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Table of Contents

NSSA Spring 2025 Graduate Paper Award

Autonomous Vehicles: Development Challenges and Security Threats

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Abstract

The first automobile was built in 1886, and self-driving cars, or autonomous vehicles, have been in development since 1925. In 2024, how close is society to fully autonomous vehicles without the need for human involvement in driving or the dynamic driving task (DDT)? This scholarly research paper examines the Society of Automotive Engineers (SAE) Taxonomy and Definitions for Automated Driving Systems (ADS). It explores the current deployments of ADS in today's society, such as Waymo One, a SAE Level 4 autonomous rider-only, ride-hailing service. The Waymo Driver ADS data has shown a 55% reduction in crashes compared to the human benchmark. Additionally, SAE Level 4 ADS-equipped semi-trucks are being deployed by Aurora Innovations, Kodiak Robotics, and Torq Robotics, with promising data from Aurora Innovations logging over two million commercial miles and Kodiak Robotics achieving a 100% on-time pick-up and delivery rate with no reported accidents after 50,000 autonomous trucking miles. Current ADS hardware and software suites are truly a symphony of autonomy and have implications to be outfitted into various vehicles, such as the Kodiak Robotics and Textron Systems RIPSAW M3, an autonomous tracked and unmanned military ground vehicle. Current innovations in machine learning have allowed the Waymo Driver ADS to learn over twenty billion miles of simulation, combined with over twenty million miles of real-world driving. With future research in artificial intelligence and hardware innovations, autonomous vehicles can seamlessly integrate into today's society.

***Keywords*: autonomous vehicles, self-driving cars, automated driving systems, artificial intelligence, machine learning

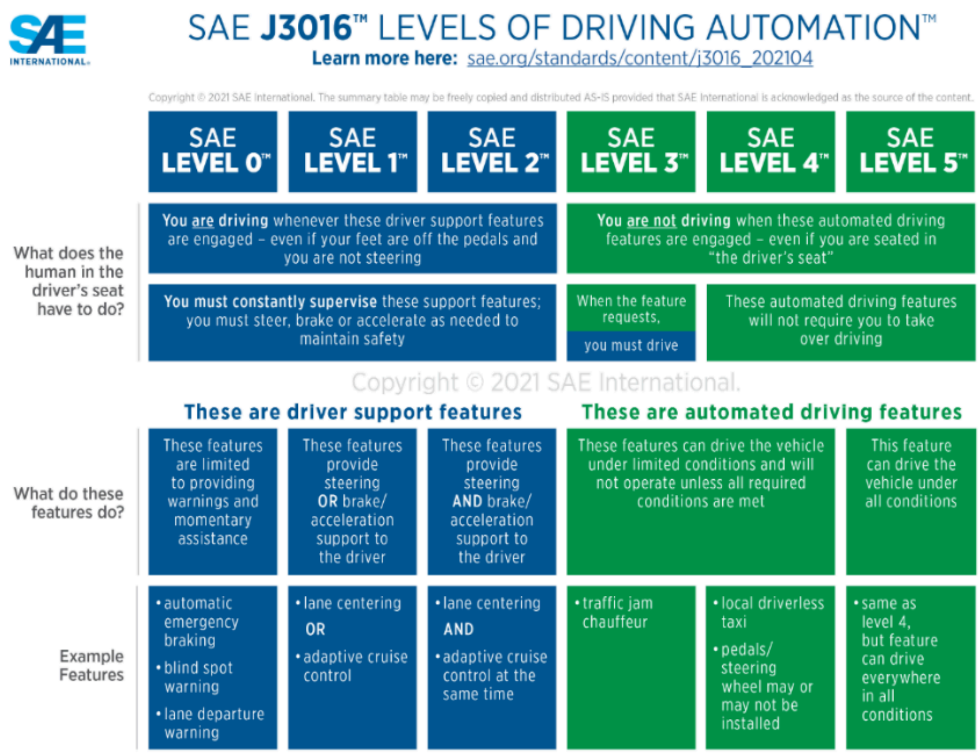
Introduction

For as long as automobiles have been on the road and generations have been enjoying science fiction works, self-driving vehicles have been depicted to the world. These depictions may have just started as someone's wild fantasy, but in today's world, they have turned into something much more. The technology available in the world today has taken this fictional idea of what the world could be and has started making it into a reality. The first automobile was built in 1886 by German engineer Karl Benz. The first step towards a self-driving car was only thirty-nine years later, in 1925. This first "self-driving" vehicle debuted in July of 1925 and was demonstrated by the Houdina Radio Control company. The car "was equipped with a transmitting antenna" in the backseat area and "was operated by a person in another car that followed it" ("Radio Driven Car"). This began the journey over the next twenty years of different experiments with radio control, circuits, wires, and electronic devices being embedded in the surface on which the car traveled, such that it could be guided. In the year 1940, Bel Geddes published Magic Motorways in which he predicted "that humans would be removed from the process of driving one day." In 2024, how close is society to his prediction of a self-driving car without the need for human involvement in the process of driving? Indeed, there are many "bumps in the road" during the development of self-driving cars; however, as technology and interconnectivity advance, what threats do autonomous vehicles face today in the digital age? Additionally, what challenges must be addressed for fully autonomous vehicles to function seamlessly in today's infrastructure and society?

The definition of a self-driving car, or autonomous vehicle, has changed since it first began to emerge in the 1920s. As Bel Geddes predicted, a self-driving car or autonomous vehicle can navigate and operate without human intervention. There is no all-encompassing definition of an autonomous vehicle, but rather a taxonomy that has been developed. In April of 2021, the Society of Automotive Engineers (SAE, 2021), in conjunction with the International Organization for Standardization (ISO), released the SAE (2021) Recommended Practice: Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles. "The document describes vehicle driving automation systems that perform part or all of the dynamic driving task (DDT) on a sustained basis" and further provides definitions that outline six levels of driving automation from no driving automation (Level 0) to full driving automation (Level 5) (SAE, 2021). The SAE (2021) Levels of Driving Automation is currently the industry standard for automated vehicles and driving automation.

Figure 1

The SAE (2021) Levels of Driving Automation



The SAE Levels of Driving Automation

According to the SAE (2021) Recommended Practice: Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles, the levels of autonomy apply to the driving automation features that are engaged in any given instance of on-road operation of the autonomous vehicle; additionally, it refers to three primary actors in driving: “the [human] user, the driving automation system, and other vehicle systems and components.” Essentially, the levels of driving automation are defined by the role played by each of the three primary actors as it pertains to the DDT. The DDT is defined as:

> “all of the real-time operational and tactical functions required to operate a vehicle in on-road traffic, excluding the strategic functions such as trip scheduling and selection of destinations and waypoints, and including, without limitation, the following subtasks: 1. Lateral vehicle motion control via steering (operational); 2. Longitudinal vehicle motion control via acceleration and deceleration (operational); 3. Monitoring the driving environment via object and event detection, recognition, classification, and response preparation (operational and tactical); 4. Object and event response execution (operational and tactical); 5. Maneuver planning (tactical); 6. Enhancing conspicuity via lighting, sounding the horn, signaling, gesturing, etc. (tactical)” (SAE, 2021).

The SAE (2021) Recommended Practice: Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles classifies six levels of driving automation:

Level 0: No Driving Automation

Level 1: Driver Assistance

Level 2: Partial Driving Automation

Level 3: Conditional Driving Automation

Level 4: High Driving Automation

Level 5: Full Driving Automation

At Levels 0, 1, and 2, the driver performs all or part of the DDT, where the driver still performs the dynamic driving task whenever the driver support features are engaged, even if the driver’s feet are on the pedals and they are not steering. At these levels, the driver must constantly supervise the driver support features and must steer, brake, or accelerate as needed to maintain safety.

At Levels 3, 4, and 5, the automated driving system (ADS) performs the entire DDT while the feature is engaged. The driver is not performing the DDT even if the driver is seated in the driver's seat; however, at Level 3, the driver must perform the DDT if the ADS requests it. At Level 4 and 5, the ADS will not require the driver to take over driving (SAE, 2021).

Level 0: No Driving Automation. At this level, the driver is required to perform the entirety of the DDT functions even if enhanced by active safety systems such as automatic emergency breaking, blind spot monitoring, and lane departure warning. At Level 0, these systems are limited to providing warnings and momentary assistance. Sustained lateral and longitudinal vehicle motion control, as well as object and event detection and response (OEDR), are required by the driver. DDT fallback, if an ADS failure occurs or exceeds its operational design domain (ODD), is required by the driver. The role of the ADS, if equipped, does not perform any part of the DDT on a sustained basis; however, active safety systems may provide warnings or momentary emergency intervention (SAE, 2021).

Level 1: Driver Assistance. At this level, the ADS, while active, performs part of the DDT by executing either the longitudinal or the lateral vehicle motion control sub-task, but not both. The ADS will also disengage immediately at the driver’s request. Also, at this level, the driver must perform the remainder of DDT not performed by the ADS; supervise the ADS and intervene when necessary to maintain the operation of the vehicle; determine whether, or when, engagement of the ADS is appropriate; and immediately perform the entirety of the DDT whenever required or desired. Essentially, at this level, one ADS is active, such as lane centering, which provides steering inputs for the DDT, or adaptive cruise control, which provides acceleration or braking for the dynamic driving task, but not both. ODER is still required to be performed by the driver. DDT fallback, if an active safety system ADS failure occurs or exceeds its ODD, is required by the driver (SAE, 2021).

Level 2: Partial Driving Automation. At this level, the ADS, while active, performs part of the DDT by executing both the longitudinal and the lateral vehicle motion control subtasks. The ADS will also disengage immediately at the driver’s request. The driver must, at this level, perform the remainder of the DDT not performed by the ADS; supervise the ADS and intervene when necessary to maintain the operation of the vehicle; determine whether or when the engagement of the ADS is appropriate; and immediately perform the entirety of the DDT whenever required or desired. Essentially, at this level, ADS such as lane centering and adaptive cruise control are both actively performing sustained lateral and longitudinal vehicle motional control subtasks of the DDT. OEDR is still required to be performed by the driver. DDT fallback, if an active safety system ADS failure occurs or exceeds its ODD, is required by the driver (SAE, 2021).

Level 3: Conditional Driving Automation. At this level, the ADS performs the entirety of the DDT while engaged. The ADS will drive the vehicle under limited conditions and will not operate unless all required conditions are met. The ADS will only engage in operation within its ODD. Once engaged, the ADS will perform the entirety of the DDT within its ODD and make determinations if its ODD limits are about to be exceeded. If so, the ADS will issue a timely request to the driver or user for DDT fallback. The ADS will be disengaged at an appropriate time after a request to intervene has been issued to the driver or user. Additionally, the ADS will disengage immediately upon the request of the driver or user. While the ADS is not engaged, the driver or user must verify the operational readiness of the ADS-equipped vehicle and make a determination whether to engage the ADS. The driver or user must then become the DDT fallback-ready user once they engage the ADS. Once the ADS is engaged, the driver or DDT fallback-ready user must be receptive to a request to intervene by the ADS if it determines it is about to exceed its ODD limits or if a failure in the ADS occurs. The driver or user must then perform the DDT when the ADS disengages and decide whether and how to achieve a minimal risk condition where the driver or user brings the vehicle to a stable, stopped condition "to reduce the risk of a crash when a given trip cannot or should not be continued" (SAE, 2021).

Level 4: High Driving Automation. At this level, pedals or a steering wheel may or may not be installed, and the user may be the driver or the dispatcher of the autonomous vehicle. A dispatcher would be required in the case of an autonomous vehicle used for commercial purposes. The ADS performs the entirety of the DDT while engaged. The ADS will drive the vehicle under limited conditions and will not operate unless all required conditions are met. The ADS will only engage operations within its ODD. Once engaged, the ADS will perform the entirety of the DDT within its ODD and make determinations if its ODD limits are about to be exceeded; if so, the ADS may prompt the passenger to resume operation of the vehicle when approaching an ODD limit; however, the passenger is not required to perform the DDT if a fallback is required. The ADS will perform the DDT fallback to bring the vehicle to a minimal risk condition if a failure in the ADS performance-related system occurs, or if the vehicle is about to exceed its ODD. The user or dispatcher may also request that the ADS bring the vehicle to a minimal-risk condition. However, the ADS may delay the user-requested disengagement. As it pertains to the driver or dispatcher of the autonomous vehicle, the user must verify that the ADS-equipped vehicle is operationally ready and make a determination whether to engage the ADS. Once the ADS is engaged, the user then becomes the passenger if physically present in the vehicle. The passenger or dispatcher of the autonomous vehicle does not perform the DDT and is not required to be the DDT fallback user. Additionally, the passenger does not determine whether or how to achieve a minimal risk condition if the ADS encounters a failure or exceeds its ODD limits. Essentially, at this level, the ADS will not require the user to take over driving (SAE, 2021).

Level 5: Full Driving Automation. This level of driving automation is essentially the same as Level 4. However, at this level, the ADS can drive the vehicle under all conditions, and there is no limit to the ODD. The ADS will perform the entirety of the DDT, DDT fallback, and automatically transition to a minimal risk condition if a performance-related system failure occurs or if the user requests that it achieve a minimal risk condition. The ADS will disengage, if appropriate, but only after it achieves a minimal risk condition, or a driver is performing the DDT. As it pertains to the driver or dispatcher of the autonomous vehicle, the user must verify that the ADS-equipped vehicle is operationally ready and make a determination whether to engage the ADS. However, this function may be performed by a person or entity other than the driver or dispatcher, depending on the usage specification or deployment concept. Once the ADS is engaged, the user then becomes the passenger if physically present in the vehicle. The passenger or dispatcher of the autonomous vehicle does not perform the DDT and is not required to be the DDT fallback user. The passenger may request the ADS disengage; however, the system may delay the user-requested disengagement (SAE, 2021).

Autonomous Vehicles: Current Deployments

Currently, an autonomous taxi service is being deployed by Waymo (2025b), formerly the Google self-driving car project. Their Waymo One is considered to be the world’s first autonomous, rider-only, ride-hailing service without a human driver in the vehicle or remotely (Waymo, 2025b). The Waymo Driver, the ADS of the Waymo One, operates at SAE (2021) Level 4: High Driving Automation and does not require the passenger to perform any DDT

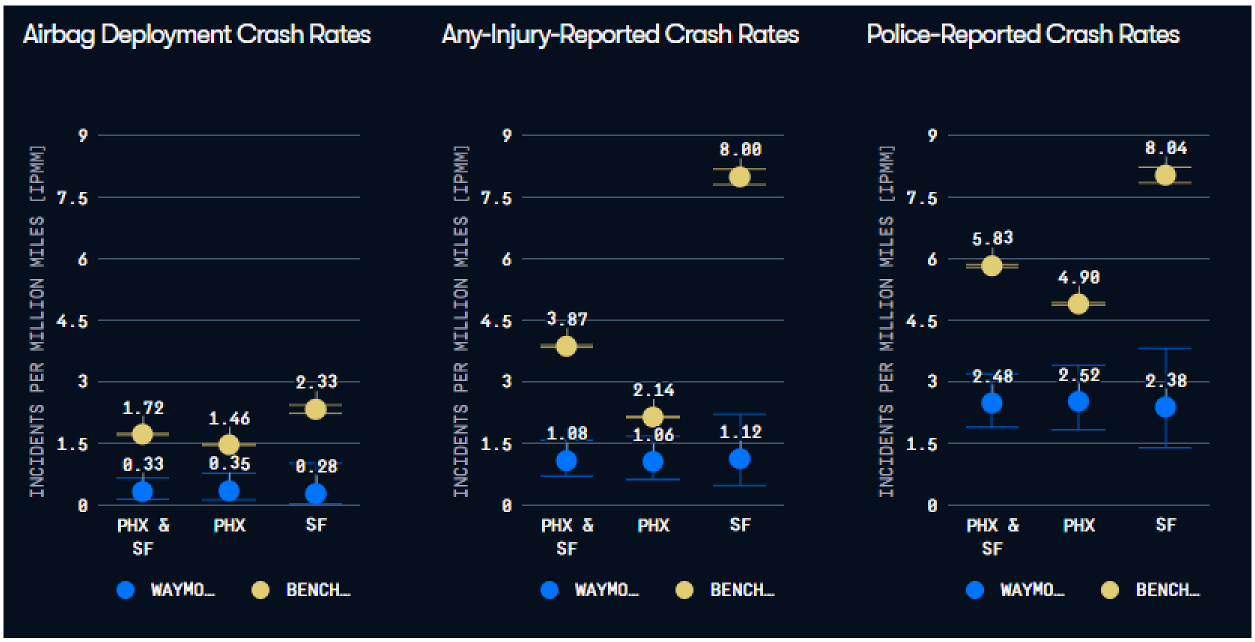
(Ackerman, 2021). Waymo currently deploys around seven hundred Waymo Driver autonomous vehicles in three major metropolitan areas: Phoenix, Arizona; San Francisco, California; and Los Angeles, California, with plans to expand its ODD to Austin, Texas (Kusano et al., 2024).

Autonomous Vehicles: Safety

The NHTSA, National Highway Traffic Safety Administration, a division of the U.S. Department of Transportation, reported that 42,514 people were killed in motor vehicle crashes in 2022. The NHTSA states that "vehicle safety promises to be one of automation's biggest benefits," essentially removing the human aspect from the chain of events that can lead to a crash, where one source estimates that "human error is a cause or the cause of roughly 95% of crashes" (Baase, 2018). Waymo states that "the status quo of road safety is unacceptable" and "autonomous driving technology can save lives and improve mobility for all" (Waymo, 2025b). Waymo cites that, along with the 42,514 deaths in the U.S. in 2022 in motor vehicle crashes, there were an additional 2.5 million injuries, causing $836 billion in harm from loss of life and injury each year. A study evaluated the safety performance of the Waymo Driver utilizing crash data from the NHTSA's Standing General Order (SGO) "requiring identified manufacturers and operators to report to the agency certain crashes involving vehicles equipped with ADS (Waymo, 2025a). The study concluded that "any-injury-reported crashed vehicle rate was 0.41 incidents per million miles (IPMM) for the ADS vs 2.80 IPMM for the human benchmark, an 85% reduction or a human crash rate that is 6.7 times higher than the ADS rate. Police-reported crash vehicle rates for all locations together were 2.1 IPMM for the ADS vs. 4.68 IPMM for the human benchmark, a 55% reduction or a human crash rate that was 2.2 times higher than the ADS rate" (Kusano et al., 2024). The data shows a promising safety trend in the support for fully autonomous vehicles, such as the Level 4 Waymo Driver (Waymo, 2025a; Waymo, 2025b).

Figure 2

Waymo Driver compared to human benchmarks



Autonomous Trucking

While Level 4 autonomous vehicles are seeing personal use in California and Arizona for rail-hailing services, in New Mexico and Texas, Level 4 autonomous Class 8 commercial trucks, or semi-trucks, are being prepared for full Level 4 autonomy in commercial use projected by the end of 2024. Aurora Innovation (CNBC, 2024) and Kodiak Robotics (2025), respectively, have been utilizing Texas as their primary test bed for their fleets of Level 4 ADS fully integrated into Class 8 commercial trucks. Currently, Texas is the largest interstate freight market in the U.S., with almost 15% of all freight in the U.S. moving throughout the Texas triangle, which includes interstates I-10, I-35, and I-45 (CNBC, 2024).

