reliable. It was found that using AI for ergonomics in public sector universities is a practical and important way to boost comfort, mental abilities and make workplaces better. Compatible models demonstrate that implementing AI in schools and education support systems is very beneficial. More studies should be carried out to learn about long-term gains, ethical issues and cost-saving effects to make sure smart ergonomic systems are sustainable and applied equally in all academic and administrative university offices.</i>
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Introduction

Now that technology is advancing rapidly, artificial intelligence (AI) is changing the way things work in healthcare, getting around and education. Rising attendance, getting older facilities and greater pressure for effectiveness are challenging public universities, but the design and comfort of their spaces are currently not being looked at. Making environments suitable for users by applying ergonomics improves how comfortable, secure and productive people are in schools. If settings are poorly designed, it can lead to tiredness, bone and muscle disease, trouble concentrating and reduced learning and working performances in school. Using AI to assess and improve ergonomics is both needed right now and greatly transformative. The use of AI helps institutions shape settings that are flexible, rely on data and put more importance on human well-being and better performance in all areas (Dwivedi et al., 2023).

Educational institutions cannot do without the importance of ergonomics. They are not only places where people are, but also places where ideas are shared, information grows and decisions are made affecting many people. Over the years, most of these environments were designed the same way, often forgetting that users have differing needs and work and learning change on a regular basis. Many students sit in hard chairs and unmoving desks for long stretches and teachers and administrative staff often have to work at inflexible desks that do not adjust to their body size. Over a period of time such factors can bring about ongoing illnesses, poor attention spans and more employees not being present at work. The issue is especially important for public universities which face financial and structural limits when trying to improve their campuses. AI tools can analyse a lot of data, find helpful patterns and provide useful insights to address these issues (Storey & Beeman, 2023).

The assessment starts by looking at and understanding how people interact with their physical environment. It concerns posture, how people move around, length of time spent sitting, brightness, air quality, noise, temperature and how furniture and equipment are arranged. Technology such as computer vision, wearable sensors and smart furniture is used to obtain instant data. Cameras equipped with AI can point out wrong sitting habits, curved backs or activities that overwork hands, telling users or managers to take action before they cause health problems. Sensors used for the environment can track CO₂ in the air and lighting, making sure the environment is optimized for good learning. AI is powerful because it detects problems and also recommends alterations to design, seating position or the way work is organized based on the evaluation of human actions and the surroundings (Özsungur, 2024).

When AI is used for checking ergonomic issues, schools can get more comfortable and inclusive for everyone. Around the world, people are adopting learning spaces with flexible furniture, adjustable seats and adjustable structural setups. AI can make this concept stronger by monitoring how students communicate and relate to the world around them. It helps determine the best way to arrange seats to maximize student participation or how changing the lighting level affects their attention at different times. With this information, AI might help adjust the layout, customize furniture for students and confirm the physical space meets different learning needs. It can advise students with physical disabilities on personalized ergonomics that meet their unique needs which supports inclusion and fairness in the classroom (Oecd, 2019).

Also, applying AI-driven ergonomics to office areas at universities helps both academic staff, administrative employees and researchers. Such places are still structured based on old designs which often do not take into account how work has evolved to mainly involve laptops, online conferencing and managing several jobs on different gadgets. AI can assist in creating versatile offices that employ designs that adjust to how each person likes and needs to work. Over time such

workstations and chairs adjust their positions and features based on the user's selections without any manual changes. Using AI, work habits like sitting time and activity levels can be observed to recommend breaks, proper sitting posture and stretching exercises. Sometimes, these actions are not obvious, but they can really improve health and productivity on the job over time. AI systems can point out unused spaces and propose organizing or transforming them to make everything more efficient and collaborative (Skylark & Ai, 2025).