COVID-19 brought on social distancing mandates in 2020, forcing much of the world's workforce into remote, work-from-home roles. This forced many brick-and-mortar retailers to either shut down or increase and improve their online retail presence and shopping experience. Effectively, the demand for online shopping and shipping increased dramatically. A study by The American Trucking Association in 2021 concluded that the nation's truck driver shortage hit a record high of over 80,000 drivers needed. By 2024, that number has tapered off; however, there is still a demand for truck drivers in the U.S. to handle the increase in demand for online shopping that has not tapered off. Can autonomous transportation trucks account for those numbers?

Companies like Aurora Innovations (CNBC, 2024) believe so. With support from state legislators in Texas and its location as a national transportation hub, Aurora Innovations built an autonomous trucking hub in Palmer, Texas, and has been training its Level 4 autonomous trucks on routes between Dallas and Houston and Dallas and El Paso. The trucks operate at Level 4: High Driving Automation. However, a safety driver is present behind the wheel monitoring the truck's activity, as well as a secondary operator in the passenger seat monitoring the ADS (CNBC, 2024). Aurora's autonomous pilot program has shown great success with over seven thousand loads hauled for pilot customers such as FedEx, Werner, Schneider, Ryder, and Uber Freight. CNBC's (2024) Aurora has logged over two million commercial miles, with plans to expand operations into Arizona with an autonomous route from Fort Worth, Texas, to Phoenix, Arizona. The route via I-20 and I-10 is just over one thousand miles and takes just over fifteen hours to complete (Guthrie, 2024). According to regulations set by the Federal Motor Carrier Safety Administration, the maximum length of time a human driver may drive is eleven hours, after ten consecutive hours off duty. Currently, there are no federal laws that regulate the length of time autonomous trucks can continuously operate, as an ADS does not experience or show the signs of driver fatigue as a human would. This makes Aurora's expansion to Phoenix, Arizona, a very promising test route for its Aurora Driver (CNBC, 2024).

Kodiak Robotics (2025) has also been at the forefront of autonomous trucking in Texas with an autonomous trucking hub located in Lancaster, Texas. In January 2024, Kodiak Robotics (2025) teamed with shipping giant J.B. Hunt Transport Services and global tire manufacturer

Bridgestone Americas to transport Bridgestone passenger vehicle tires from Graniteville, South Carolina, to Lancaster, Texas. Kodiak's Level 4 autonomous trucks receive their truckload of tires at the company's autonomous trucking hub in Villa Rica, Georgia, just west of Atlanta, and begin a 750-mile fully autonomous route to Kodiak's autonomous trucking hub in Lancaster, Texas. While the route is fully autonomous, Kodiak, just as Aurora Innovations, employs a driver behind the wheel to monitor the truck's activity, as well as a secondary operator in the passenger seat to monitor the ADS (CNBC, 2024; Kodiak Robotics, 2025). As of August 2024, the collaboration has "surpassed 50,000 autonomous long-haul trucking miles" with "no accidents and achieved 100% on-time pick-up and delivery" (Kodiak Robotics, 2025). Indeed, this data provides continued support for the safety, efficiency, and dependability of ADS in Class 8 commercial trucks.

A smaller company, Torc Robotics, was founded in 2005 by a group of Virginia Tech students who would go on to place third in the DARPA Urban Challenge in 2007 with their autonomous vehicle. Torc Robotics then teamed with military contractors to help develop autonomous military vehicles that could be utilized in potentially dangerous missions such as Improvised Explosive Device (IED) route clearance. In 2019, Torc Robotics teamed with trucking leader Daimler Trucks to develop Level 4 autonomous semi-trucks. Torq Robotics and Daimler Trucks began testing in Virginia later that year. In 2020, Torc expanded into New Mexico, opening an autonomous trucking test center in Albuquerque, New Mexico. In 2022, Torq Robotics opened a facility in Austin, Texas, effectively joining Aurora Innovations and Kodiak Robotics in the pursuit of the normality of Level 4 autonomous Class 8 trucks (CNBC, 2024; Kodiak Robotics, 2025).

Autonomous Vehicles: Hardware and Software

There seems to be a current evolution, or perhaps a revolution, in autonomous vehicles, but what does it take to develop a vehicle with a SAE (2021) Level 4: High Driving Autonomy? Can such an ADS be installed in an ordinary vehicle? This question can be answered by examining the hardware and software suites on one of the most current advanced SAE (2021) Level 4 ADS, the Waymo Driver, to make such a determination.

The fifth generation of Waymo Driver utilizes an incredibly powerful hardware and software suite that is a true symphony of autonomy. The Waymo ADS hardware is comprised of: lidar, cameras, radar, and server-grade computers. Light Detection and Ranging, or Lidar, sends millions of laser pulses in all directions and measures the amount of time it takes to bounce off objects and back to the sensors. This allows the computer to create a three-dimensional representation of the vehicle's surroundings with or without any illumination. The Waymo Driver has four perimeter lidar sensors with a wide field of view to detect objects in proximity to the vehicle. Additionally, the Waymo Driver has an incredibly powerful three-hundred-and-sixty-degree lidar atop the vehicle to provide the ADS with a bird's eye view around the vehicle with a range of over three hundred meters. The vision system of the Waymo Driver is comprised of twenty-nine ultra-high-resolution cameras, of three hundred and sixty-degree cameras with overlapping fields of view; long-range cameras that can detect objects over five hundred meters away; perimeter cameras to provide the Waymo ADS with another view of objects in close proximity to the vehicle; and peripheral cameras that provide views of blind-spots to the ADS. There are six high-resolution imaging radar sensors located around the vehicle that can detect stationary and moving objects, see small objects at great distances, distinguish between closely spaced objects, and complement the Waymo Driver lidar and vision suites with its unique capabilities in adverse weather conditions such as rain, fog, and snow. The Waymo Driver combines the latest server-grade central processing units (CPUs) and graphics processing units (GPUs) to process the vast amount of information provided by the lidar, camera, and radar suites. The Waymo Driver hardware and software suites are currently integrated into base 2021 Jaguar I-PACE electric vehicles prepped by the original equipment manufacturer (OEM) to accept the ADS. Waymo intends to expand its Waymo Driver ADS into other vehicle platforms driven toward different purposes (Waymo, 2025a).

On the software side, the Waymo Driver combines real-time information from the sensor suites with programmed experience of the Waymo Driver program with over twenty million miles of real-world learned driving, as well as over twenty billion miles of simulation, leveraging artificial intelligence, to anticipate the best possible path ahead (Ahn, 2020). A study by Waymo, conducted by Scanlon et al., provided the Waymo Driver ADS with data from seventy-two real-world human-involved fatal crashes involving ninety-one vehicles. After building the ODD specific to each crash, the researchers developed a “novel counterfactual ‘what-if’ simulation” to “synthetically replace” the human driver with the Waymo ADS. “The results of these simulations showed that the Waymo Driver ADS was successful in avoiding all collisions when replacing the crash initiator, that is, the road user who made the initial unexpected maneuver leading to a collision”. Additionally, when the researchers input the Waymo Driver ADS as the driver reacting to the actions of the crash initiator, it resulted in “82% of simulations where a collision was prevented and an additional 10% of simulations where the collision severity” was not fatal. The remaining 8% of simulations, the Waymo Driver ADS had a similar fatal outcome. However, those simulations involved the Waymo Driver “being struck in the rear in a front-to-rear” collision. These results give valuable insight into the capability of machine learning as it pertains to ADS.

With the amount of valuable and sensitive sensors and devices that comprise the Internet of Things (IoT) in an autonomous vehicle, what cybersecurity challenges might arise? Most modern vehicles have a CAN bus (controller area network bus) to “allow multiple microcontrollers” for automobile systems such as the engine, transmission, braking, heating, entertainment, and other systems to communicate without a central host computer. Most vehicles are composed of multiple computers, all operating semi-autonomously and virtually without any security, as demonstrated by hackers at Defcon 21 who were able to disable cars on the go over the Internet (Rosenblatt). In 2015, hackers Miller and Valasek were able to take control of a Jeep Cherokee and disable it utilizing Chrysler’s Uconnect feature, which “controls the vehicle’s entertainment and navigation, enables phone calls, and even offers a Wi-Fi hotspot” (Greenberg). These security threats are certainly of great concern, especially when it comes to autonomous vehicles such as a SAE (2021) Level 4, with no driver behind the wheel to take control.

Luckily, autonomous vehicle companies such as Waymo take cybersecurity seriously. Their Waymo Driver ADS is protected by a robust process to “identify, prioritize, and mitigate cybersecurity threats in alignment with industry and government-defined security best practices”; additionally, the Waymo Driver has a secondary onboard computer that is designed to bring the vehicle to a minimal risk condition should it detect a failure of the primary ADS (Ahn, 2020). Next, independent collision detection and avoidance systems are onboard in the event of a primary ADS failure. Redundant steering with a secondary driver motor system, independent controllers, and separate power supplies are onboard in the event of an ADS failure. Redundant braking systems, as well as redundant internal measurement systems for vehicle positioning are also available and cross-check each other and will assume control if a fault is detected in the other system. Finally, backup power systems with independent power sources are provided for each critical driving system in the Waymo Driver.

Automated Driving Systems: Military Applications

Currently, autonomous ride-hailing services are seeing use on the West Coast and expanding into other large cities; furthermore, autonomous commercial trucks are being deployed across the Southwest with plans for full SAE (2021) Level 4 autonomous routes by the end of 2024. Where will autonomous vehicles and ADS be implemented next? In May of 2024, Kodiak Robotics (2025) teamed with Textron Systems Corporation, a leading developer of manned and unmanned military ground vehicles (Kodiak Robotics, 2025). In conjunction with Textron Systems, Kodiak Robotics (2025) refined its proprietary SensorPods utilized on its autonomous trucking fleet for military use and developed its DefensePods, which are a military-grade modular sensor system that is “the industry’s only hardened solution built to be reliable, serviceable, and maintainable” (Kodiak Robotics, 2025). Kodiak’s (2025) DefensePods are designed to be adaptable to any vehicle in the field, expanding the capability of U.S. military personnel by providing them with an autonomous vehicle solution for the next generation of military operations, “offering enhanced survivability, endurance, and the ability to operate in hazardous environments” (Kodiak Defense, 2025). Additionally, Kodiak’s (2025) DefensePods are designed to be pre-calibrated and pre-built hardware enclosures containing all necessary sensors for autonomous driving; moreover, Kodiak (2025) engineered the DefensePods to be easily swappable by personnel in the field “using standard tools and minimal training” in approximately ten minutes, ensuring the continued operational capability of the autonomous vehicle even in the most challenging of mission environments (Kodiak Robotics, 2025).

The Kodiak Robotics (2025) and Textron Systems collaboration came to fruition with an official press release on September 18th, 2024, unveiling a Textron Systems RIPSAW M3 vehicle, a tracked, unmanned robotic ground vehicle integrated with Kodiak Robotics (2025) Kodiak

Driver ADS and DefensePods. Kodiak's approach to autonomy in military ground operations is dynamic, leveraging "an advanced perception system to identify what is around the vehicle, recognize drivable surfaces, and then navigate the vehicle as a human would" (Kodiak Robotics, 2025). Kodiak also integrates its proprietary Assisted Autonomy technology, allowing a user to control the unmanned autonomous vehicle when necessary, ensuring "safe operations while enabling human intervention for mission-critical tasks" (Kodiak Robotics, 2025).

Automated Driving Systems: Industrial Applications

Kodiak Robotics (2025) has also adapted its proprietary SensorPods and Kodiak Driver ADS to heavy industrial environments such as mineral transport, mining operations, and logging transport, where dirt roads are plentiful and driving conditions are harsh for even the toughest of human truck drivers. Kodiak Robotics provides a true industrial autonomous driving solution with ruggedized SensorPods and a robust communication infrastructure providing constant communication even in remote environments; additionally, the true SAE (2021) Level 4 Kodiak Driver ADS can operate safely "with fully redundant steering, braking, and power" even if connectivity is lost (Kodiak Robotics, 2025). This benefits heavy industrial environments with productivity gains, extending operating hours beyond that of the industry standard for humans, lowering costs by automating manual tasks and increasing operating margins, reducing emissions by boosting efficiency, and reducing potential workplace accidents caused by driver fatigue and distractions.

Automated Driving Systems: Non-terrestrial Applications

While the largest focus for commercial use of autonomous vehicles is currently on land, there are two other focus areas. The first is the use of AUVs, autonomous underwater vehicles, for the exploration and surveillance of Earth's oceans. AUVs have been key to the exploration of the ocean since their development in the 1960s. Specialization for deep-sea mapping was developed in the 1980s to allow AUVs to be programmed to go beyond many of the same limitations that are created by the human body on land, but within the ocean. AUVs come in many shapes and sizes, depending on what their specific task is. Unlike autonomous vehicles on land, AUVs are preprogrammed with a route and then set out to collect the data specific to their specialization. This data can range from deep-sea mapping to geological makeup to water composition (NOAA, 2020). The second and more formidable area of focus is outer space. The Center for Aerospace Autonomy Research, or CAESAR, was founded to tackle unsolved problems with autonomy in space using artificial intelligence. There are three projects that are currently in development that use existing AI programs that have been reorchestrated for each project's specific objectives. The first of these projects is a collaboration between three separate projects. The result is the Spacecraft Pose estimation Network, or SPN. The focus "integrates machine learning with a classical navigation algorithm to robustly estimate a target spacecraft's position and orientation from monocular images" (Sanford, 2024). Autonomous Rendezvous Transformer (ART) is a program that "aims to optimize spacecraft trajectories by allowing AI to provide a 'smart initial guess' that is fine-tuned by traditional mathematical optimization" (Sanford, 2024). Finally, there is ReachBot, a small autonomous robot that is being designed to explore surfaces that humans cannot get to. The idea is that ReachBot will have extendable "arms" from the robot's body that will allow it to grip the sides of a lava tube and a rock overhang, which would be incredibly dangerous for a human being (Sanford, 2024). At this time, the data and technology required for the training of the AI systems that are yet to be developed are not available. Space imposes a plethora of variables, known and unknown, that make these projects much more difficult than on land.

Conclusion

Indeed, the future for autonomous vehicles is bright. Some might argue that the legality, morality, or ethical implications may slow the development of autonomous vehicles. This may be the case in some states, such as California, which has banned autonomous commercial trucks in the state. However, current data shows that the push for autonomous vehicles should be viewed in a positive light, scrutinized, but embraced. Additional research should be focused on machine learning for automated driving systems. With further results in machine learning for ADS and innovations in hardware technology such as lidar, radar, and ultra-high-definition cameras, autonomous vehicles can certainly "learn" how to integrate into today's society, regardless of an aging infrastructure or older non-autonomous vehicles around them. There is truly an autonomous vehicle revolution happening throughout today's society.

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"Teacher Prep Program and Identification ("ID's") Perceptions and Strategies for Teaching and Learning Since Covid-19 Campus Closure"

By

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The global pandemic brought many rapid changes. School districts and higher education institutions scrambled to put their classes online spring of 2020. Initially, they thought this would be for a brief period; however, COVID-19 changed how education is, and will be, delivered in the future (Singh et al., 2021). This qualitative study addressed the reactions of, and ongoing impact on a university's college of education's administrators, faculty, undergraduates, and the institution's instructional designers when the campus closed on March 30, 2020. Their academic, financial, psychological, and social health are explored in the literature. Snowball sampling was used to identify participants, and member checks and data triangulation increased the study's validity. An interview instrument created by the researcher was utilized to gain the participants' perspectives. Educators and administrators alike can learn from the participants' stories regarding best practices for teaching and learning, and online teaching and learning in higher education during and after a crisis. It is the hope of this investigator that hearing the participants' voices will inform online pedagogy, aid administrators and professors in assisting their distance education students, and inform the practicum experience. The study also addresses how administrators and faculty can better meet the needs of their students during and after a crisis by not only investigating their academic needs, but also their financial, psychological and social needs. The findings will add to the body of knowledge in this field.

Keywords: COVID-19, emergency remote teaching, instructional designers, online learning, and teacher education

Introduction

The global pandemic brought many rapid changes. School districts and higher education institutions scrambled to put their classes online spring of 2020. Initially, they thought this would be for a brief period; however, the impact of COVID-19 caused a paradigm shift in education. Online teaching and learning became the world's primary conduit of knowledge. This qualitative study addresses the reactions of, and ongoing impact on, a mid-Atlantic University's College of Education and Professional Development's (COEPD's) administrators, faculty, undergraduates, and the Institution's instructional designers and Counseling Center's director when all courses went online on March 30, 2020, due to the campus closure (Jerome Gilbert, personal communication, March 11, 2020). The stakeholders' perceptions of the academic, financial, psychological, and social challenges they faced, and continue to face; and how they addressed them, were explored through interviews. Their initial online readiness and how online teaching strategies have evolved since the spring of 2020 were also investigated. This researcher hopes that hearing these stakeholders' stories will aid administrators and educators in assisting distance education students, inform online pedagogy and the practicum experience, and further the body of knowledge in this field.

Background

The World Health Organization declared COVID-19 a pandemic on March 30, 2020 (World Health Organization, 2020). The Governor of West Virginia closed schools to prevent the virus's spread (Damron, 2020a). Two days prior, the University's president issued a campus-wide email stating all face-to-face classes would be virtual as of March 30 (J. Gilbert, personal communication, March 11, 2020).

On March 29, 2020, the Johns Hopkins Center for Systems Science and Engineering's COVID-19 Dashboard displayed 1,123,836 deaths in the United States (John Hopkins University & Medicine, 2023). Ted Mitchell, the American Council on Education president, summarized the impact COVID-19 was having on higher education. "It isn't an exaggeration to say that this is the biggest shock to the higher education system in a generation" (Green, 2020, para. 4).

In some cases, students lost their jobs, housing, and access to the internet (Lederer et al., 2020; Willans et al., 2020). There were instances of food insecurity and estrangement from peers (Soria & Horgos, 2020; Willans, et al., 2020). These stressors added anxiety (American College Health Association, 2020; Willians, et al., 2020). Lower-income students were more likely to experience these challenges (Browning et al., 2021; Mucci-Ferris, et al., 2021). Students and faculty alike struggled with online readiness and finding a quiet place to work from home when all of their courses went remote (Johnson et al., 2020; Talib et al., 2021). Nearly half of the faculty lowered the expected volume of work for students (Johnson et al., 2020).

Challenges and benefits of online learning, along with best practices for online teaching and learning strategies utilized by faculty and undergraduates during campus closures emerged from the literature (Eisenbach et al., 2020; Erlam et al., 2021; Singh et al., 2021). An urban and rural preservice teacher's practicum lessons were described (Kim, 2020; Stringer Keefe, 2020), along with three predominant instructional strategies used during the transition: synchronous virtual instruction (all students online simultaneously), fully online instruction, and a hybrid model that included online and virtual (Murphy et al., 2020). A popular strategy utilized by several teachers during the lockdowns, flipped classroom, was provided as an example of the hybrid/blended model (Erlam et al., 2021; Singh et al., 2021; van Alten et al., 2019).