Setting up AI-powered ergonomic services in public sector universities requires an overall plan with technology, policies and user input. The first step is to conduct a full review of sites, relying on AI to analyses who uses the place and what their surroundings are like. After that, AI systems are put in place to watch for problems continuously and respond in real time. While a class management system might adapt lighting and assign seats based on the number of students and sunlight, an advanced office assistant may help staff customize their desks and chairs ergonomically. For these efforts to be successful, they have to depend on help from workers as well as on technology. Programs are needed to teach students, faculty and administrators the benefits of ergonomics and the use of AI. Also, users should be empowered to give feedback by reporting concerns or providing ideas which aids the system's growth (Taiar, 2022).

While the benefits of AI-assisted ergonomics are many, still, certain problems have to be faced to see it put into action. The main issue today is how data can be protected. Because the systems use videos, data from sensors and information about how users interact, privacy may be put at risk if security measures are not strong. It is necessary for universities to clearly outline how data is collected, used and stored to follow national laws and ethical standards. The beginning costs for setting up AI infrastructure, for example, sensors, smart furniture, cloud storage and AI platforms, are usually quite high. Keep in mind that this thinking pays off over the long run: people are healthier, miss work less often, perform better academically and more space can be used. Resistance to new technology within a culture can block its usage. They must share stories of successful projects and invite their consumers to be involved in planning and executing ideas to earn people's trust and make them more comfortable with the results (Lobschat et al., 2019).

Using AI in ergonomics brings about a big shift in the way schools and workplaces handle and manage spaces used for teaching and work. Financial limits often prevent public sector institutions from doing much, but AI can provide a broad solution for health, better living and raising productivity across their school population. AI-based posture detection, environmental monitoring and adaptive design help colleges change from fixed, set layouts to ones that respond to users' needs. They react to whoever is feeling discomfort and also anticipate it, change how they operate per each user's actions and keep improving to better human well-being. As schools across the globe ask for digital transformation, the field of AI-driven ergonomic optimization becomes a key yet not fully explored aspect in the future development of higher education (Eke et al., 2023).

Literature Review

More and more, tools like machine learning and computer vision from artificial intelligence are being used to review and better ergonomic settings in different environments. The authors of the study, Sun (2020), emphasize the use of wearable devices and AI-based algorithms to identify poor posture, unusual movements and work environments, in order to prevent work-related musculoskeletal disorders (WMSDs). Such devices offer quick responses and suggestions based on your needs which help you take active steps for good ergonomics.

AI is now being used to do ergonomic assessments in both classrooms and offices. Dwivedi et al. (2022) study how wearable technology can measure students' involvement and concentration

during lectures, giving insights into the link between posture and effectiveness in learning. Employees' desks have been examined by AI to uncover the risk of being in a fixed position or doing the same activity too often and the systems have proposed choices for ergonomic improvements.

How classrooms are built affects how engaged students are and their academic achievements. Typical classroom layouts do not usually suit different learning and physical habits. AI is helping to establish flexible learning spaces. AI studies students' actions and the environment in the room to offer ideas for comfortable seating, proper light levels and an improved layout. Also, AI systems keep track of the classroom, changing things like temperature and air quality to maintain the best atmosphere for studying (George & Wooden, 2023).

Being involved in designing and judging their workplaces is recognized as an important style in ergonomic care. Publicity helps ensure a comfortable fit and leads to content and joyful customers. The application of AI to participatory ergonomics improves the changes made which means ergonomic challenges in classrooms can be solved more effectively (Porter, 2020).

Rarely do public sector university offices have layouts that are up-to-date with modern ways of working. AI allows for changes to be made to these spaces to boost ergonomics and let employees work more efficiently and comfortably. AI algorithms identify the efficiency of workspace use, spot places that are unused and anticipate ways to make better use of space and avoid overcrowding. In addition, AI can sense lighting, surroundings noise and air and thus take needed steps to raise comfort and performance in the workspace (Noviaristanti, 2021).

AI can be used to provide personalized support and therapies in workplace ergonomics. AI technology is able to observe how employees sit and move and it can provide staff members with advice on better posture. It helps to prevent injuries in the joints and muscles of professors and staff which contributes to their general well-being (Experts, 2023).

Integrating AI into work areas means that reactive and stiff methods are abandoned for new technologies that are always working and making things better. AI is effective in ergonomic assessments since it can gather and review lots of data from many sources such as motion sensors, wearables, video recordings and sensors monitoring the workplace. In their review, Shahid, Farooq and Khan (2020) discussed how AI models based on machine learning and computer vision are able to find postures, strain movements and lighting issues in real time. They may personalize recommendations and also change the surroundings such as lights or the desk height, to support good ergonomics (Guild, 2023).

AI is put to use in classrooms to help create adaptable and student-friendly learning spaces. Typical classrooms are set up in unchangeable ways, with stationary furniture which makes it hard for students to learn actively. Brooks found in his research (2011) that moving, working together and personalizing spaces in classrooms can raise student involvement and boost academic success. Artificial intelligence may use its abilities to collect ongoing information about seating options, body posture and focus of students in these areas. When computer vision is used in systems, it can detect when a student looks tired or is slouching, so it can suggest ways to sit and rest. AI could also recommend flexible room setups based on how the space is used, how many students are seated and how active students are which helps create an inclusive and engaging environment (Qin et al., 2024).

These benefits have shown up when using this setup in offices. People working in higher education spend long periods sitting and using their computers to handle details that demand mental focus. For example, a study done by Hedge (2016) notes that people with sedentary jobs

often suffer from back pain, carpal tunnel syndrome and eye strain. AI can lessen the problems caused by these initiatives by communicating with smart furniture and clothing to detect human behavior. With AI, it could be recognized by the system that a user has been sitting with poor posture for one hour, so it might suggest a break or some stretches. AI can also assign tailored ergonomic training and change workstations according to employees' needs which creates environments that match each employee's requirements rather than following a usual design (Vanka et al., 2021).

AI in ergonomics can be very useful, but the published research points out a few challenges. Protecting data privacy and resolving ethical questions is at the heart of the discussions. A lot of AI systems use surveillance by cameras and sensors which has led to people wondering about privacy and permission in educational and work settings. Wiklund et al. (2022) point out that organizations have to clearly outline how data is gathered and used, ensuring that procedures are legal and help restore user trust. The risk of algorithms being biased is something else to worry about. Issues in ergonomics may not be addressed correctly when AI is only taught on data that lacks diversity such as for workers who are disabled or look unlike the average person. So, making design and data inclusive is necessary to carry out the strategy properly.

Costs for implementation and insufficient preparedness of infrastructure are big challenges chiefly faced by public colleges in developing regions. AI brings long-term benefits but investing in the hardware, software and training staff in the beginning can cost organizations a lot. Scholars such as Chien and Chen (2020) believe that working with technology partners, carrying out pilot studies and phasing in changes step by step can reduce pressure on the budget. Also, issues such as reluctance from users and not enough knowledge of digital tools can interfere with adoption. Success when adopting technology depends on both tech tools and the people and structure within the organization. It is necessary for institutions to organize training, awareness sessions and use participatory ways for ensuring that students and staff know about and use the new systems (Vidal et al., 2024).

Participatory ergonomics is recognized as the best way to include AI in our daily work environments. Users are actively involved in designing, testing and evaluating new ergonomic ideas using this method which makes sure solutions are suitable, approved and focused on those who will use them. According to Vanka et al. (2021b), including workers in ergonomic efforts brought about greater satisfaction, better compliance and enduring results rather than simply being directed by management. Merging AI and participatory ergonomics can create systems in the university that are both solid technically and aware of the values and customs of the campus.

Methodology

The main purpose of this meta-analysis was to look into and bring together published research studies about the use of AI in ergonomics for both educational and office settings, especially among public universities. Recognizing the role of AI such as machine learning, computer vision and intelligent sensor networks in improving ergonomics in institutions, we should gather information about their efficiency, how widely they can be used and where they have limitations. A strict process guided by PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) was used in selecting articles, extracting data, evaluating quality and summarizing results of this meta-analysis (Pauceanu & Porada-Rochoń, 2024).

They started the meta-analysis by choosing the main research question: "How do AI-guided ergonomic techniques affect the comfort, health, performance and use of space for users in classrooms and offices of public sector universities?" The secondary aims also took into account

examining AI tools used, evaluating ergonomics and checking the rigor of current research. The formulation set the guidelines for including or excluding studies as well as for choosing search terms and the databases used to gather papers.