Pilot Study

To increase the research instrument's content validity and inform its questions this researcher conducted a pilot study (Creswell, 2014) by interviewing a local pastor and an urban, high school teacher. Their reactions to technology usage before and after going online due to COVID-19-related closures were compared with a case study of a rural, Alaskan high school teacher's reactions (Kaden, 2020). The investigator surmised the interviewees would not like being "forced" to go online. However, the findings were surprising. Both of them enjoyed the benefits that being online afforded them. The pastor's attendance increased after using Zoom, and the teachers' introverted students enjoyed the anonymity of being online. However, the extroverted students missed the social interactions with their peers.

In follow-up telephone interviews two years later, the urban high school teacher reflected on transitioning all her classes online spring 2020. She recalled, "It was really tough for us [teachers] converting from hands-on to digital. We had to keep going every night to create a lesson. Everything was like being a first-year teacher."

She said she now feels more adept at using technology online, and revealed that she has seen an increase in hospitalizations of students with mental health issues such as anxiety. She emphasized, "This never happened before. I think it is because their world collapsed having to be inside [due to the COVID-19-related lockdowns]."

Prior to the COVID-19 induced lockdowns, the pastor avoided technology. During and after COVID-19, he began using Zoom and now continues to use it for Bible studies and prayer meetings. He uploads his sermons to YouTube, which has increased his attendance.

This study aimed to gain a more in-depth understanding of the initial and ongoing impact of COVID-19 on a teacher education program. The focus of the study was to investigate the perceptions of a mid-Atlantic University's College of Education's stakeholders about the Institution's closure due to COVID-19 and its ongoing effects. More specifically, the study's purpose was to explore the initial and ongoing challenges to continue teaching and learning, and the initial and ongoing strategies used to overcome them during, and after, an abrupt transition do to the campus' closure.

Research Questions

This qualitative study addressed the following research questions:

1. What challenges have college of education administrators, faculty, and students faced while continuing teaching and learning since the start of COVID-19?
2. What strategies did college of education administrators, faculty, and students use to continue teaching and learning at the start of COVID-19?
3. What ongoing strategies, if any, did college of education administrators, faculty, and students implement as a result of COVID-19 that they continue to use?

Delimitations of the Study

A delimitation of the study was its possible small sample size. Snowball sampling, where participants refer other participants, was applied to gather the names of those who might participate. All of the stakeholders were from the same institution, and all of the student participants were recommended by one faculty member. They were sophomores in her class at the time of the campus closure. This made for a limited perspective.

Literature Review

COVID-19 brought more than sickness. To curb its spread, governors mandated mask-wearing, social distancing six feet apart, and hand-sanitizer usage (Damron, March 13, 2020a). Only essential businesses remained open (Damron, 2020b). Social events were canceled, loved ones were not allowed to see each other even if hospitalized or in nursing homes, and "stay at home orders" caused most of the population to be homebound (Damron, 2020b, p. 1).

Higher Education Experience

For the more than 17 million (NSCRC, 2020) postsecondary students who were enrolled spring of 2020, their college experience was not what they had envisioned. Colleges and universities across the United States closed dormitories and dining halls, cut class sizes, or closed altogether. Eighty-four percent of undergraduates had some or all of their classes moved to online-only instruction (NCES, 2021). Some students did not have access to the library and its free Wi-Fi or computers. Large gatherings such as sporting events and graduations were canceled for the class of 2020 (Lederer et al., 2020).

Lederer's et al. (2020) explored several issues that impacted college students during COVID-19. The authors stated, "College students now face increasing housing and food insecurity, financial hardships, a lack of social connectedness and sense of belonging, uncertainty about the future, and access issues that impede their academic performance and well-being" (p. i).

Whillans et al.'s (2020) *Harvard Business Review's* survey discovered that 15% of college students worried about food security or housing in 2020. Soria and Horgo's (2020) indicated low-income students were more likely to experience food insecurity (58%) and housing insecurity (34%).

Mental Health

With all the disruption in the "normal" undergraduate experience due to COVID-19, this researcher wanted to investigate the reactions of undergraduates in a college of education during the 2019-2020 academic year and their faculty. As of March 13, 2020, students were not allowed on campus for the remainder of the semester (Damron, 2020a). Where did the students go, and how did they feel about this? How was their mental health? Did they feel isolated or lonely?

Several studies reported the adverse psychological affect COVID-19 had on 18-24 year olds. Browning et al.'s (2021) survey reported 59% of primarily undergraduates experienced high levels of psychological impact due to COVID-19. Czeisler et al., (2020) reported 41% of their participants claimed at least one negative mental health issue at the end of June 2020. Around 25% said they had seriously considered suicide in the past 30 days. Amad et al. (2020) determined students had increased drug overdoses, and the American College Health's (2020) survey revealed students felt lonely.

Freuhwirth et al. (2021) found that the isolation induced by COVID-19 increased anxiety and depression. Previous research indicated that college students with lower-quality social support were more likely to experience mental health problems (Hefner & Eisenberg, 2010).

Economic Impact

Economic hardship may have been a factor in the increase in undergraduate anxiety. *Harvard Business Review* (Willans et al., 2020) announced that 60% of college students experienced a loss of income due to the pandemic, which added to higher stress levels. National Center for Educational Statistics (NCES, 2021) reported 29%. Soria et al. (2020) found 35% of undergraduates screened positive for major depressive disorder, and 39% screened positive for generalized anxiety disorder. The researchers discovered that low-income students were more likely to have experienced lost wages or the cancellation of expected jobs or internships, and significantly higher rates of anxiety (53%) or depressive (50%) disorders than their peers.

Faculty Well-Being

Students were not the only ones feeling stressed by the pandemic. Several studies indicated that COVID-19 affected faculty well-being adversely. In a survey conducted by Fidelity Investments for *The Chronicle of Higher Education* (2020), stress levels of faculty more than doubled in 2020 (69%) as compared to 2019 (32%), and Deznabi et al.'s (2020) findings concurred.

In October 2020, more than two-thirds of the faculty surveyed by *The Chronicle* reported that they had struggled with increased workloads and deterioration of work-life balance—particularly female faculty members (Tugend, 2021). Bergerson and Davis (2022) echoed her results.

Erlam et al. (2021) reported that faculty found it hard to find a quiet place to work from home (Singh et al., 2021; Talib et al., 2021). Ninety-five percent of the academic staff said too much screen-time was their top initial challenge (Erlam et al., 2021).

Internet Access

In March 2020, the sudden school closures forced educators to put their classes online (NCES, 2021). Now, most educators and students needed access to the World Wide Web. However, 5.4% of 3 to 18 year-old students, and 7% of adults in the Nation, did not have internet access in 2020 (Irwin et al., 2022; Pew Research, 2021). Irwin et al.'s (2021) survey indicated that 11% of families with household incomes of $25,000 or less did not have internet access, and 14% accessed the internet only through a Smartphone.

Higher than the national averages, an astounding 35.9% of West Virginia residents did not have internet access, and only 83% could access high-speed internet up to 10 megabits per second (Mbps) (Broadbandsearch.net, 2021). This ranked West Virginia with the second slowest download speed in the nation, just behind Montana (Broadbandsearch.net, 2021).

Given the sudden and brief period in March 2020, in which to transition all courses to online, faculty and instructional designers used a crisis form of pedagogy termed in the gray literature as emergency remote teaching (ERT) (Hodges et al., 2020). Hodges and his coauthors asserted that this eclectic kind of teaching is intended for short-term use as compared to traditional online learning.

Challenges of Online Teaching and Learning

Erlam et al.'s (2021) survey included several challenges and benefits due to the rapid transition to all-online courses. Some of the significant challenges were:

1. Concerns about student access to technology
2. Finding a quiet space to work
3. Lack of digital competence skills
4. Too much screen-time
5. Work/life balance

The South Eastern Research University's (SERU) survey results indicated that 76% of the undergraduates said they lacked motivation for online learning (Soria et al., 2020; Soria & Horgos, 2020). More than half of the students reported a lack of interaction with other students, the inability to learn effectively, and a lack of access to an appropriate study space. College students in Mucci-Ferris et al.'s (2021) study iterated the same challenges.

Strategies of Online Teaching and Learning

Online teaching and learning strategies emerged from the literature. Correia (2020) suggested faculty should learn from the practices of exemplary online teachers and reach out to instructional designers. Correia shared faculty could utilize the University of Central Florida's repository of examples of best practices of online teaching (https://topr.online.ucf.edu/) and the Instructional Design Emergency Response Network (https://www.idernetwork.com/) for free online assistance.

Some of the strategies were directly related to the advantages inherent in online learning. Erlam et al. (2021) listed four benefits of all-online classes:

1. Enhanced flexibility
2. Enhanced teacher creativity
3. Increased autonomy of learners
4. Reduced commute time

Singh et al.'s (2021) findings agreed that flexibility was the primary benefit of online learning in higher education. She added that online learning decreased stress when unexpected events required time off. Talib et al. (2021) noted that stress was also reduced when using online discussions because students avoided the uncomfortable feeling of speaking in front of a live audience. Another benefit was efficiency in completing work due to online learning being individually paced (Erlam et al., 2021; Singh, et al., 2021; Talib, et al., 2021). Dorsah (2021) added that online learning allowed collaboration with teachers and international students from different schools.

The United States Department of Education (n.d.) enumerated some benefits of online learning. According to The Department, "Online learning opportunities and the use of open educational resources and other technologies can increase educational productivity by accelerating the rate of learning; reducing costs associated with instructional material or program delivery, and better utilizing teacher time" (para. 2).

A college student in Mucci-Ferris, et al.'s qualitative study (2021) expressed a positive of online classes. She said that her lectures were more engaging: "We had–instead of just having a normal lecture–we've done trivia for some of them, we've done small groups for some of them, which I've never had" (p. 209).

Eisenbach et al. (2020) elaborated that some of their preservice candidates used innovative strategies to continue teaching and learning. They maintained presence with their students by holding virtual office hours and synchronous class meetings, and some English language arts preservice teachers created virtual BINGO card activities to serve as content enrichment. Eisenbach et al. (2020) elaborated:

> [The candidates] transitioned collaborative writing and peer consultation from physical group discussion to online collaborative documents and integrated comments. Candidates teaching within the math classroom used ingenuity to transform their cellphones, books, and desk lamp into a make-shift document camera. Without a whiteboard, they created effective means of sharing their mathematical process and computations with students through a recorded YouTube video series. (pp. 1-2)

Incorporating trivia and using small groups were just a few online teaching strategies utilized during emergency remote instruction. Singh and Thurman (2019) defined online learning as "learning experiences in synchronous or asynchronous environments using different devices (e.g., mobile phones, laptops, etc.) with internet access" (p. 289). Three types of online strategies used during COVID-19 to continue teaching and learning were: Synchronous virtual instruction (all students online simultaneously virtually), asynchronous (fully online instruction), and a hybrid model that included both (Lederer, 2020; Murphy, 2020).

Many faculty used the hybrid or blended model of instruction (Erlam et al., 2021; Singh et al., 2021; van Alten et al., 2019; Wheeler & Hill, 2021). The face-to-face synchronous online component can be facilitated in person or through video-conferencing software. Wheeler and Hill (2021) listed some of the benefits of the blended model as: better preparation of students for "expectations in their profession, offers engagement, and greater flexibility" (p. 5).

As an example of the blended model, several studies encouraged the use of the Flipped Classroom model of instruction as an online teaching strategy (Erlam et al., 2021; Singh et al., 2021; van Alten et al., 2019). In this instructional method, faculty embrace the role of facilitator. van Alten et al. (2019) and his colleagues described the flipped teaching model. They stated, "Students study instructional material before class (e.g., by watching online lectures) and apply the learning material during class" (p. i). van Alten et al.'s (2019) meta-analysis discovered that the model achieved higher learning outcomes when the face-to-face class time was not reduced or when quizzes were added.

The Clinical Experience

The Education Commission of the States (2021) defines the student teaching or clinical experience for teachers as "an extended practice teaching that prospective teachers complete prior to certification" (p. 2). Clinical experience, student teaching, or internship is often the culminating activity in an undergraduate preparation program. Students are matched with a mentor or cooperating teacher in the schools who serves as a role model and support for perspective teachers.

Alternative Practicum Strategies

Higher education students were not the only ones affected by COVID-19. Over 290 million, preschool through high school students, and nearly 50.8 million U.S. students had to stay home spring of 2020 (Irwin, 2021; UNESCO, 2020b). Teacher education programs across the country had to suddenly adapt their school placement or clinical practice requirements for licensure (Choate et al., 2021; Quezada et al., 2020).

In a member survey of the American Association of Colleges for Teacher Education (AACTE, 2020), 98% of these institutions transitioned to an online format, and 80% of the state of Washington's teacher education programs surveyed by Choate et al. (2021) waived or reduced the length of time required for student teaching.

Student teachers or preservice teachers had a two-fold challenge due to COVID-19. This unique population had to adapt abruptly to learning and teaching online (Thomas et al., 2021). As an alternative to student teaching face-to-face in a brick-and-mortar school, one rural graduate teacher education program in North Carolina developed a strategy that included virtual coaching (Stringer Keefe, 2020). It employed the same elements of traditional preservice training: observation, practice, reflection/feedback, and goal setting, but in an online environment.

Another strategy developed by an urban, early education program instructor in Long Island suggested student teachers should observe videos of early childhood classrooms and present lessons to their colleagues online (Kim, 2020). She quickly adapted her practicum course to require her student teachers to teach children online instead of in-person.

In strategizing on how to deliver her content, this student teachers' supervisor utilized both synchronous and asynchronous teaching methods (Kim, 2020). She did not change her content, but added information regarding online teaching and distance education. For the asynchronous portion of her class, she used discussion boards for the students to post their weekly reflections and respond to their classmates. During her scheduled, synchronous courses, she delivered content while she and her students interacted online.

Diverging from the traditional student-teacher practicum with in-person students, the educator recruited children for her students to teach online using a social networking service (Kim, 2020). She was able to obtain enough volunteers from different states within two weeks. She used video conferencing software instead of in-person observation. The student teacher was able to share visuals via a web camera, or by using online presentation software. After class, the other student teachers unmuted and shared their reflections and suggestions, and the one teaching shared how to improve the lesson. A video-recording of the lesson was emailed to the student teacher to write a self-reflection after reviewing.

Kim (2020) noted a difference between traditional preservice teacher training and online training:

> Online teaching allowed student teachers to learn through their direct teaching experience and observing others' teaching. When a student only teaches children in a classroom setting, only the supervisor can observe the lesson and debrief with an individual candidate. (p. 154)

Kim (2020) elaborated on the benefits of online teaching. She said it was convenient and could increase enrollment because it was not limited by the learner's location. Adult learners could participate even when they have full-time or part-time employment. Kim expressed that online teaching can be cost-effective because it reduced travel and school maintenance costs. It also fostered timely feedback to her students and communication with parents, and allowed her to arrange virtual meetings if students needed further assistance.

On the other hand, Kim (2020) expressed a challenge with online teaching. She stated, "A limitation of online teaching often comes from teachers' limited experience or skills of using ICT [Information and Communication Technologies]" (p. 154). She recommended that teacher preparation programs focus more extensively on developing skills for teaching with technology.

Ferdig et al.'s (2020) eBook devoted a section to articles about alternative field experiences in preservice teacher education. Monroe et al. (2020) relayed how the University of

Central Florida used innovative technology in meeting the student teaching requirements. Their teacher candidates taught five student avatars (computer simulated students) via Skype for their practicum experience. Two of the avatars were native English speaking, and the other three were at various levels of English proficiency. Student teachers had to differentiate their lesson to accommodate all of these levels. The preservice teachers received positive and constructive feedback from two, seasoned observers. Although the student teachers were interacting with avatars, results indicated, they displayed "competent and capable 'teacher personas' in the areas of classroom management" (p. 304).

Hendrith et al. (2020) discussed Murray State's use of digital portfolios as a replacement for practicums as the culminating assessment for student teachers. Preservice teachers created a website using Google Sites that included lesson plans, video lessons, and an interdisciplinary unit plan to showcase strategies that their cooperating teacher could use to assist with the non-traditional instruction of their elementary classroom students. Hendrith et al.'s survey revealed that "64% of the student teachers perceived the e-portfolio to be an acceptable way of showing pedagogical abilities" (p. 312).

Lee and Freas (2020) studied how East Carolina University filled the void of field placements. Their preservice teachers utilized teaching simulations with five avatars for small group mathematics discussions. Under traditional conditions of in-person student teaching, selecting which students would share in the discussions, and in what order, are usually impromptu decisions. The simulations afforded the teachers more time in planning their discussions. One student teacher reflected, "When we did not get to be in the classroom, this experience [the use of student avatars] has provided guidance to help build discussion, questioning, and confidence" (p. 335).

Methods

This qualitative study was informed by the phenomenological research approach. In this type of inquiry, the investigator attempts to gain a more in-depth understanding from a specific group of people's perceptions during a particular experience (Patton, 2015). For this study, the researcher derived this meaning from the constituents' own voices regarding their reactions to a campus closure due to COVID-19.

The researcher used Microsoft Teams video conferencing software to conduct 17 virtual interviews during the fall semester of 2023 with a mid-Atlantic teacher preparation program's stakeholders, and two instructional designers. The transcripts were analyzed and categorized based on four challenges and strategies used for continuing teaching and learning during COVID-19 found in the literature: Academic, financial, psychological, and social (Lederer et al., 2020). An amended protocol found in Appendix B was used for the Institution's director of the Counseling Center to determine if students utilizing its services increased in 2020, and it did (Layne, 2024).

Research Questions

Again, this qualitative study addressed the following research questions:

1. What challenges have college of education administrators, faculty, and students faced while continuing teaching and learning since the start of COVID-19?
2. What strategies did colleges of education administrators, faculty, and students use to continue teaching and learning at the start of COVID-19?
3. What ongoing challenges and strategies, if any, did college of education administrators, faculty, and students observe and implement as a result of COVID-19 that they continue to use?

Major Findings and Discussion

This section summarizes the major findings of the study. Construct validity was enhanced by triangulation of the data. The data supported the literature review with the exception of some emergent themes. Results were organized into categories using the four themes discovered in the literature and used in the main protocol: academic, financial, psychological, and social.

Research Question 1: Initial Challenges

The transcript analysis revealed the initial academic challenges included: working from home issues such as: connectivity problems, distractions of family members and pets, cancellation of practicums, and lack of online readiness.

The main initial financial challenge was loss of employment. Two of the student participants were furloughed from their jobs due to the shutdown.

Important initial psychological challenges included: the stress of teaching and learning during a pandemic shutdown with a disability such as ADHD, feelings of isolation, caregiving for older parents/in-laws or for children with a disability. The surprising finding was that so many of the participants were dealing with ADHD.

The initial social challenges were dormitory closure and the loss of social life. Most of the participants mentioned they missed seeing their colleagues, peers, or students in-person.

Research Question 2: Initial Strategies

Transcript analysis revealed the initial academic strategies included: creating alternative assignments, deletion or reduction of assignments, creating a virtual option for absent students, homeschooling, and relaxing requirements.

Due to school closures, administrators created alternative assignments as a substitute for going out into the schools for clinicals or student teaching. Faculty videotaped themselves, used instructional videos, and posted class notes to the University's online Learning Management System (LMS). Several of the faculty reduced or deleted assignments.

The WVDE allowed student teachers to be hired. The University offered a credit/no credit option for courses (Marshall University, 2020), which did not affect students' GPAs, and the administrators in the student teacher placement office canceled clinicals and practicums.

The initial financial strategies were: CARES Act funding and refunds from the University. All of the student participants received CARES Act funding and/or refunds from the University to help offset any financial duress caused by the closure.

The Dean, an anonymous faculty member, and a student reported an initial psychological strategy was faculty checking on students' well-being. Two initial social strategies were creative interactions and using social media to stay connected with friends and family. An administrator attended a virtual book club and started a walking group.

Research Question 3: Ongoing Challenges and Strategies

The transcript analysis revealed the ongoing academic challenges are: administrators and faculty feel "on call", students expect leniency on due dates, and students want virtual classes/office hours.

Students were contacting an administrator after business hours because she said this was the protocol she had fostered during the initial campus closure due to COVID-19. Students were also expecting extensions of due dates now like they had received during the initial campus closure.

The transcript analysis indicated the important ongoing academic strategies are: increased usage of technology and continued virtual option for absent faculty/students. All of the participants were forced to learn how to teach or learn online. Several of the participants continue to use technology. The technology that most of the participants utilized and continue to employ is Microsoft Teams, and some faculty are still providing the virtual class option to students if they are absent.

Discussion

The study's college president announced on March 11, 2020, that all class instruction would be delivered "non-face-to-face" by March 30, 2020, in an effort to "protect our university community, and to mitigate the spread of Covid-19 in our community at large," (J. Gilbert, personal communication). This meant faculty had a brief period of time to transition their face-to-face classes to an online format. The abruptness of the change, compounded by the uncertainty of the virus, induced stress on all of the stakeholders in this study.

The stakeholders had to navigate the challenges of working from home, which included lack of internet access and devices, and caregiving for older parents. Because the governor had closed public schools, faculty had to create alternative assignments for the practicum experience. Faculty found themselves having to learn how to teach virtually. This involved creating video lectures, putting assignments in the University's LMS, and having students create videos of themselves teaching. This new format proved valuable when students or faculty could not attend class in-person due to sickness, inclement weather, or other reasons.

The vestiges of that time are still seen in students wanting virtual classes and leniency on due dates. All the stakeholders have increased their use of technology especially using Teams or Zoom. The experience has increased their self-efficacy in using technology.

Implications of the Study

COVID-19 closed colleges and schools and forced the participants to learn a new way of teaching and learning. This study's College of Education struggled to provide the practicum experience required for teacher preparation because public schools closed due to the pandemic. Administrators and faculty had to use technological solutions in creating alterative assignments to substitute for the knowledge gained by student teaching in the schools. The pandemic demonstrated that colleges of education not only need to prepare their teacher candidates to teach in-person, but also to teach virtually so that learning can continue when in-person is not an option.

Institutions of higher education should consider the wholistic needs of their students as they prepare contingency plans for in-person interruptions of learning. They ought to consider not only students' academic needs, but also their financial, psychological, and social needs as well.

Faculty and students alike need better preparation on how to teach online (Kim, 2020). As the University's Senior Instructional Designer Adams advised, "In online teaching, faculty not only have to know their content, but they must familiarize themselves with the technology tools available to convey this knowledge to students in a dynamic way," (personal communication, November 2, 2023). Faculty should reach out to their institution's instructional designers to learn from the experts (Correia, 2020). If these recommendations are implemented, colleges and universities may see their enrollment, retention, and graduation rates increase, and students' academic performance may improve.

Recommendations for Further Research

Since all of the participants were from one institution, it would broaden the results if participants were interviewed from teacher preparation programs within and in different states to discover if there are similar or different themes in perception. It would also be interesting to interview international students and student athletes in the College of Education to garner their unique perspectives on the campus closure.

Snowball sampling limited the participants to sophomores from one faculty member's class. Interviews with participants at different stages of their teacher preparation would provide a more comprehensive analysis of this phenomenon of a teacher preparation programs stakeholders' reactions to a campus closure due to a world-wide pandemic, and the strategies they used to continue teaching and learning.

Conclusion

COVID-19 changed education and exposed the need for alternative means of continuing teaching and learning when face-to-face instruction is not possible. Four take aways from this study are: Teacher preparation programs should focus more on developing skills for teaching with technology (Kim, 2020), they should have faculty and students practice online teaching and learning to better prepare them for non-face-to-face instruction (D. Adams, personal communication, November 2, 2203), and faculty should learn from the practices of exemplary online teachers and reach out to instructional designers to aid their online course development (Correia, 2020). Finally, institutions of higher learning should not only consider students' academic needs, but also their financial, psychological, and social needs when preparing contingency plans for interruptions in learning.

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Appendix A: Interview Questions

Schools were shuddered, masks were required, and social distancing was the norm spring semester 2020. COVID-19 cases were climbing, and most of the world's schools were transitioning to an all online format. You are answering questions about your initial and ongoing reactions to Marshall University's campus closure due to COVID-19, March 13th, 2020.

Challenges RQ1 and Strategies RQ2

1. Reflecting back, what was it like for you working from home?
2. What were some of the initial challenges you faced and how did you address them when you heard Marshall's campus was closing?
   [Thank them for sharing their challenges and solutions.]

3. A. Literature discussed specific types of challenges including __ challenges. Did you know about these? Could you share some examples and how you dealt with them?
   B. Related to __ challenges, some examples in the literature included __. Did you know about these? Could you share some examples and how you dealt with them?

Problem	Solution
a. Academic	
● Access to internet, devices, or bandwidth	Provided laptops, hot spots
● Reduction or deletion of assignments	More online and virtual classes
● Lack of online readiness	Profs. helped each other; IDs
● Alternative field experiences	Videos, virtual coaching, avatars
b. **Financial**	
● Reduction of income and job/internship loss	Government checks
● Food and housing insecurity	Pres. kept dining/residence open
c. Psychological	
● Increased stress and substance abuse	Self-efficacy and task force
● Finding a quiet place to work from home	Creativity
● Work/life balance	Virtual meetings
d. Social	
● Feelings of isolation	Texting and calling friends

- Feelings of loneliness Professors checked on students

4. What are some of the ongoing challenges you continue to face as a result of the pandemic, and how are you addressing them?

Ongoing Strategies RQ3

5. It might be challenging to think in terms of benefits, but have there been any lasting changes or adaptations that you would consider beneficial?

A. Related to __ benefits, some examples in the literature included __. Did you know about these? Could you share some examples?

- Initial increase in the interest in the well-being of others
- Flexibility
- Increased self-efficacy in online teaching and learning, videotaping lectures, and creating an online meeting
- Working remotely more
- Traveling less due to meeting virtually more

Wrap Up Questions

6. Is there anything you would like to add?
7. I would like to talk with faculty, students, and graduates who might have had varied experiences. Could you recommend anyone for this study?
   - Faculty online readiness
   - Student housing
   - Clinical placements

Appendix B: Amended Protocol Questions

1. Was there an increase in the number of undergraduate students contacting the Center during spring of 2020?
2. Was there an increase in faculty and administrators referring students spring of 2020, fall of 2020, and spring of 2021?
3. Were there any types of mental health issues that were occurring or increased specifically because of the campus closure due to COVID-19?
4. Have you seen an increase in mental health issues in undergraduates since fall of 2019, and specifically an increase in stress, anxiety, depression, feelings of isolation, or substance abuse?
5. Is there any other information you would like to add that you feel is relevant to the study?

Graduate Student Perceptions of Generative AI: Ethical Implications and Policy Perspectives in Online Higher Education

By

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Abstract

This study aims to better understand graduate student perceptions of Generative AI (GenAI) in online higher education courses. Because graduate-level online programs rely heavily on asynchronous, writing-intensive work (e.g., discussion forums, module papers, term projects), students routinely demonstrate mastery through written products where GenAI tools may be used. Understanding how students view GenAI use and policy (e.g., ChatGPT) can inform curriculum design and clearer course and departmental guidelines. To this end, this study explored student perceptions of the ethical implications of GenAI at the graduate level among students enrolled in fully online doctoral programs in education. Survey data (n = 30) and semi-structured interviews were used to measure attitudes toward Generative AI, ethical risks, academic integrity, and institutional policy perspectives. Findings indicate that while students hold positive attitudes toward GenAI, they also recognize ethical concerns related to plagiarism, critical thinking, and unclear academic policies. Students reported a spectrum of usage ranging from cautious application to more liberal integration of AI in their written assignments. The findings yield several implications for policy and practice."

Keywords: Generative AI, academic integrity, ethical use of AI, higher education, academic writing, graduate students, institutional policy, student attitudes, online learning, AI policy in education**.**

Introduction

This study investigates how graduate students perceive the use and ethical implications of Generative AI (GenAI) in online higher education courses. GenAI has become increasingly prevalent across educational landscapes due to its ability to produce high-quality, authentic content that supports a range of learning and teaching practices (Kasneci et al., 2023). GenAI refers to a class of artificial models capable of creating new content, including text, images, code, or audio, and this is accomplished by learning patterns from large datasets. Platforms like

ChatGPT simulate human-like creativity and have become widely accessible in academic contexts, creating both opportunities and challenges (Dwivedi et al., 2023). Large language models (e.g., ChatGPT) utilize advanced language processing techniques to generate human-like responses through chatbot interfaces, making them widely accessible to students.

A growing concern in higher education is how to ethically integrate GenAI into academic writing tasks while upholding standards of academic integrity at a rigorous level. Misuse of AI-assisted work may undermine student learning and assessment validity, particularly when overreliance on AI reduces opportunities for developing critical thinking and independent writing skills. Despite the increasing use of GenAI, there are no universal guidelines for when and how it should be used in coursework, which leaves students vulnerable to unclear expectations and inconsistent instructor policies (Wang et al., 2024). Universities now face the challenge of integrating AI into academic settings while maintaining academic integrity. A key concern is the misrepresentation of AI-assisted work as original student output, which risks undermining learning outcomes and assessment validity. Additionally, overreliance on AI for content creation may limit students' ability to develop critical thinking and analytical skills (Escalante et al., 2023).

Although some critics question the quality and reliability of AI-generated content, ongoing advancements will likely enhance fluency, coherence, and realism, making detection tools increasingly ineffective. Research suggests that current AI detection software is inconsistent (Wang et al., 2024), a concern that will only grow as AI evolves. GenAI's potential for overuse or misuse may weaken trust between students and instructors, which contributes to increased skepticism about academic integrity.

Educators need to understand students' perceptions of AI technologies and the policies that govern them, especially as the conversation changes from whether AI should be used to how it can be ethically integrated into educational practice (Draxler et al., 2023). Understanding student perceptions and practice with GenAI is particularly important in fully online doctoral programs, where students engage heavily in asynchronous academic writing and may turn to GenAI for brainstorming, summarizing, or proofreading tasks. When applied thoughtfully, GenAI offers valuable benefits, including personalized feedback, enhanced problem-solving, and automation of repetitive tasks (Cotton et al., 2023). A goal in AI policy development is to acknowledge AI as a complement to learning rather than a substitute for human cognition.

Research Aim and Questions

This study examines how graduate students perceive using GenAI in academic writing, particularly concerning ethical risks, academic integrity, and institutional policy. By exploring student attitudes toward GenAI, this research seeks to clarify students' perceptions of boundaries between acceptable and inappropriate use. This is partly accomplished by offering insights into the levels of and relationships among ethical considerations, AI policy perceptions, and writing practices. Findings from this study can inform the development of more consistent and transparent AI policies at both the institutional and course levels. Such findings can contribute to appropriately applying GenAI to support learning without compromising academic standards. The following research questions guided the study:

1. What are the perceived levels of attitudes toward Generative AI, ethical risks, academic integrity, and institutional policy perspectives in academic writing within higher education?
2. What are the relationships among attitudes toward Generative AI, ethical risks, academic integrity, institutional policy perspectives, age, writing skill, and writing experience?
3. How do students describe their attitudes toward Generative AI, ethical risks, academic integrity, and institutional policy perspectives in their own words?

Key Constructs in the Study

Attitude toward GenAI in Academic Writing: Attitude toward AI in academic writing refers to students' overall disposition, including their beliefs, feelings, and behavioral intentions regarding using GenAI to support various stages of writing, from brainstorming to final revision. Students' attitudes toward GenAI in higher education settings are generally positive (Almassaad et al., 2024; Chan & Hu, 2023) for reasons including help generating ideas and summarizing text. In the context of academic writing, students hold positive attitudes and utilize GenAI for writing process, multi-tasking writing assistant, virtual tutor, and digital peer to assist in writing processes and performance (Kim et al., 2025b).

Ethical Risks: Ethical risks refer to students' concerns about the potential misuse of GenAI, particularly in academic writing. These risks may include diminished critical thinking, overreliance on AI-generated content, and unintentional plagiarism (Cotton et al., 2024). Academic stakeholders (e.g., instructors, policymakers, and students) can make informed decisions about integrating GenAI into teaching practices and course design by understanding the levels and types of perceived risks. For example, students should be discouraged from using GenAI in high-stakes assessments such as term papers or capstone projects, where students need to exercise independent thinking. In contrast, low-stakes tasks like article summarization or brainstorming activities may pose fewer risks and can be cautiously encouraged during skill development.

Academic Integrity: The relationship between academic integrity and ethical risks offers valuable insight into AI policy development, as policies should clearly define the contexts in which students believe AI use aligns with academic integrity. In this study, academic integrity refers specifically to appropriate uses of GenAI in proofreading and brainstorming during the writing process. Emerging literature indicates that students appreciate the affordances of GenAI for these pre-writing and revision-related tasks (Kim et al., 2025b); however, the relationship between acceptable support and ethical risk remains unclear.

Institutional Policy Perspectives: Institutional AI policies guide whether and how students can use GenAI in their academic work. These policies vary widely in their strictness, ranging from full prohibitions to open integration. Further, AI policy differs in scope, from university-level frameworks to policies left to the discretion of individual instructors (McDonald et al., 2025; Wang et al., 2024).

Literature Review

Theoretical Framework: Theory of Planned Behavior

The theoretical framework guiding this study is the Theory of Planned Behavior (TPB; Ajzen, 1991). TPB offers a useful lens for understanding how students form intentions to use GenAI in academic writing by emphasizing the association among attitude, subjective norms, and perceived behavioral control. The crux of TPB posits that attitude reflects how individuals evaluate a behavior. A more favorable attitude predicts stronger intentions to engage in that behavior. In academic contexts, students who perceive GenAI as useful for tasks such as brainstorming or revising are more likely to use these tools (Ivanov et al., 2024). Ivanov et al. (2024) demonstrated that perceived benefits and advantages of GenAI positively influence attitudes, subjective norms, and perceived behavioral control.

Subjective norms refer to perceived social pressures or expectations from important referents, including institutional policies or instructor guidance. Prior research supports the idea that subjective norms significantly predict behavioral intention through social influences (Meng & Choi, 2019; Otache, 2019). For instance, students may be more inclined to integrate AI into their writing practices when they believe faculty accept or encourage AI use.

In continuing to outline the TPB framework, the next construct is perceived behavioral control. Perceived behavioral control reflects students' perceived ease or difficulty in using GenAI. This dimension captures factors such as digital literacy and institutional support. This can either facilitate or constrain GenAI usage in writing. When students feel confident in their ability to use AI effectively and ethically, and when institutional structures offer guidance, they are more likely to adopt GenAI for academic purposes.

To better understand how students form intentions to use GenAI in academic contexts, the following literature review is organized around five key areas that map onto the components of TPB: (1) institutional policy trends and pedagogical guidance, which informs subjective norms; (2) multicultural perspectives, which inform contextual attitudes toward AI use; (3) research university approaches, which informs structural and normative influences; (4) student usage and perceptions, which informs attitudes and perceived behavioral control; and (5) concerns related to academic integrity, which informs ethical tensions and potential barriers to use. Together, these areas provide a comprehensive view of how institutional, cultural, and individual factors influence GenAI integration in higher education.

Evolving AI Policies and Pedagogical Considerations in Higher Education

One approach universities are taking is keeping AI policy decisions at the instructor level (Wang et al., 2024). Wang et al. (2024) analyzed AI policies across U.S. universities by reviewing academic documents, including institutional policies, course syllabi, and faculty workshop materials. Their study focused on technical aspects, ethics, pedagogy, data privacy, limitations, and AI detection tools. One key finding was that 54.8% of universities allowed instructors to establish their own AI policies, while 47.3% prohibited AI use by default. Other institutions maintained a more open or neutral stance on its use. Specific criteria can help guide policy decisions as universities work to integrate AI into academic settings. Four key pedagogical considerations have emerged: (1) recognizing AI's presence in education, (2) aligning AI use with learning objectives, (3) adapting curricula to minimize misuse, and (4) employing diverse assessments to ensure academic integrity (Wang et al., 2024).

Emerging research also suggests that using GenAI constitutes plagiarism (Eke, 2023), creating anxiety among educators unsure how to regulate its use (Barrett & Pack, 2023). In response, institutions have begun offering webinars and training sessions to guide faculty on ethical and appropriate AI implementation (Kaplan-Rakowski et al., 2023). These responses highlight the urgency with which universities are attempting to balance innovation with academic integrity.

While much of the policy discourse centers on U.S. higher education, GenAI's global and multicultural use introduces further complexity. An et al. (2025) explored global perspectives on GenAI in higher education, addressing the gap in AI research by incorporating multicultural viewpoints. Using an online survey of 1,217 participants from 76 countries, their study found that GenAI is widely used and students intend to continue leveraging it for text retrieval and paraphrasing. The findings suggest that AI policies should be adaptable and responsive to cultural expectations. In so doing, universities support equitable access and ethical use across diverse academic settings.

Trends in AI Policy at Research Universities

Many universities have begun supporting GenAI in coursework, but concerns remain about ethical guidance and long-term implications. McDonald et al. (2025) examined AI policies at 116 high-research-activity (R1) universities and found that most institutions encourage GenAI use while guiding ethical implementation. Over half of these institutions offered sample syllabus statements, and many provided structured AI curriculum and activities to help integrate the technology into coursework, particularly in writing-intensive disciplines.

However, McDonald et al. (2025) caution that universities' increasing endorsement of AI in pedagogy may overlook long-term implications such as time investment, ownership concerns, and data privacy. One major issue raised is the inconsistency in citation practices, where universities require students to cite academic sources rigorously but only broadly cite

GenAI-generated content, prioritizing authenticity over intellectual property. This raises the issue of what guidance higher education institutions are actually providing to their constituents about GenAI use. According to TPB, these institutional messages form part of the subjective norms that shape students' intentions to use AI.

University Student Use and Perceptions

GenAI such as ChatGPT offers several benefits for students, including translation, writing assistance, feedback on writing, and text summarization (Huang et al., 2023). However, student usage patterns and perceptions vary based on demographic and institutional factors. Kim et al. (2025) studied 1,001 U.S. college students, examining how they perceive and use ChatGPT. Their findings indicate that factors such as gender, age, major, institution type, and institutional policy significantly influence ChatGPT usage for academic and non-academic tasks. Notably, older students (ages 30–40) reported using ChatGPT more frequently than younger students. Additionally, non-native English speakers were more likely to rely on ChatGPT compared to native English speakers (Kim et al., 2025a).