Part of the approach was to look for related publications, conference proceedings, theses and technical reports in several databases. For the following step, researchers looked into these databases: Scopus, Web of Science, IEEE Xplore, PubMed, ScienceDirect and Google Scholar. Keywords were assembled using Boolean combinations that included: “AI in ergonomics,” “artificial intelligence classroom optimization,” “AI workplace ergonomics,” “public university ergonomic design,” “AI in educational environment,” “smart classroom ergonomics,” “intelligent office systems,” and “posture recognition AI in education.” Included were English papers from the period of January 2010 to March 2025 to show when AI applications became practical in ergonomics (Black et al., 2021).

The first stage of searching found 1,482 results. When duplicates were eliminated ($n = 372$), the titles and abstracts of 1,110 studies were checked to see if they were relevant. The filtering process removed papers with a different focus (e.g., AI in the curriculum design) or that had no strong research findings. 204 of the articles were reviewed in detail by reading their full texts. In this period, 139 more studies were removed because they did not provide adequate information on the methods used, did not include proper control groups, took place in workplaces unrelated to education or paid no attention to AI ergonomics. Finally, the meta-analysis included 65 papers.

Every one of the 65 chosen studies was carefully reviewed for data. The data extraction form included questions about the study’s plan, sample size, type of organization (favoring public universities or higher education forms), information on participants, AI applications included (neural networks, computer vision, fuzzy logic systems), variables analyzed in terms of ergonomics (posture, environmental comfort, disorders of the muscles and bones, productivity), span of the intervention and results reported. Both types of results were kept as data. When necessary, numbers such as effect sizes, means, standard deviations and p -values were either found directly or were calculated from the statistics offered.

A two-part method was used to check and ensure that the included studies were of high quality and reliable. At first, a research tool called the Mixed Methods Appraisal Tool (MMAT) was used to measure the quality of mixed, qualitative and quantitative research. Every report was analyzed in the domains of study design, data sources, how accurately the subjects represented the population, the strength of the measures and whether the outcomes were important to the theme. Those studies that scored lower than 60% on MMAT were thrown out of the analysis. Cochrane’s Risk of Bias (RoB 2) tool was used to check for bias in randomly selected studies, while ROBINS-I was applied to non-randomized studies. The risk level of each study was determined as low, moderate or high using these criteria which guided assessment of their influence when putting together the research results.

The research’s large variety of AI approaches, intervention durations and school types called for a random-effects meta-analysis approach. Ergonomic improvement was the main result sought, shown by lower reports of painful symptoms, better work performance or better conditions in the workplace (like air quality and lighting). Participant satisfaction, how well the intervention was followed and adaptive capabilities by the AI system were all looked at as secondary outcomes. Values of Hedges’ g were used to allow different studies to be compared, despite the various scales they used. The presence of heterogeneity was checked with the I^2 statistic and the Cochran Q test and publication bias through funnel plots and Egger’s test.

Whenever studies did not report effect sizes or standard deviations, authors were contacted to ask for the original information. Absent data, proximity to effect size was generated through sample

size, p-values and reported means by following conventional statistical conversion. Robotic vision cameras provided data once the software (e.g., WebPlotDigitizer) was installed to allow for approximate values. Having many valid data points helped maintain the scientific quality of the study.

Synthesizing the data was paired with close study of narratives to look for trends, contrasting results and factors impacting what was uncovered. This helped a lot when reviewing mixed-methods studies or studies that came up with descriptive observations. It was found in multiple studies that the success of different AI integrated tools for ergonomics depends on institutional habits, the state of technology and user opinions. Examples from universities in Asia and Latin America showed how having stakeholders involved is very important for using AI, using a participatory ergonomics strategy.

Experiments were conducted to check how much the results were impacted by small changes in numbers. The analyses examined if the differences found were due to the AI method (computer vision versus embedded in IoT systems), the number of students at the school, the duration of the intervention or the environment (school or office). The research found out what factors contribute to AI treatments working best. Meta-regression was used to find out how research characteristics (such as publication year and sample size) relate to the effect sizes found in the studies.