Despite recognizing the utility of ChatGPT, students expressed mixed feelings about its use. Some reported concerns over potential policy violations, while others valued the tool for its practical benefits (Kim et al., 2025a). This highlights the tension between institutional regulations and students' need for academic support through AI-driven tools.

Diminished Writing Quality and Academic Integrity Concerns

One of the primary concerns regarding students' use of GenAI is diminished writing quality and an increase in plagiarism cases (Draxler et al., 2023). Many students report that an overreliance on ChatGPT reduces creativity and results in lower-quality writing (Smolansky et al., 2023). Additionally, GenAI is often perceived as a threat to academic integrity, with some viewing its use as a form of cheating (Firat, 2023).

Burleigh et al. (2024) examined the role of GenAI in academic research, particularly its application in data collection for doctoral dissertations. Using a qualitative approach, their study employed ChatGPT to generate responses to interview questions based on a previously published article. The findings revealed significant risks to data integrity, emphasizing the need for clear institutional policies regarding AI use in academic research. Burleigh et al. (2024) advocate for strong governance policies to address concerns related to plagiarism, ethical considerations, and academic misconduct.

Currently, higher education institutions place the responsibility for AI policy on individual instructors, raising concerns about inconsistent guidelines and enforcement (Burleigh et al., 2023). This inconsistency may hinder the development of stable subjective norms, making it more difficult for students to form intentions aligned with academic integrity.

Ethical Integrity

Concern is growing over the increasing reliance of students and researchers on tools like ChatGPT for writing tasks (Eke, 2023). To address this, higher education institutions must carefully evaluate the academic opportunities and challenges posed by GenAI while implementing practical strategies to ensure its ethical and responsible use. Eke (2023) emphasizes the importance of establishing clear policies to maintain academic integrity, especially in regions with limited access to advanced plagiarism and AI detection tools.

Several measures are recommended to address challenges such as plagiarism risks, ethical concerns, diminished critical thinking, and uncertainty around institutional guidance. These measures include integrating GenAI as a *structured and supportive tool* in teaching and research, developing comprehensive training programs for educators and students, updating academic integrity policies, and investing in reliable tools to detect GenAI-generated content. Sullivan et al. (2023) highlight institutional responses to GenAI, academic integrity concerns, limitations of current tools, and the potential of GenAI to enhance learning. Importantly, they note its particular benefit for students from disadvantaged backgrounds. Other challenges include overdependence, decreased critical thinking, plagiarism, and low assignment quality (Blanco Fontao et al., 2024; Gammoh, 2024). These perceptions directly influence students' attitudes and perceived behavioral control, completing the three pillars of TPB that shape intention and action in GenAI use.

Methodologies

This mixed methods study used both survey and interview data to examine graduate students' perceptions of the ethical use of GenAI in academic writing within higher education. Semi-structured interviews were analyzed using thematic analysis, following Creswell’s (2018) coding procedures, including open coding and identifying key themes. Survey data were analyzed using descriptive statistics (mean scores) and correlational analysis to explore relationships among the study's key constructs. Data collection occurred in Fall 2024 and involved students enrolled in fully online education doctorate courses.

Participants

Students from the College of Education (CoE) were invited to complete the study, resulting in 30 completed surveys. All participants held at least one graduate degree and were currently enrolled in a doctoral program in education. Ages ranged from 20 to 60, with most respondents between 30 and 40 years old ($n = 11$), followed by those aged 20 to 30 ($n = 9$), 40 to 50 ($n = 8$), and 50 to 60 ($n = 2$). All participants reported engaging in academic writing during both semesters and breaks, including tasks such as term papers, dissertations, and proposals. On a 10-point scale, students also self-rated their academic writing skills. 100% of participants reported ongoing involvement in scholarly writing.

Environment

In the CoE, graduate students complete their coursework through the university's learning management system. Coursework typically includes three courses per semester (3-credit classes). Throughout each semester, instructors hold weekly, bi-weekly, or monthly Zoom sessions to review content and discuss assignments. Instructors also maintain regular communication with students through various electronic means, including email, Zoom, smartphones, and other digital platforms. While students are encouraged to attend synchronous sessions, all coursework can be completed 100% asynchronously. As a result, writing comprises a significant portion of the expected workload. Students complete course modules (i.e., subcomponents with specific learning outcomes), end-of-course key assessments (i.e., substantial assignments with significant grade weight), and engage in online forum discussions through posts and replies. Although video essays, presentations, and other oral communication tasks (e.g., student-teacher meetings) offer some variation, written output typically constitutes the majority of course assessment.

Survey Instrument

The survey instrument used in this study was developed in-house to align with the research questions and the focus on GenAI use in higher education. Although newly constructed, the development of scale items was informed by prior research on perceptions of AI, ethical risks, academic integrity, and institutional policy perspectives.

The Attitudes Toward GenAI construct was informed by findings from recent studies on student and faculty perceptions of GenAI (Kim et al., 2025a; Chan & Hu, 2023). The Ethical Risks construct drew from prior research exploring ethical dilemmas and challenges associated with AI in academic contexts (Eke, 2023; Miao et al., 2024). The Academic Integrity construct was informed by surveys and reports examining student behavior and academic standards in the context of AI (Sefcik et al., 2023; Wiley, 2024). Finally, the Institutional Policy Perspectives construct was guided by studies analyzing institutional responses and emerging policies for AI in higher education (An et al., 2025; Draper & Newton, 2024; Rasky, 2023).

Participants responded to items using a five-point Likert scale ranging from 1 (Never) to 5 (Always). This scaling method assessed the frequency and consistency of participants' attitudes, perceptions, and experiences related to GenAI use.

Survey Administration and Interview Protocol

Students from the CoE were invited to complete the study's questionnaire via email. Two rounds of email were sent, an initial round and a reminder. The survey entailed an information page explaining the nature of the study. Students were made aware that participation was anonymous and allowed to opt out. Further, students were allowed to have their data omitted from the study. A final item in the questionnaire asked students if they were interested in participating in a one-on-one Zoom interview to further discuss the integration of GenAI in higher education.

Students who had provided their email and displayed interest in the interview portion of the study were contacted via email. Interview sessions were scheduled and lasted approximately 25 minutes each. The semi-structured interview protocol entailed interview questions that fell within the framework of the questionnaire, including 1) attitudes, 2) ethical concerns, and 3) institutional policy. A fourth category of questions inquired how students used AI to assist with academic writing, professional life, and personal use. Interview questions are listed in Table 1.

Table 1

Interview Protocol: Key Constructs, Questions, and Probes

Scale	Open-Ended Interview Questions	Follow-Up Questions
Attitudes Toward Generative AI Use	How do you feel about using generative AI tools in academic writing, and how do they impact your writing process?	1. Can you describe a specific instance where AI positively or negatively influenced your writing? 2. What features of AI tools do you find most helpful or concerning? 3. How do you decide when to use AI tools in your work?
Ethical Concerns	What concerns, if any, do you have about the ethical implications of using Generative AI tools in academic contexts?	1. How do you think AI could affect academic integrity in your field? 2. What steps do you believe are necessary to ensure responsible use of AI? 3. Do you think students and educators differ in their ethical perspectives on AI use?
Institutional and Policy Perspectives	What role do you think institutions should play in providing guidance and setting policies for ethical AI use in academic writing?	1. How effective do you find the current guidance provided by your institution on AI use? 2. What additional support or training do you think institutions should provide? 3. How might mandatory guidelines influence student and faculty use of AI tools?

Table 2 provides background information on the interviewees, including age range, highest degree earned, area of concentration, and years of teaching experience. This demographic context helps situate the perspectives offered in the interviews and illustrates the characteristics of professional backgrounds represented in the sample.

Table 2

Background information of interviewees

Participant	Age Range	Highest Degree Earned	Area of Concentratio n	Years of Teaching Experience
Maria	25–30	Master's	Literacy	5–10
Sophia	30–35	Master's	Literacy	5–10
James	30–35	Master's	K-12 Ldr.	5–10
Priya	25–30	Master's	Higher Ed.	5–10
Lauren	40–45	Master's	Literacy	5–10
Daniel	30-35	Master's	Literacy	5–10

Data Analysis

Quantitative data were analyzed using IBM SPSS Statistics (Version 28). To address Research Question 1, descriptive statistics (means and standard deviations) were computed to examine perceived levels of attitudes toward GenAI, ethical risks, academic integrity, and institutional policy. To address Research Question 2, Pearson correlation analyses were conducted to examine relationships among key variables, including age, writing skill, writing habits, and perceptions of GenAI use.

For Research Question 3, qualitative data from semi-structured interviews were analyzed using thematic analysis following Creswell's (2018) procedures. This involved open coding, axial coding, and identifying emergent themes related to student attitudes, ethical concerns, and institutional policy perspectives on GenAI in academic writing.

Results

Research Question 1

The first research question examined students' perceived levels of the key variables. This was done through a mean score analysis (see Table 3). Overall, students reported generally high levels across all variables, with most mean scores above 3.25. For Attitude Toward GenAI, the highest-rated item was having a positive outlook (*M* = 3.50, *SD* = 1.07), followed by embracing AI to enhance academic writing skills (*M* = 3.43, *SD* = 1.22). Despite these positive attitudes, students also expressed concerns about ethical risks. The most notable was the perceived risk to academic integrity (*M* = 4.53, *SD* = 0.63), along with the need for clear guidelines on AI use (*M* = 4.37, *SD* = 0.63). In terms of academic integrity, students considered it ethical to use AI for proofreading and editing (*M* = 4.07, *SD* = 1.01), as well as for idea generation (*M* = 4.77, *SD* = 1.07).

Finally, students emphasized the importance of guidance in navigating appropriate AI use. Many agreed that institutions are responsible for educating students on the ethical use of AI (*M* = 4.20, *SD* = 0.71) and that such guidance should be a required part of the course curriculum (*M* = 4.07, *SD* = 0.78).

Table 3

Descriptive statistics of study variables

		M	*SD*	α
Attitude Toward GenAI	1. I have a positive outlook on the potential benefits of using AI in academic writing.	3.5	1.07	.88
	2. I embrace AI as a valuable tool for enhancing my academic writing skills.	3.43	1.22	
	3. I appreciate the convenience AI offers for summarizing lengthy texts in my academic writing.	3.27	1.34	
	Total	3.40	1.10	
Ethical Risks of AI in	4. I think AI can compromise academic integrity if not used responsibly.	4.53	0.63	.86

Higher Education	5. I feel institutions should establish clear ethical guidelines for AI use in academic contexts.	4.37	0.85	
	6. I believe using AI-generated content without acknowledgment is unethical.	4.10	0.99	
	7. I worry that AI could lead to unintentional plagiarism in academic writing.	3.97	1.00	
	8. I am concerned about the over-reliance on AI tools diminishing critical thinking and originality.	3.87	1.28	
	Total	4.17	0.78	
Academic Integrity	9. It is ethical to use AI tools for proofreading and editing my academic writing.	4.07	1.01	.66
	10. I consider it ethical to use AI for generating ideas, provided it does not replace my own thinking.	3.77	1.07	
	Total	3.92	0.90	
Policy Perspectives	11. I believe institutions have a responsibility to educate students on ethical AI use.	4.2	0.71	.79
	12. Ethical considerations in AI use should be a mandatory component of higher education curricula.	4.07	0.78	
	13. Institutions should mandate disclosure when AI tools are used in academic work.	3.63	0.89	
	Total	3.97	0.67	

Research Question 2

Research Question 2 explored the relationships among AI use perception variables and their associations with age, writing skill, and academic writing experience. No statistically significant relationships were found between AI use perception variables and age, writing skill, or writing habits.

As shown in Table 4, attitude toward GenAI use (e.g., embracing AI) had a negative relationship with ethical risk perceptions (e.g., concern that AI could lead to plagiarism), with an r value of –.449 ($p < .05$). In contrast, attitude toward AI use had a positive relationship with academic integrity beliefs (e.g., viewing AI use for proofreading as ethical), with an r value of .655 ($p < .01$).

Another significant relationship was observed between ethical risk perceptions and policy perspectives ($r = .448$, $p < .05$), suggesting that students who recognize potential ethical risks of AI also acknowledge the institution's responsibility to establish clear guidelines for its use.

Table 4

Correlation analysis and mean score for study variables

		1	2	3	4	5	6	7
1	Age	-						
2	Writing Skill	.034	-					
3	Writing Habits	.339	-.107	-				
4	Attitude Toward GenAI	.242	-.197	.050	-			
5	Ethical considerations in AI use	-.126	.156	-.245	-.449*	-		
6	Academic Integrity	.275	-.144	.058	.655**	-.250	-	

7	Policy Perspectives	.011	-.098	-.188	-.217	.448*	-.033	-

Note. $p^* < .05$.

Research Question 3

Research question 3 explored student perceptions of AI use in higher education academic writing through semi-structured interviews.

Theme: Responsibility and Preparedness

Teachers emphasized the importance of using AI thoughtfully and with care. They noted that AI can support learning but should not replace critical thinking or professional judgment. Many believed students need guidance, not restrictions, when using these tools. During interviews, James remarked, “These things are here. They're going to be used, and I think that they need to be used wisely.” He added, “We need to wrap our heads around it and manage it,” and described AI as “a double-edged sword.” Sophia explained her cautious approach and said, “I use Grammarly but not other AI like ChatGPT for academic writing,” adding, “Robots are tools to support, not replace humans.” Maria reflected on her changing perspective and noted, “At first, I thought ChatGPT would ruin academia. Now I believe it can help if used responsibly.” She added, “I sometimes use AI to generate an outline, but then write the paper myself.”

Priya said, “Telling students not to use it will backfire. Educate instead.” She stressed that AI is useful for sparking ideas, not for learning foundational skills, saying, “There is a place for AI, but not to gain fundamental knowledge.” Daniel encouraged openness and stated, “Faculty should be proactive in teaching ethical AI use, not pretend it doesn't exist.” He added, “Professors should model appropriate AI use instead of just warning about it.” Lauren pointed out that experienced educators are better prepared to handle AI use and said, “Teachers can critically assess AI-generated content.” She added, “I only use ChatGPT if I already know the content.”

Theme: Ethical Concerns

Participants raised concerns about ethical risks like misinformation, fairness, and protecting the learning process. Some also expressed worries about false accusations and data privacy.

James emphasized user responsibility, saying, “They make mistakes. They're not always right, and that's completely on the person that's writing the paper.” He added, “You need to make sure you're right before you go out there and say so.” Sophia said, “ChatGPT reuses the same verbiage — professors can spot it,” and warned, “Using AI as a shortcut to capstones, standards, milestones is unethical.”

Maria shared concerns about authenticity and noted, “I'm more nervous because my natural style might be flagged as AI.” She added, “The biggest ethical concern is whether we're seeing the real work of a student.” Priya said, “Personally, I don't touch AI because I'm in a terminal degree program,” and warned that “students could use AI to create work without any real knowledge.” Lauren noted, “Sometimes I see errors in what's generated,” and raised concerns about privacy, saying, “I don't know where the information is coming from or where my input goes.” Daniel added, “Using AI without understanding the content is like copying without learning,” and expressed caution, saying, “It can save time, but it feels risky in graduate work.”

Theme: Learning and Development

Teachers saw AI as a way to enhance instruction but agreed it should never replace foundational learning. They emphasized that critical thinking skills must come first. James reflected on his early exposure to technology, saying, “When I was a little kid in Star Trek…” and “Hey, Siri…” Sophia stressed that AI cannot replace professional judgment and said, “AI can't replace lesson planning. It undermines professional skill.” She added, “AI should only come after mastery of skills, not before,” and continued, “We can’t stop AI — we must teach students to navigate it.”

Maria described how AI helped her refine her writing and noted, “It has helped me make my writing more concise and aware,” but also warned, “This is especially concerning for high schoolers — they need to show comprehension.” Priya explained the importance of foundational knowledge, saying, “Fundamental knowledge must come first. Then, creativity tools can be used.” She added that she introduces AI only after students have the basics, noting, “I teach students to use AI for creativity once they have the fundamentals.”

Daniel emphasized the need to teach critical thinking first and said, “Students need to be taught critical thinking before they can use AI effectively.” He explained, “AI should be treated like a tool, like a calculator, useful but not a replacement for learning the math first.” Lauren gave practical examples and shared, “I use AI often to produce exemplars for students,” and added, “I use ChatGPT almost every day to make lessons more interactive and engaging.”

Theme: Institutional Policy and Guidance

Participants agreed that institutions need to provide structure and guidance on AI use. While views varied on how strict policies should be, most called for training, clarity, and flexibility. James said, “If we don't capitalize this and as educators drive it in the right direction, we're going to be sorry.” Lauren described her school’s approach, noting, “Maybe some guidance from institutions is needed, depending on the cohort,” and added, “We have monthly AI training…and it's been very effective.” She also supported formal policies, stating, “Mandatory guidelines would help clarify expectations for AI use.”

Sophia agreed on the need for structure, saying, “We need expectations and boundaries around AI use,” and suggested that policies should “focus on inference skills and equitable use.” Maria stressed balance, stating, “Universities should not be 0% anti-AI; they should build strong boundaries.” She added, “There should be clear rules on acceptable vs. unacceptable AI use,” and further noted, “AI policies should be treated like plagiarism policies.”

Priya supported local control, asserting, “Institutional policy should stay department- or instructor-specific,” and encouraged more exposure, exclaiming, “APSU should bring more AI speakers for simple updates and training.” She also warned, “Schools that resist AI are falling behind.” Daniel emphasized the need for transparency, stating, “Clear AI policies would help students know what's allowed instead of guessing,” and added, “Workshops on ethical AI use would help faculty and students feel more confident.” He concluded, “Policies banning AI completely are unrealistic. Students will find ways to use it anyway.”

Discussion

Several important findings emerged from this study. For research question one, graduate students generally expressed positive attitudes toward AI. This finding is supported by earlier research showing that GenAI is widely seen as a helpful and accessible tool to support academic writing and learning (Dwivedi et al., 2023; Kasneci et al., 2023). However, students voiced concerns about ethical risks. These concerns, particularly regarding plagiarism and the potential misuse of AI, echo extant literature documenting worries about compromised academic integrity and diminished originality (Escalante et al., 2023; Firat, 2023).

Students made distinctions in how they viewed appropriate AI use. They generally found it acceptable for low-stakes activities, including proofreading and generating ideas. This pattern reflects observations from Cotton et al. (2024), who noted that students often turn to AI for brainstorming and summarizing, and Kim et al. (2025b), who described similar preferences during early and revision phases of writing. Despite this openness to AI, many students emphasized needing more precise guidance from their institutions. Their desire for formal policies and training reflects concerns raised in the literature about inconsistent and sometimes vague AI rules in higher education (McDonald et al., 2024; Wang et al., 2024). Eke (2023) also pointed out that without clear guidelines, students and faculty may struggle to navigate ethical boundaries when using AI.

Research Question Two revealed several important relationships among the study's variables. First, positive attitudes toward AI were associated with beliefs about ethical use, including using AI for proofreading. This finding aligns with Kim et al. (2025b), who reported that students view AI as acceptable for pre-writing and revision tasks. In addition, students who perceived greater ethical risks tended to support institutional policies and guidelines. This connection between perceived risk and policy reflects similar findings by McDonald et al. (2024) and Wang et al. (2024), who explain the need for AI policies in academic settings. Finally, demographic factors, including age, writing skill, and writing habits, showed no significant relationship with the study's variables. This outcome is consistent with Kim et al. (2025), who found that while demographic traits like gender and major can affect how students use generative AI, their attitudes and intentions are often influenced more by context, including field of study, learning environment, and institutional culture.

Research Question Three aimed to gain a deeper understanding of how students perceive GenAI use and its ethical implications through interviews. Participants emphasized the importance of thoughtful, guided use of AI and generally rejected the idea of forbidding the use of AI in academic writing. In line with this view, many students suggested that faculty should model and explain appropriate and ethical AI use. This echoes findings from Draxler et al. (2023), Cotton et al. (2024), and Alier et al. (2024), who noted a change in academic discourse from prohibiting AI to focusing on ethical integration. Furthermore, consistent with Cotton et al. (2024), Escalante et al. (2023), the findings confirm that ethical concerns about AI extend beyond plagiarism to include issues such as misinformation and fairness.

A final key point from the interviews was that AI should not replace foundational learning. Students unanimously agreed that mastering core writing skills must remain a priority and that GenAI should only serve as a supplemental tool. The interviews support much of the data emanating from the questionnaire. Students strongly supported clear institutional policies, training, and balanced approaches rather than outright bans, reflecting sentiments reported in the study's questionnaire. This desire for clarity reinforces the idea that current institutional policies are inconsistent and require greater effort to improve clarity (McDonald et al., 2025; Wang et al., 2024).

Pedagogical implications from this study highlight the importance of clear and consistent AI policies. Instructors should define appropriate use directly within syllabi, assignment instructions, and course modules. Integrating discussions of ethical AI use into coursework can promote responsible engagement. A flexible approach may permit GenAI for low-stakes tasks such as brainstorming, outlining, or proofreading. Faculty can also model ethical AI use by transparently using GenAI in module overviews, announcements, or instructional materials. Additionally, incorporating GenAI into classroom activities can help students develop digital literacy and understand how to use these tools appropriately.

Conclusion

This study examined how graduate students perceive the use of GenAI in academic writing, with particular attention to attitudes, ethical concerns, academic integrity, and institutional policy. Guided by the Theory of Planned Behavior, the results showed that students generally view GenAI positively, especially for tasks like brainstorming and editing. Concurrently, students expressed unease about issues such as plagiarism, loss of originality, and unclear policy guidance. Notably, students who held stronger concerns about ethical risks were also more likely to support the development of formal institutional policies. These findings underscore the administration's role in messaging responsible AI use in academic writing.

A shared theme emerged across different age groups and levels of writing experience: students want clear, practical guidance rather than inflexible rules or blanket bans. Interviews confirmed that most students see GenAI as a helpful tool when used appropriately, rather than a replacement for core academic skills. Participants repeatedly emphasized the importance of maintaining critical thinking and writing abilities while using AI to enhance learning.

This study has several limitations. First, the sample size was small (n = 30), which may limit the generalizability of the findings. Second, all participants were from a single university, reducing diversity in an institutional context. Next, the study focused solely on graduate students, excluding undergraduate perspectives. Further, participants were primarily from education-related fields, limiting disciplinary variation. Lastly, self-reported data may be subject to bias or inaccuracies.

Despite its limitations, this study offers valuable insights into shaping AI policy and understanding student perceptions. There is a clear need to better understand the specific AI strategies students use during the planning, monitoring, and reviewing stages of academic writing. Gaining this insight can help guide instruction and AI-related training, enabling students to integrate emerging AI technologies into their academic routines in an ethical and educationally sound manner.

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An Empirical View of Covid Lockdown Outcomes in Silicon Valley

By

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Abstract

In looking at the impact of covid lockdowns in Silicon Valley, Estill(2022) found very disparate impacts using zip codes from Santa Clara County. Using simple descriptive statistics, he found very different impacts based on west versus east county zip codes showing differences based on rates of infection, income, ethnicity, unemployment, population density, family size, median age health coverage, education level, poverty rates. While some of these differences appeared large, none of them were tested for statistically significant differences. In this paper, we accomplish two things. First, we produce regression results to see what variables are important in determining differences in COVID-19 rates by zip code. Second, we add three additional years, 2021-2023.

Keywords: COVID-19, lockdowns, unintended consequences, discriminatory public policy, interactive regression models

Introduction

As noted in Estill (2022), Santa Clara County imposed stricter standards than those recommended by the state and federal governments. Technically, the federal government made recommendations, but they were routinely made into requirements by the State of California. Imposing a one-size-fits-all approach ignores a simple benefit cost approach that would be recommended by economists. For example, Modoc County, which is located in the far northeastern corner of California, had the same lockdown restrictions imposed on it as more urban counties. Modoc county consists of a few small towns and most of the land is Federally owned. It took nearly 5 months before they posted their first case of Covid.[1] As noted by Estill, Santa Clara County imposed even stricter standards than recommended by the State of California. These standards were also often arbitrary.[2] Estill highlighted the 6 zip codes with the highest and six with the lowest infection rates to highlight the different results of the County's lockdown policy that showed that the economically disadvantaged and primarily non-white zip codes suffered significantly higher infection rates than the wealthiest ones.

In this paper we will empirically test the data to see the significance of disparate impact of lockdowns across several variables. We also include additional years of Covid infection rates to see if these impacts decreased as restrictions were eventually reduced.

The Disparate Impact of "Complete" Lockdowns

The original argument for a "complete" lockdown was to isolate people from transmitting the disease, which would eliminate the disease in a few weeks. The problem with this argument is that lockdowns fail to completely isolate all people. First of all, the lockdown restriction would exclude public services like police, fire, water, waste disposal, etc. Second, certain retail services, like gas stations, grocery stores, home improvement stores would remain open. Some businesses would close their buildings but allow their employees to work from home. Educational institutions closed their campuses, but allowed instructors to teach their courses online. As Estill notes many high-tech companies in Santa Clara County continued with business as usual for the most part. Unfortunately, workers in the service industry were unable to work. Examples would be restaurants, hotels, house-cleaners, landscaping companies, home healthcare services, day laborers, and many other types of commercial and service firms. An incomplete lockdown

[1] https://usafacts.org/visualizations/coronavirus-covid-19-spread-map/state/california/county/modoc-county/

[2] A great example is high end Garden and Nursery stores. In Sacramento county, a high-end store, Green Acres Nursery and Supply was seen as essential and allowed to sell plants, and outdoor furnishings. With many people working at home, the customer lines were out the door. In Santa Clara County a similar high-end store, Yamagami's Garden Center was not viewed as essential and was forced to close, whereas Home Depot, a home improvement store, was allowed to stay open and sell plants and outdoor furnishings.

means that some people will still be in contact with each other and will make it difficult to reduce the transmission of the disease.

Another reason for failure resulted from the inability of the medical and political institutions to use current data to make better informed decisions. The COVID-19 virus was certainly not the first virus to start a worldwide epidemic. For whatever reasons, the medical community seemed to think this was a unique virus and viewed it differently from previous epidemics. In the beginning of the epidemic there was uncertainty on the impact of the virus on different segments of the population. As with any decision-making approach, decision-makers hope to have a clear understanding of the outcomes and the probability distribution of the outcomes. Without a clear understanding of the probability distribution, most decision-makers would employ conservative decision-making approaches using the Maximin or the Minimax regret criterion.[3] These conservative approaches would suggest people isolate until the data reveal some information about the probability distribution. After 3 months, the probability distribution became very clear on the impact of the COVID-19. Over 95 percent of the deaths were attributed to people over age 50. The infection and death rate for children aged 0-17 was essentially zero. With this information the medical experts and government bureaucrats should have warned seniors of their risk and told families with children that they were at very little risk. The lockdown on the economy should have been lifted. Unfortunately, in California the lockdowns were allowed to continue, K-12 schools remained closed, and parents were told to vaccinate their children.

The consequences of the lockdown as reported by Estill were,

> *"postponed diagnostic medical treatments, fewer regular checkups,...,hospital restrictions, (Moses 2020), increased family violence(Centers for Disease Control and Prevention (2020), increased drug and alcohol abuse, suicides (Li 2020),*

[3] Maximin is choosing the option that has the highest minimum, and the Minimax regret criterion is choosing the option with the minimum regret. Means(2021) provides a nice example of decision making comparing risk and uncertainty in Chapter 6.

serious mental health problems,…, (Brooks 2020), business failures,…, (Sasso 2020), school dropouts,…, (Brooks 2002).”

In the next section we will provide the empirical tests to see what groups bore the brunt of the impact in terms of infection rates.

The Data and Sample Statistics

The original findings presented by Estill reported the infection rates for 54 zip codes in Santa Clara County with 10,000 people or more (Zip-Codes 2021-24, ZipDataMaps 2021-24). His bar chart on zips codes and infections rates reported the six highest and six lowest infection rates in Santa Clara County. In Figure 1 below, we report all zip codes along with years 2021, 2022, and 2023.

Figure 1.

Bar Graph of 2020 Infection Rates per 100k by zip code

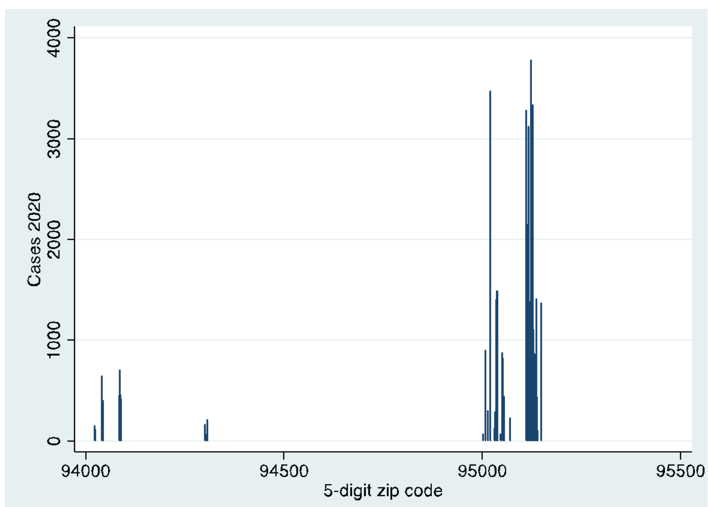


Figure 2.

Bar Graph of 2021 Infection Rates per 100k by zip code

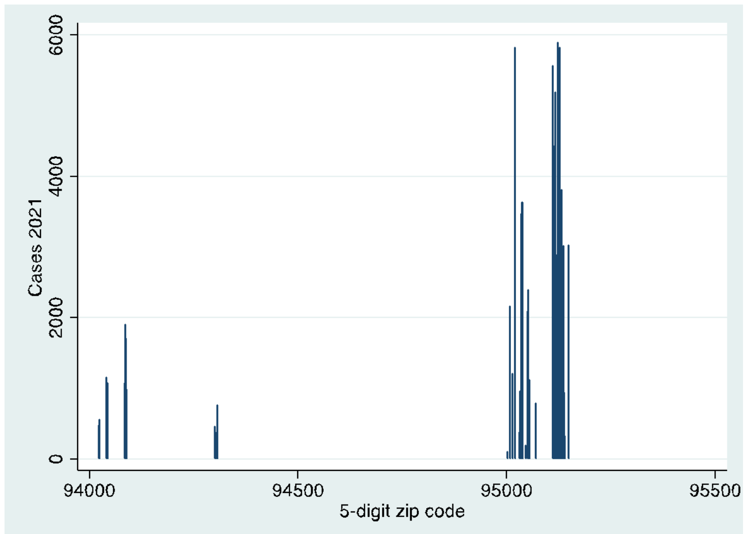


Figure 3.

Bar Graph of 2022 Infection Rates per 100k by zip code

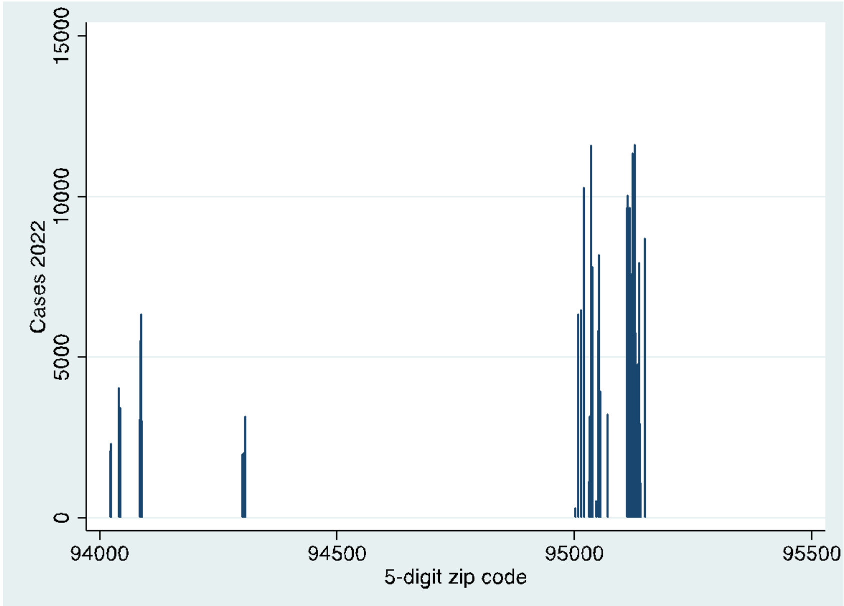
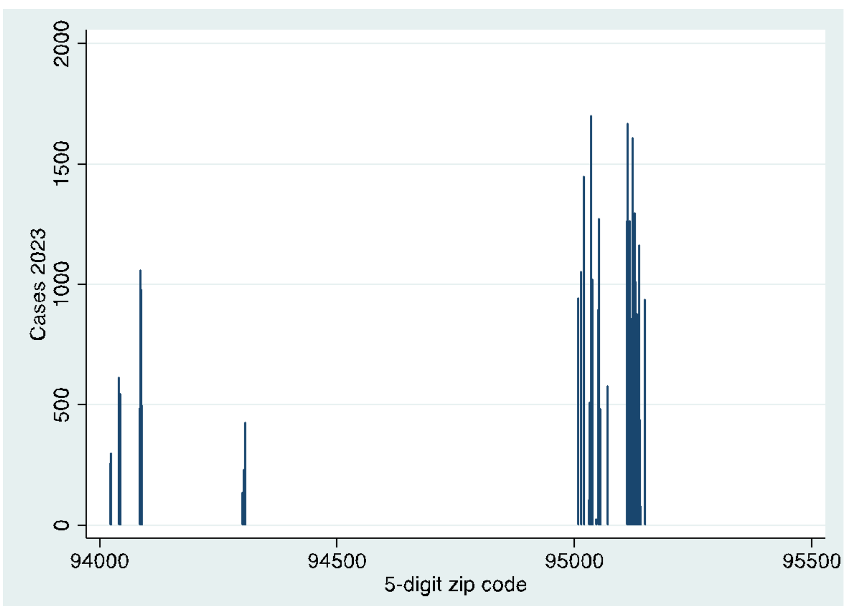


Figure 4.

Bar Graph of 2023 Infection Rates per 100k by zip code



The zip codes greater than 95100 represent most of the east side of the county while the zip codes below 94500 represent mostly west-side county zip codes. We have constructed indicator variables (West, East, Central and South) that better represent the geographic areas of the zip code. Below we report the sample means for the median income and infection rates for all 4 years for eastern and western county zip codes.

Table 1.

Median Individual Income and Infection Rate per 100,000 geographic Zip Code

East County Zip Codes

Variable	Obs.[4]	Mean	Std. Dev.	Min	Max
Infection rate2020	30	2865.161	1535.878	946.9598	6747.92
Infection rate2021	30	6381.168	2526.316	2687.401	14000.95
Infection rate2022	30	16053.85	3717.405	10212.97	30232.56
Infection rate2023	29	3620.235	7695.859	1113.676	43569.06
Median Individual Income	31	45650.81	15884.66	24096	9035

[4] The decline in zip codes over time is due to dropping sparse mountain area zip codes that included nearby counties.

West County Zip Codes

Variable	Obs.	Mean	Std. Dev.	Min	Max
Infection rate2020	16	1133.571	458.4206	489.7682	1989.407
Infection rate2021	17	2956.227	973.651	774.5319	4667.786
Infection rate2022	17	11015.48	2069.56	5086.296	14408.1
Infection rate2023	17	1519.304	496.4694	649.0135	2189.494
Median Individual Income	17	69007.82	18675.5	14888	100671

The mean median income for the western zip codes is $69,007, whereas the eastern zip codes equal $45,650. The eastern zip codes contain all of the San Jose city area codes plus a few northern county towns like Milpitas. Comparing the East and West zip codes, the 2020 infections rates are more than two and a half times higher for the East.[5] For the years 2021 to 2023, the ratio declined but in 2023 the eastern county zip codes average is still 2.38 times higher than the western county zip codes.

Empirical Results

In this section we report regression results suggesting that it is the Hispanic population that is bearing the brunt of the high infection rates. The basic model is to specify the infection rate per 100,000 population for a zip code as a function the median age, the percent uninsured for health care, percent of homeownership, family size, individual median income, percent Black, Asian, and the Hispanic. We introduce a new variable, the change in the unemployment rate during the pandemic period, in order to see if the virus has an economic impact on each zip code (CDDD 2020). We report the change in unemployment from May to October in 2020, allowing one to see how infections rates were impacted due to a change in the unemployment rate. All of the

[5] This result is skewed by the particularly six high and six low infection rates outlined in Estill.

values for this variable are positive suggesting unemployment increased for all zip codes during this time period. The change in the unemployment rate will be a proxy for economic well-being. A larger positive increase in the unemployment rate change will proxy for a significantly negative impact on economic well-being of residents in that zip code. Two models are tested: a basic model with no Hispanic interaction terms and a second model with a fully interacted Hispanic variables. Models 2 and 4 are the same as model 1 and 3 respectively, but report heteroscedastic errors.

Table 2.