The included investigations were thoroughly documented in terms of ethics. Only research where privacy issues related to AI surveillance (such as using posture skeletons without personal identifiers, doing local data processing) were handled, as well as studies that used informed consent, were part of the analysis. The importance was higher because of potential concerns related to always watching in education. All research that did not conform to proper or ethical procedures was left out in the full-text review.

R software was chosen for the data analysis and the programs "metafor" and "meta" were used to perform the statistical synthesis (Galindo et al., 2025). It was decided to use confidence intervals at 95% and the data was considered significant if $p < 0.05$. All code and data used for the analysis were carefully recorded and put into a secure research repository so that the analysis could be repeated and evaluated by other experts.

Results and Discussion

Table 1: Overview of Attributes of Included Studies

Attributes	Description
Number of Studies Included	65
Mean Year of Publication	2019
Areas Selected	North America, Asia, Europe, Middle East
Ai Technologies Implemented	ML, Computer Vision, Neural networks
Environments Selected	Classroom (35 studies), Offices (30 studies)
Average Sample Size	132 Participants
Expected Ergonomic Outcomes	Musculoskeletal pain, Postural adjustment, Illumination, Air quality
Average Duration of Interventions	6 to 12 weeks

The collection represented in table 1 gives an overview of AI-driven ergonomics, counting 65 different studies which is important for conducting a meta-analysis in this emerging field. The data from 2019 indicate that the majority of the research was published in the last five to seven years which matches the recent rise in attention and improvements in AI being used today. An important part of the dataset is the use of different AI methods, for example, machine learning

(ML), computer vision and neural networks. Using these technologies, ergonomic evaluation systems have improved a lot. Many times, machine learning is used to group postures or estimate a user's chance of pain judging from how they use the device. Most of the research (65 out of 95) happened in either classrooms or offices which are two important places within the university environment. Classrooms have lots of students, who come and go often and the lighting changes a lot while classes are taking place. Offices usually require people to sit for extended times, maintain the same posture and have individual desks. The median sample size in all the studies is 132 people which makes the research possible without sacrificing chance to detect significant outcomes. Having so many people in the study gives us a good chance of spotting any moderate effect on ergonomics such as musculoskeletal discomfort or productivity, while making things simple logistically. All the anticipated improvements—less musculoskeletal pain, right posture, good lighting and better air quality—agree with traditional ergonomics as well as modern smart-environment standards (Oecd & Organization, 2019). The time period for interventions which is generally 6 to 12 weeks, has methodological importance. This time is perfect for finding noticeable behavior and physiological changes, including less back pain or better attention and it is short enough for effective participation by everyone involved.

Table 2: Table of Results from Meta-Analysis

Outcome Variable	No. of Studies	Pooled Effect Size	95% CI	I ² (%)	p-value
Reduction of Postural Discomfort	42	0.58	(0.45, 0.71)	38	<0.001
Enhancement of Productivity	27	0.47	(0.31, 0.62)	42	0.002
Classroom Participation	22	0.51	(0.36, 0.67)	35	<0.001
Quality of the Environment (Adjusted for AI)	18	0.63	(0.49, 0.78)	30	<0.001

The table 2 presents meta-analytic results that show how effective AI-based ergonomic measures are inside public university universities. It combines data from previous studies on the following key outcomes: less postural discomfort, greater productivity, more class involvement and how AI systems affect the environment. All outcomes focus on unique parts of ergonomic well-being which may be physical, mental or focused on the environment.

The eased posture discomfort in 42 research has a combined effect size of 0.58 and lies within the 95% confidence interval of (0.45, 0.71). The impact is noticeable which means AI tools, including recognition systems for sitting positions, ergonomic chairs and desks that involve AI monitoring, help ease musculoskeletal stress and help improve sitting posture. A moderate heterogeneity (I² value of 38%) means that researchers have varied results, but the conclusions remain the same enough to be applicable broadly. Finding a p-value below 0.001 means that it is very unlikely that the result happened by sheer luck.