Basic 2020 Model with Hispanic and Fully Interacted Hispanic Variable

Dependent Variable:	(1)	(2)	(3)	(4)
Infection Rate per 100,000	rate2020	rate2020	rate2020	rate2020
Median age	112.255**	112.255*	5.045	5.045
	(40.975)	(42.055)	(74.417)	(64.699)
Median Individual Income	0.000	0.000	0.009	0.009
	(0.010)	(0.007)	(0.023)	(0.017)

Percent Home Ownership	-24.587*	-24.587*	-11.589	-11.589
	(9.227)	(9.421)	(15.820)	(10.187)
Percent Uninsured health	13.771	13.771	20.956	20.956
	(76.233)	(89.617)	(173.642)	(135.153)
Family Size	1163.108*	1163.108	-77.263	-77.263
	(566.640)	(693.030)	(1140.212)	(901.004)
Ch. Urate May-Oct 2020	25.464	25.464	8.164	8.164
	(54.219)	(43.646)	(109.743)	(69.590)
Percent Black	147.785*	147.785	101.578	101.578
	(61.781)	(91.462)	(65.639)	(78.098)
Percent Asian	4.796	4.796	6.341	6.341
	(9.125)	(9.646)	(10.087)	(9.147)
Percent Hispanic	72.804***	72.804***	2.770	2.770
	(18.912)	(19.916)	(161.148)	(158.073)
Hisp*median age			1.811	1.811

			(3.335)	(3.945)
Hisp*med. ind. income			-0.001	-0.001
			(0.001)	(0.001)
Hisp* Home Ownership			0.421	0.421
			(0.640)	(0.694)
Hisp*uninsured health			1.510	1.510
			(6.995)	(7.312)
Hisp*familysize			3.779	3.779
			(24.185)	(24.609)
Hisp*ch. urate			1.140	1.140
			(6.170)	(4.569)
Constant	-7037.662**	-7037.662**	413.049	413.049
	(2175.597)	(2418.863)	(5642.651)	(4188.272)
N	50	50	50	50
R-sq	0.891	0.891	0.912	0.912

adj. R-sq	0.866	0.866	0.873	0.873
F	36.192	43.676	23.501	39.775

Standard errors in parentheses

* p<0.05, ** p<0.01, *** p<0.001

For model one three variables are significant at the five percent level. The signs for median age and family size are positive suggesting that interaction with more family members increased infection rates and hit older people much harder. Home ownership is negative, suggesting that zip codes with a higher percent of home ownership have lower infection rates. The percent Hispanic is positive suggesting that zip codes with a higher Hispanic population are impacted negatively by the pandemic and the resulting lockdowns. The Black population coefficient is also positive and significant. The last significant variable, the change in the unemployment rate is positive, suggesting that zip codes with a higher change in unemployment had a higher infection rate.

The fully interacted Hispanic Model reports significant F-values for regressions 3 and 4, suggesting the relationship significantly different from the other racial groups.

Table 3.

F-tests for Hispanic Interacted Model

Model 3.

H_0: Hispanic and all Interaction terms equal zero.

H_1: At least one coefficient does not equal zero.

F(7, 34) = 3.42

Prob > F = 0.0071

Model 4. (heteroscadastic errors).

H_0: Hispanic and all Interaction terms equal zero.

H_1: At least one coefficient does not equal zero.

F(7, 34) = 4.34

Prob > F = 0.0016

Table 4 reports our final set of results. Model 5 is the basic Hispanic model with the eastern zip code indicator variable included along with the interaction term with Hispanic. Model 6 is the same model but estimated using the 2023 infection rates. Model 7 includes only the location indicator variables (east, central and south) with the west zip coded as the base variable. Model 8 is similar to Model 5 and includes the central and south zip code indicator variables.

Table 4

	(5)	(6)	(7)	(8)
Dependent Variable	rate2020	rate2023	rate2020	rate2020
Median age	116.094*	380.494		116.980**
	(44.115)	(257.484)		(42.282)
Median Individua Income	0.006	0.068		0.007
	(0.010)	(0.062)		(0.010)

Percent Home Ownership	-27.406*	2.159		-27.377**
	(10.226)	(47.869)		(9.210)
Percent Uninsured Health	41.513	259.525		76.076
	(80.097)	(552.644)		(80.585)
Family Size	1625.562*	-3836.451		1636.384*
	(679.782)	(3435.399)		(636.841)
Chg. Urate Oct-May 2020	88.821	74.910		25.639
	(88.886)	(636.747)		(100.503)
Black	176.783*	2552.455***		180.348**
	(65.926)	(465.363)		(64.563)
Asian	1.569	94.295		3.395
	(9.506)	(63.542)		(9.406)
Hispanic	70.636**	161.653		57.392*
	(21.821)	(153.344)		(21.285)
East	-156.352	-627.660	1731.590***	83.818

	(539.798)	(3735.296)	(397.254)	(497.032)
Hisp*East	-9.525	-34.040		
	(15.265)	(94.609)		
Central			727.569	199.127
			(717.357)	401.591)
South			2016.803*	1101.249
			(807.358)	(595.013)
Constant	-9196.876**	-17257.321	1133.571***	9079.737***
	(2801.070)	(9102.260)	(320.812)	(2435.179)
N	50	52	53	50
R-sq	0.895	0.627	0.298	0.903
adj. R-sq	0.865	0.525	0.255	0.872
F	29.575	6.124	6.938	28.839

Standard errors in parentheses

* p<0.05, ** p<0.01, *** p<0.001

The actual F-test results are reported in the appendix and will be summarized below. The first set of F-tests check whether Hispanics in the eastern zip codes are different from the base model. Model 1 suggested that Hispanics in general were hit harder than other groups. As reported earlier we suggested in the eastern zip codes, where a large majority of the Hispanic population in the county is located, had higher infection rates. When we include the eastern zip codes and the other control variables, the impact is not significantly different from the other zip codes. The same holds for the 2023 infection rates. For model 5, the Black variable is significant at the 5% level from the White population and significant at the 5% level from Asian population but not statistically significant from the Hispanic population. The Hispanic population is significant from the White population at the 1% level and at the 0.1% for the Asian population. The F-test between Hispanic and Black is not significant. For the 2023 results Black is now statistically significant from the White and Asian population but not the Hispanic population.

Model 7 compares only the zip codes and the eastern zip codes are statistically significant at the 0.1% from the western zip codes but not significantly different from the central or south zip codes.

Model 8 includes the basic model with all three zip codes. The Black variable is statistically significant from the White variable at the 1% level and the Hispanic variable is significant at the 5% level. Both variables are significantly different from the Asian population. In terms of location none of the variables are significantly different from each other.

The F-test results suggest that the impact on the infections rates for the Hispanic population were different. The results also suggest the Black population which represents less than 3% of the county population had slightly less significant impacts. In terms of population size, the Hispanic population was hit harder than any other racial group.

Part of the explanation for this difference can be explained by job differences. Most of the high-tech corporations are located in the western zip codes of Santa Clara County. Most of these corporations shut down their offices and allowed their employees to work from home. This group of workers are mostly White and Asian. In the service industry, many firms like restaurants were closed, but many other types of service industries were allowed to remain open. Examples include grocery stores, gasoline stations, some maintenance companies, some landscaping companies, and construction companies. The workers in these jobs interacted with more people suggesting more contact and the potential to become infected. Additionally, those firms that closed often laid off lower income individuals who lived in multi-generational, high-density housing that predominates the East side of San Jose.

Summary Findings

The updated regression results from our paper suggest that the Hispanic group and the residents located in the east side of Santa Clara County were impacted in a statistically negative way compared to other ethnic groups and residents not located in the eastern region of the county. Results using 2023 infection rates suggest that these impacts were reduced over time. Our results conclude that lockdowns had very disparate impact on some racial groups and were not uniform throughout the county.

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Appendix

Table 1. Variables

Variable Name	Variable Definition
age_median	Median Age of ZC (zip code)
income_indivi~n long	Median Individual Income in ZC
home_ownership	Percent Home Ownership in ZC
health_uninsu~d	Percent No Health Insurance in ZC
family_size	Average Family Size in ZC
dUrateOctMay	Oct 2020 - May 2020 ch in Unemployment rate in ZC

race_black	Percent Black in ZC
race_asian	Percent Asian in ZC
hispanic	Percent Hispanic in ZC
rate2020	2020 Covid infection Rate per 100K population in ZC
rate2021	2021 Covid infection Rate per 100K population in ZC
rate2022	2022 Covid infection Rate per 100K population in ZC
rate2023	2023 Covid infection Rate per 100K population in ZC

Table 2. Descriptive Statistics

Variable	Obs.	Mean	Std. Dev.	Min	Max
age_median	57	37.8	6.0	19.3	54.3
income_ind~n	56	52064	20245	2763	100671
home_owner~p	57	57.2	20.0	13.1	100
health_uni~d	57	4.6	3.0	0	18.3
family_size	57	3.3	0.55	1.88	4.5
dUrateOctMay53	8.3	2.3	3.9	10.1	
race_black	57	2.8	2.1	0	11.4
race_asian	57	32.4	18.4	0	68.6
Hispanic	57	24.3	17.1	3.2	64.3
rate2020	59	2052	1567	0	6747
rate2021	61	4632	2869	0	14000
rate2022	61	12779	5443	0	30232

rate2023	60	2413	5461	0	4356

Table 3. F-tests for Table 4 Results

Model 5

test hispanic = eastzc = hispinteastzc = 0

F(3, 38) = 5.49

Prob > F = 0.0031

test race_black - hispanic = 0

F(1, 38) = 2.31

Prob > F = 0.1366

test race_black - race_asian = 0

F(1, 38) = 6.92

Prob > F = 0.0123

test hispanic - race_asian = 0

F(1, 38) = 16.20

Prob > F = 0.0003

Model 6

test hispanic = eastzc = hispinteastzc = 0

F(3, 40) = 0.75

Prob > F = 0.5271

test race_black - hispanic = 0

F(1, 40) = 23.02

Prob > F = 0.0000

test race_black - race_asian = 0

F(1, 40) = 27.58

Prob > F = 0.0000

test hispanic - race_asian = 0

F(1, 40) = 0.31

Prob > F = 0.5802

Model 7

test eastzc - southzc = 0

F(1, 49) = 0.13

Prob > F = 0.7152

test eastzc - centzc = 0

F(1, 49) = 2.16

Prob > F = 0.1480

test centzc - southzc = 0

F(1, 49) = 1.73

Prob > F = 0.1945

Model 8

test race_black - hispanic = 0

F(1, 37) = 3.07

Prob > F = 0.0882

test race_black - race_asian = 0

F(1, 37) = 7.33

Prob > F = 0.0102

test hispanic - race_asian = 0

F(1, 37) = 13.13

Prob > F = 0.0009

test eastzc - southzc = 0

F(1, 37) = 4.09

Prob > F = 0.0505

test eastzc - centzc = 0

F(1, 37) = 0.08

Prob > F = 0.7783

test centzc - southzc = 0

F(1, 37) = 2.44

Prob > F = 0.1270

The Ethics of AI in the Math Classroom

By

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Abstract

As artificial intelligence (AI) technologies continue to evolve, their integration into educational settings has generated enthusiasm and concern. This paper examines the ethical implications of AI in the mathematics classroom, analyzing its potential benefits and challenges. AI offers significant advantages, including personalized learning experiences, automation of administrative tasks, and enhanced accessibility to educational resources. However, its use also raises ethical concerns, such as algorithmic bias, data privacy risks, and the potential reduction of human interaction in teaching and learning. Through an analysis of current applications, ethical frameworks, and case studies, this paper argues that while AI can enhance math education, its implementation must be carefully managed to ensure fairness, transparency, and equity. Recommendations for mitigating ethical risks include increasing transparency in AI algorithms, providing teacher training, and addressing digital disparities. Ultimately, this paper advocates for a balanced approach that maximizes AI's educational benefits while protecting the ethical rights of students and educators.

Keywords: artificial intelligence, mathematics education, ethical considerations, algorithmic bias, data privacy, digital equity, personalized learning, AI transparency

Introduction

This paper aims to critically examine the ethical considerations surrounding the integration of Artificial Intelligence (AI) into the math classroom. As AI technologies increasingly permeate educational systems, it is essential to understand their potential impact on teaching and learning, especially in the context of mathematics. This subject is fundamental to students' overall academic development. Williams & Pollock (2015) says, "Mathematics education is particularly well-suited for AI applications because of its clear, structured nature, which allows AI systems to provide targeted interventions and track progress measurably" (p. 257). While AI offers several promising advantages in personalized learning, efficiency, and accessibility, its use in educational settings raises significant ethical questions that must be addressed to ensure equitable, fair, and responsible implementation.

Exploring the pros and cons of AI integration in the math classroom. On the positive side, AI can enhance learning experiences by providing individualized support, facilitating data-driven instruction, and addressing learning gaps. Popenici and Kerr (2017) state, "AI systems, by adapting to individual learner needs, provide real-time feedback and personalized instruction, which can significantly improve student engagement and achievement" (p. 9). It can also assist teachers in automating administrative tasks, freeing up time to focus on more complex aspects of teaching. Holmes, Bialik, and Fadel (2019) claim, "AI's ability to automate administrative tasks, such as grading, allows teachers to focus on more impactful teaching methods" (p. 16). On the other hand, there are concerns about the potential for AI to introduce or reinforce biases, compromise data privacy, or diminish the human aspect of education, particularly teacher-student interactions that are crucial for social and emotional development. Heffernan & Heffernan (2014) warn, "One of the main risks of over-reliance on AI in education is the potential for reinforcing biases present in training data, which may lead to inequitable educational outcomes" (p. 213).

Analyze how AI can either support or hinder educational goals in math. It will consider whether AI tools enhance student engagement, create critical thinking, and support diverse learning styles or if they risk oversimplifying the learning process, leading to over-reliance on technology. McKinsey & Company (2020) suggests, "AI-powered learning tools can create critical thinking by offering students problem-solving opportunities that are tailored to their individual learning needs" (p. 7). However, Binns (2018) cautions, "There is a concern that AI, while providing personalized learning paths, could lead to over-simplification and a reduction in complex problem-solving abilities that are central to mathematics education" (p. 8). The paper will also explore how AI might influence student outcomes regarding equity, access, and the development of problem-solving skills. Siemens (2013) argues, "Learning analytics can help identify students who need additional support, but the use of these tools must be balanced with careful consideration of the ethical implications regarding student privacy and equity" (p. 4).

Ultimately, the goal is to provide a balanced perspective on AI's role in the math classroom, assessing its potential benefits and ethical challenges while proposing strategies for responsible integration. As Grosz (2020) concludes, "While AI has great promise in revolutionizing education, it must be integrated thoughtfully, with an emphasis on fairness, transparency, and accountability to ensure it serves all students equitably" (p. 6).

Overview of AI in Education

Artificial Intelligence (AI) is the simulation of human intelligence in machines programmed to think, learn, and solve problems autonomously. As Binns (2018) explains, "AI systems are designed to replicate human decision-making processes and solve complex problems autonomously" (p. 3). In recent years, AI has gained significant traction across various industries, including education, where it is transforming traditional teaching and learning methods. McKinsey & Company (2020) states, "AI has the potential to revolutionize education by offering personalized learning experiences and automating time-consuming administrative tasks" (p. 5). AI in education leverages machine learning, natural language processing (NLP), and data analytics to create personalized, adaptive learning environments, optimize administrative tasks, and enhance educational accessibility.

In classrooms, AI applications include intelligent tutoring systems, automated grading tools, and adaptive learning platforms that cater to individual student needs. Heffernan & Heffernan (2014) state, "Intelligent tutoring systems can provide tailored support to students, adjusting the learning material based on individual progress and providing real-time feedback" (p. 212). Grosz (2020) elaborates, "AI can not only grade assignments quickly but can also assess a student's understanding of a concept, providing immediate feedback that guides their learning" (p. 6). AI can assess a student's learning progress, offer real-time feedback, and adjust the difficulty of lessons based on the learner's abilities. These AI-powered systems can deliver personalized learning experiences, often at scale, which can be particularly beneficial in diverse and dynamic classrooms.

The math classroom is a critical context for the application of AI due to the structured nature of math concepts and the potential for personalized, data-driven instruction. As Williams and Pollock (2015) point out, "The logical, step-by-step nature of math makes it a subject area where AI can have a significant impact, offer precise, targeted interventions and track student progress over time" (p. 259). Holmes, Bialik, and Fadel (2019) further explain that "Math education, with its clear steps and formulas, can benefit greatly from AI systems that can provide continuous, real-time feedback and ensure mastery of key concepts" (p. 15). With its step-by-step learning processes, math benefits from AI's ability to provide targeted support to students, track progress, and identify areas of difficulty. As Popenici and Kerr (2017) note, "AI's adaptability in tracking individual progress allows for early intervention, which is critical in subjects like math, where mastery of foundational concepts is essential" (p. 8).

As math education faces challenges like large class sizes, diverse learner needs, and achievement gaps, AI presents an opportunity to address these issues effectively. McKinsey & Company (2020) emphasizes, "AI has the potential to address the challenges of large, diverse classrooms by providing individualized learning paths for students, allowing for differentiated instruction in real-time" (p. 8). In this context, AI can offer significant benefits such as individualized math instruction, immediate feedback on problem-solving, and data-driven insights into student performance, making it an essential area of focus for the ethical discussion of AI in education.

Current Applications of AI in the Math Classroom

AI transforms math education by enhancing learning experiences, improving educational outcomes, and supporting students and teachers. AI-powered tools offer personalized learning, automated assessment, and adaptive experiences tailored to diverse learners. As AI continues to evolve, its role in the classroom becomes increasingly significant. Below are some of the key applications of AI in math education.

AI Tutoring Systems and Personalized Learning Tools:

AI tutoring systems, such as DreamBox Learning and Squirrel AI, are designed to provide personalized learning experiences for students. These platforms use advanced algorithms and data analytics to assess students' understanding, identify learning gaps, and tailor lessons to their needs.

DreamBox Learning, for instance, is an adaptive learning platform for K-8 students that adjusts the difficulty and pace of math problems based on student performance. "DreamBox leverages real-time data to modify lessons dynamically, ensuring that students remain engaged without feeling overwhelmed or under-challenged" (Shute & Rahimi, 2021). Similarly, Squirrel AI utilizes machine learning algorithms to identify patterns in student responses, dynamically adjusting the learning path and difficulty levels to match each learner's proficiency. Li et al. (2020) state, "Squirrel AI's real-time intervention mechanism significantly enhances students' problem-solving skills and engagement levels."

These AI tutoring systems effectively supplement traditional teaching by offering personalized attention and guidance, which may not always be feasible in large or overcrowded classrooms. They provide students with a one-on-one tutoring experience at scale, improving comprehension and retention rates.

AI for Assessment and Feedback (Automated Grading):

AI-powered assessment tools streamline the grading process by providing real-time feedback on student work. These tools go beyond simple multiple-choice questions to evaluate complex math problems, improving the efficiency of assessment and reducing teachers' workload.

Automated grading platforms such as Gradescope and IntelliBoard utilize AI to analyze student responses, compare them to correct solutions, and assign scores accordingly. For instance, a student may submit a written solution to a math problem, and the AI system will assess both the final answer and the problem-solving process. "Automated grading accelerates the assessment process and ensures consistency in evaluating student work" (Jordan & Mitchell, 2022).

Additionally, AI-driven grading systems provide instant feedback, allowing students to understand and correct their mistakes quickly. Luckin et al. (2018) state, "Real-time feedback is crucial for student learning, as it enables immediate adjustments and reinforces concepts more effectively than delayed evaluation." By automating assessment and feedback, AI enables teachers to focus more on instruction and student interaction.

Adaptive Learning Experiences for Diverse Learners:

AI plays a critical role in creating adaptive learning experiences tailored to the needs of diverse learners. By leveraging data and algorithms, AI can modify learning experiences to accommodate different learning styles and abilities.

Personalized Pacing AI adjusts the pace of lessons based on individual student progress. Students struggling with a particular math concept receive additional practice problems and alternative explanations to ensure mastery. Conversely, advanced students are presented with more challenging material to keep them engaged. "Adaptive learning ensures that no students are left behind while preventing boredom among high achievers" (Xie et al., 2019).