Productivity increase is the second variable and the 27 pieces of research combined show a pooled impact value of 0.47 (95% CI: 0.31, 0.62). Although the result is slightly less than postural pain, it is still important for sleep purposes. Getting more done might be achievable by reducing tiredness, cutting out distractions caused by discomfort and making sure the environment is comfortable (e.g., the room is bright and not too cold or hot). Because heterogeneity (I² = 42%) is high, it is clear that productivity results are influenced by factors like the kind of work, how engaged learners

are and the type of institution. At the same time, the small p-value (0.002) indicates the finding is accurate.

The effect of classroom involvement, analyzed in 22 different studies, was 0.51 (95% CI: 0.36, 0.67) which is moderately heterogeneous ($I^2 = 35\%$) and is also statistically significant ($p < 0.001$). So, AI tools such as posture monitors and adaptable environment can assist in increasing how much students pay attention. The research says that when environments are ergonomically correct, students and teachers gain advantages in interaction and attention.

Next, AI's effect on environmental quality was considered most important, according to 18 studies showing a 0.63 score (95% CI: 0.49, 0.78) and low heterogeneity ($I^2 = 30\%$). It means that AI can competently oversee building comfort by controlling lighting, clean air and room temperature automatically. The fact that the results have almost no variation and are highly statistically significant ($p < 0.001$) demonstrates that the advance is seen in every analysis.

Table 3: Summary of Risk of Bias Evaluation

Risk Domain	Low Risk	Moderate Risk	High Risk
Generation of random sequences	42	20	3
Concealment of allocation	35	25	5
Participant blinding	28	30	7
Completeness of outcome data	48	14	3
Discriminatory reporting	52	10	3

The table 3 summarizes the risk of bias assessment, helping to evaluate the quality of the 65 studies used in the meta-analysis about AI-driven ergonomic solutions. Generally, the majority of the studies met good research standards, there were, however, some moderate issues identified.

Out of the 42 random sequence studies, only a few presented risks in assignment methods which implies that most minimized any flaw in the internal validity of their experiments. At the same time, 20 reports were moderately at risk and 3 were identified as highly at risk which means that some did not precisely explain how they randomized participants.

Thirty-five of the studies were assessed as having a low concealment risk, 25 had moderate risk and 5 were regarded as having high risk (Li et al., 2022). It highlights a common difficulty in quasi-experimental or tech-integrated trials, where it is clear to researchers which group patients have been assigned to which can affect the selection process.

The highest percentage of participant blinding considered moderate risk was 30 and the highest for high-risk blinding was 7. It explains why AI tools are helpful in ergonomics, since most participants realize they are involved in some way.

Most of the data (found in 48 studies) was well-reported which means it was reliable. Most of the selected studies (52) were categorized as low risk for biased reporting, indicating that nearly all the outcomes reported represented all the study's objectives. Much of the evidence exists, but scientists must be more open about their methods in future works (Martiadis et al., 2025).

Conclusion

Based on the findings, AI-guided ergonomic assessment and improvement can help to make classrooms and offices in public sector universities more effective and comfortable for everyone. Sixty-five empirical studies were analyzed and it was determined that using AI such as machine

learning and computer vision, brings about measurable improvements in ergonomics. They include a big reduction in discomfort from long periods of sitting, make people more productive, encourage more participation during classes and improve lighting, air quality and temperature.

The fact that AI-enhanced ergonomics works well in many places and organizations suggests it is both flexible and able to expand. When AI, real-time data, sensors and control systems are connected, new ergonomic solutions can be achieved that traditional methods could not reach. Since the effects and results were both significant and strong, we conclude that these technologies have a real influence, not only being creative.

It was also found that more effort is needed in designing studies, especially by using blinding and concealing treatment allocation to control for methodological errors. Public organizations ought to use AI-based technology to encourage better health, learning and working in spaces that include all members of the community. Both research and new policies will play an important role in ensuring AI-powered ergonomic solutions work equally for everyone and last in schools over time.

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