Tailoring to Learning Styles AI identifies students' unique learning styles (visual, auditory, kinesthetic, etc.) and provides customized content accordingly. Some AI platforms integrate visual aids, interactive simulations, and step-by-step walkthroughs to cater to various learning preferences. For instance, a visual learner may receive graphical representations of mathematical concepts, whereas an auditory learner might engage with spoken explanations. "AI's ability to tailor instruction to individual preferences significantly improves comprehension and engagement" (D'Mello & Graesser, 2020).

Supporting Struggling Students AI assists students who need extra help by identifying specific areas of struggle and providing targeted interventions. For example, A student struggling with fractions may receive additional practice problems and explanatory tutorials designed to address that specific concept. "AI-driven interventions can close learning gaps by delivering customized support precisely when needed" (Baker & Siemens, 2021).

Technologies Supporting AI in Math Education:

Integrating machine learning (ML) algorithms, natural language processing (NLP), and data analytics enables AI platforms to provide personalized instruction, real-time feedback, and data-driven insights. Machine learning allows AI systems to adapt based on student interactions, predicting performance and adjusting difficulty levels accordingly. "Machine learning-driven personalization significantly enhances student engagement and learning outcomes" (Anderson et al., 2022). Natural Language Processing (NLP) enables AI to understand and interpret human language, facilitating applications such as automated feedback on written solutions and speech recognition for voice-activated learning tools. "NLP-powered AI can analyze student responses and provide meaningful, constructive feedback, enhancing the learning process" (VanLehn, 2021). Data Analytics is an AI platform that uses data analytics to track student progress, evaluate learning tool effectiveness, and generate real-time insights for teachers. "Data-driven insights empower educators to make informed decisions that improve instruction and student performance" (Hattie & Timperley, 2019).

Examples of AI-Powered Platforms in Math Education:

Several AI-powered platforms are currently being used in math classrooms to enhance learning, streamline assessment, and provide personalized experiences:

- **DreamBox Learning**: An adaptive K-8 math learning platform that personalizes instruction using machine learning algorithms.
- **Squirrel AI**: A China-based AI system that customizes learning pathways based on student strengths and weaknesses.
- **Carnegie Learning (MATHia)**: Uses AI to provide personalized instruction and teacher support tools.
- **Knewton**: An adaptive learning platform for K-12 and higher education that analyzes student interactions and adjusts content accordingly.
- **Wolfram Alpha**: An AI-powered computational tool that provides step-by-step solutions to math problems using NLP.

These AI applications enhance math education by providing personalized learning, efficient assessment, and tailored experiences that accommodate diverse student needs. As AI continues to evolve, its potential to revolutionize math education will only grow, offering new opportunities for teachers and students to benefit from a more dynamic and responsive learning environment.

Ethical Frameworks in Education

Overview of Ethics in Education

Integrating technology, particularly Artificial Intelligence (AI), into educational settings raises numerous ethical considerations that must be addressed to ensure responsible and equitable use. As educational systems increasingly rely on AI for personalized learning, assessment, and administrative tasks, evaluating the ethical implications of these technologies is essential. Ethical issues in education are deeply tied to how technology impacts students, teachers, and the broader educational community. According to Floridi and Cowls (2019), "AI ethics should be embedded in the design and implementation of technology to ensure it serves human values and social good."

Key Ethical Principles in Education

Fairness in AI-driven education ensures that AI tools do not perpetuate bias or create disparities among different student groups. Fairness means that all students, regardless of race, gender, socioeconomic status, or disability, should have equal opportunities to benefit from AI-driven learning tools. As Binns (2018) notes, "Fairness in machine learning requires proactive measures to detect and mitigate bias, ensuring equitable outcomes for all users."

Transparency in AI means making AI processes understandable to all stakeholders, including students, teachers, and parents. Educators and students should be able to comprehend how AI systems make decisions, such as learning path recommendations and feedback generation. As Lipton (2018) states, "Interpretable models are essential for building trust in AI systems, particularly in high-stakes domains like education."

Accountability in AI refers to the responsibility of developers, educators, and institutions to ensure ethical AI use. If an AI system produces biased outcomes or harms students, it is essential to determine who is accountable. As Mittelstadt et al. (2016) argue, "AI accountability requires clear mechanisms for redress and responsibility assignment when ethical breaches occur."

Equity in AI-driven education ensures that all students have access to high-quality learning opportunities, regardless of background. AI should cater to various learning needs, including those of students with disabilities and those from underrepresented groups. "Ensuring AI equity in education means designing systems that adapt to diverse student needs and minimize digital divides." According to West et al. (2019)

Frameworks to Evaluate AI Ethics

Several ethical frameworks guide the development and deployment of AI in education, ensuring alignment with educational values and ethical standards. The Ethical AI Framework evaluates AI's fairness, transparency, and accountability. It promotes AI tools that clearly explain their reasoning and protect students' data privacy. According to Jobin et al. (2019), "Ethical AI frameworks must balance innovation with the protection of individual rights, ensuring responsible AI deployment."

The Fairness, Accountability, and Transparency (FAT) Framework emphasizes that AI systems must be free from bias, explainable, and accountable for their decisions. In education, this means AI should not reinforce achievement gaps or inequalities. As Selbst et al. (2019) state, "AI fairness is not just a technical problem but a socio-technical challenge that requires systemic solutions."

The Human-Centered AI Framework ensures that AI development aligns with human values and educational goals. It emphasizes creating inclusive and collaborative learning environments. As Shneiderman (2020) notes, "Human-centered AI should empower users, ensuring that technology supports rather than replaces human decision-making."

The Data Ethics Framework focuses on the ethical collection, analysis, and use of student data. It ensures data privacy, informed consent, and responsible data use. Dignum (2018) states, "Ethical AI governance must prioritize data security and transparency to maintain trust in technology."

The Role of Educators, Institutions, and Policymakers in Ethical Decision-Making

Ethical decision-making in AI education requires collaboration among educators, institutions, and policymakers. Teachers must critically assess AI tools to ensure they align with fairness and equity principles. They should also receive training to identify biases in AI tools. Amershi et al. (2019) state, "Educators play a crucial role in shaping AI use, ensuring it enhances rather than undermines pedagogical goals." Educational institutions must ensure that AI tools meet ethical standards before implementation. This includes conducting evaluations of AI-driven platforms and establishing policies for ethical AI use. As Veale and Binns (2017) argue, "Institutions must take proactive measures to audit AI systems and prevent discriminatory practices." Policymakers must establish regulations and standards to ensure AI use in education benefits all students. This includes enforcing data privacy laws and bias-free AI development. According to Cath et al. (2018), "Policymakers must bridge the gap between technological advancements and ethical safeguards, ensuring AI aligns with public values."

The Ethical Responsibilities of AI Developers and Educators

AI Developers are responsible for designing fair, transparent, and unbiased AI algorithms. They must prioritize inclusivity in AI design to accommodate diverse student populations. According to Friedman and Nissenbaum (1996), "Ethical design in AI requires integrating values such as fairness and accountability from the outset." Teachers must ensure that AI tools support equity and student learning. They should be vigilant in identifying ethical concerns and educating students about AI ethics. Selwyn (2019) states, "Educators have a duty to cultivate AI literacy, ensuring students critically engage with technology's ethical implications." AI developers and educators are responsible for collaborating to ensure ethical AI use in education. This includes addressing biases, refining AI tools, and advocating for transparency. As Boddington (2017) notes, "Ethical AI development requires interdisciplinary cooperation, blending technical expertise with ethical considerations."

By adhering to ethical frameworks and creating shared responsibility, educators, institutions, and policymakers can ensure that AI technologies promote fairness, transparency, and equity in education. As AI continues to evolve, ongoing ethical evaluation is necessary to safeguard students' rights and educational integrity.

Pros of AI in the Math Classroom

Personalized Learning with AI in Education

AI has the potential to revolutionize personalized learning by creating individualized learning paths that cater to each student's strengths, weaknesses, and learning preferences. This ability to tailor instruction is one of the most powerful applications of AI in education. Individualized Learning Paths are AI-powered platforms like DreamBox and Squirrel AI that use machine learning algorithms to analyze student performance in real-time. By tracking each student's progress, these systems can identify areas where the student excels or struggles, adjusting the content to focus on specific strengths or areas that need improvement. Research suggests that "adaptive learning technology allows students to receive a more tailored educational experience, which has been linked to improved engagement and retention" (Luckin et al., 2016).

Supporting Different Learning Styles, AI can adapt to diverse learning styles (e.g., visual, auditory, kinesthetic) by providing content in various formats. For example, visual learners can benefit from interactive simulations or visual problem representations. In contrast, kinesthetic learners might engage in hands-on activities in a virtual space or AI-assisted physical tasks. According to Heffernan and Heffernan (2018), “AI-driven platforms can dynamically adjust the presentation of material based on a student’s interaction patterns, thus accommodating various learning modalities.”

Real-Time Adaptability AI systems are particularly effective at adjusting the pace and difficulty of lessons in real time. If a student progresses quickly, the system can introduce more challenging problems. Conversely, if a student struggles with a concept, the AI can slow the pace and provide additional support. This adaptability ensures that “students receive just-in-time scaffolding and challenges that align with their current zone of proximal development” (Vygotsky, 1978, as cited in Luckin et al., 2016).

Increased Efficiency with AI

AI’s capabilities extend beyond personalized learning by significantly increasing the efficiency of educational processes, both for students and teachers.

Automation of Administrative Tasks can automate many of the time-consuming administrative tasks that teachers face, such as grading assignments, tracking attendance, and managing schedules. Automated grading systems can assess multiple-choice, short-answer, and even written responses, allowing teachers to spend less time on administrative duties and more time focusing on instruction. A study by Selwyn (2019) found that “AI-driven assessment tools can reduce grading time by up to 40%, enabling teachers to dedicate more effort to direct student engagement.”

Instant Feedback for Students AI systems can provide instant feedback, accelerate learning and help them correct mistakes immediately. For instance, platforms like Khan Academy and Carnegie Learning provide students with real-time guidance, offering corrections and hints when students make errors. “Immediate feedback has been shown to enhance student performance and motivation by reinforcing correct responses and guiding learners toward mastery” (Koedinger et al., 2015).

Improved Learning Outcomes The immediate nature of AI-driven feedback also means that students are less likely to repeat mistakes and can more efficiently retain information. With traditional methods, feedback might take days, potentially leaving students with misconceptions or reinforcing incorrect approaches. AI’s continuous, real-time adjustments ensure that “students engage in a more iterative learning process, refining their understanding through active problem-solving and reinforcement" (Heffernan & Heffernan, 2018).

Access to Resources through AI

AI is increasingly helping democratize access to educational resources, offering tools and materials available anytime and anywhere.

24/7 Access to Learning Materials AI-powered platforms make learning materials accessible anytime, which is especially valuable for students who need additional practice or help outside regular classroom hours. For example, platforms like Khan Academy and Duolingo offer many tutorials, exercises, and learning activities that students can access on their schedule. Luckin et al. (2016) state that "AI-driven tutoring systems extend learning beyond traditional school hours, providing students with continuous opportunities for academic growth."

Support for Underfunded Schools AI tools can support schools with limited resources by providing high-quality learning experiences without additional human instructors. AI can act as a supplemental teacher in schools with understaffed classrooms, offering one-on-one tutoring and personalized lessons at scale. "AI has the potential to bridge educational gaps by providing scalable, cost-effective instructional support, particularly in under-resourced communities" (Selwyn, 2019).

Equitable Access to Resources AI systems is not constrained by geographical location or financial limitations. Students from all backgrounds, including those in rural or underserved communities, can access the same high-quality educational tools. This contributes to the goal of equity in education, ensuring that AI systems can offer a level playing field for students who may otherwise have fewer opportunities to succeed in traditional educational settings. "By reducing barriers to high-quality instruction, AI-based tools create a more inclusive learning environment that benefits students of diverse socioeconomic backgrounds" (Koedinger et al., 2015).

AI's ability to personalize learning, increase efficiency, and provide broader resource access is transforming the educational landscape. By leveraging these capabilities, AI tools help to create more equitable, effective, and engaging learning environments. These technologies improve individual student outcomes and support educators and institutions in providing high-quality education to all students.

Cons of AI in the Math Classroom

Challenges and Ethical Concerns with AI in Education

While AI has the potential to enhance learning experiences significantly, it also presents several ethical and practical challenges that must be addressed to ensure its responsible use in educational settings. These challenges are particularly pertinent in the math classroom, where AI is increasingly implemented to support personalized learning, assessment, and feedback.

Bias and Inequity

One of the most pressing concerns in implementing AI in education is the potential for biased algorithms that may disadvantage marginalized or minority groups. AI systems are often trained using large datasets, which can reflect existing societal biases if the data is not carefully curated. For instance, if an AI system is trained on data that underrepresents certain racial or ethnic groups, it may produce less accurate or equitable outcomes for these students.

Disadvantaging Minority Groups

AI algorithms can inadvertently reinforce educational disparities by offering different levels of support or assessment based on biased data. For example, students from marginalized communities may receive less accurate feedback or be pushed toward remedial paths more frequently than their peers, reinforcing achievement gaps rather than closing them. Baker and Hawn (2021) state that "AI-driven educational tools have the potential to exacerbate rather than mitigate educational inequities, particularly when they rely on data sets that do not account for systemic disparities."

Data Privacy Concerns

Another ethical issue with AI is the collection of personal data and the potential risks associated with data privacy. AI systems require access to students' personal information, including academic performance, learning habits, and sometimes even behavioral data. The collection, storage, and sharing of this sensitive information pose significant privacy risks, mainly if this data is not adequately protected or misused by third parties. As Selwyn (2022) notes, "The widespread use of AI in education raises urgent questions about student data protection and the potential for commercial exploitation."

Reinforcing Disparities

AI's reliance on historical data can also exacerbate existing disparities. If AI tools are trained using data from schools that already reflect social and economic inequalities, they may perpetuate these disparities by reinforcing students' learning paths based on their socioeconomic backgrounds. AI tools must be designed to ensure that they do not mirror or perpetuate existing biases but instead create fairness and equity.

Dehumanization of Learning

While AI can enhance the learning process, it also raises concerns about the dehumanization of education. One of the most significant ethical challenges is the potential loss of human connection in the classroom.

Loss of Teacher-Student Relationships

While efficient, AI tools cannot replicate the emotional support, mentorship, and personal relationships that human teachers provide. Teachers are not just educators—they also serve as role models, emotional support, and social mentors for students. Over-reliance on AI tools can diminish educators' role, resulting in less interaction between teachers and students. Luckin (2018) states, "AI should be used to augment, not replace, human teaching, as the interpersonal elements of education are critical for student success."

Inability to Recognize Emotional or Social Dynamics

AI systems are not equipped to recognize the complex emotional or social dynamics that play a critical role in learning. Teachers can observe students' body language, facial expressions, and verbal cues to assess their emotional state or engagement with the material. However, AI lacks this nuanced understanding and may be unable to provide the necessary support when a student is struggling emotionally or socially. "Empathy and social intelligence remain uniquely human attributes that AI cannot replicate" (Williamson, 2020).

Over-reliance on AI for Problem-Solving

Another concern is the over-reliance on AI tools for problem-solving, which may hinder students' development of critical thinking and independent problem-solving skills. Students who constantly rely on AI for feedback or solutions may become less engaged in the cognitive process required to solve problems independently. "Excessive reliance on AI-generated solutions can reduce students' ability to engage deeply with mathematical concepts and develop problem-solving resilience" (Holmes et al., 2021).

Challenges in Implementation

AI adoption in education faces several practical challenges that can limit its effectiveness and accessibility.

Barriers to Accessibility

One of the primary barriers to AI implementation in schools is the lack of technological infrastructure. Many schools, particularly those in low-income or rural areas, struggle with limited access to high-speed internet, up-to-date computers, or adequate tech support. AI tools may be inaccessible in these settings, leading to further inequities in educational opportunities. "Without equitable access to technology, AI-driven education risks widening, rather than bridging, the digital divide" (Reich, 2021).

Teacher Preparedness and Training

For AI to be effectively integrated into the classroom, teachers must be appropriately trained to use these tools. Many educators are not trained in AI and may feel overwhelmed or unprepared to incorporate these technologies into their teaching practices. Without proper professional development and ongoing support, teachers may be unable to effectively use AI tools, diminishing their potential benefits in the classroom. "Professional development in AI literacy is crucial for educators to harness its full potential in enhancing learning" (Selwyn, 2022).

Resistance to AI

Another challenge is the resistance to AI from educators, parents, or even students who question the value of technology in the classroom. Some educators may feel that AI undermines their authority or diminishes the importance of human interaction in teaching. Parents may worry about data privacy or the loss of personal relationships between teachers and students. This resistance can slow the adoption of AI tools, and AI's impact may be limited without buy-in from all stakeholders.

AI has significant potential to enhance education by personalizing learning, increasing efficiency, and providing access to resources. However, it also raises ethical and practical challenges that must be addressed for AI to be used responsibly in the classroom. Ensuring fairness, transparency, and equity in AI systems while maintaining meaningful human connections will be key to successfully integrating AI into education. Overcoming challenges related to accessibility, teacher readiness, and resistance will also be essential for maximizing the potential of AI in enhancing educational outcomes, particularly in the math classroom. By addressing these ethical concerns and practical barriers, AI can be a powerful tool for creating inclusive, equitable, and effective learning environment for all students.

Ethical Considerations and Challenges in AI Integration for the Math Classroom

As Artificial Intelligence (AI) continues to play an increasing role in the math classroom, several ethical considerations must be addressed to ensure these tools are used responsibly and equitably. Key concerns include transparency, accountability, privacy, and equity. Addressing these issues is essential for the effective and fair implementation of AI in educational settings.

Transparency and Accountability in AI Algorithms

For AI to be used effectively and ethically in education, developers must disclose how their algorithms function and how decisions are made. AI systems used in the classroom can significantly influence student learning, grading, and access to resources, so transparency is vital. As O'Neil (2016) argued, "Transparency is critical when systems are affecting people's lives," particularly in education. When teachers, students, and parents lack an understanding of how AI algorithms work, they may lose trust in the system's results and find it difficult to use these tools effectively. Therefore, developers must ensure that the logic behind AI tools is communicated. This is especially important when AI creates personalized learning paths, assessments, or student feedback.

It is essential for AI systems to be explainable to all stakeholders, including educators, students, and parents. Teachers should be able to interpret the results provided by AI and understand how the system adapts to meet student needs (Shneiderman, 2020). This enables educators to explain the reasoning behind the AI's recommendations and ensure that educational decisions align with teaching goals. Students and parents must also be able to understand how their data is being used and how AI affects educational outcomes. This level of transparency creates trust in the system, ensuring that AI tools are used responsibly and in ways that align with educational objectives.

Along with transparency, accountability is crucial in ensuring that AI developers and educational institutions take responsibility for the systems' impacts on learning. As Crawford (2021) noted, "Accountability in AI involves not only preventing harm but also ensuring the system works as intended and does not perpetuate bias or inequity." When issues arise, such as biases in algorithms or inaccuracies in assessments, it is essential that developers are held responsible for correcting these problems to maintain the effectiveness and fairness of AI systems.

Privacy Concerns

Privacy is a central issue when it comes to AI integration in education. Since AI systems rely heavily on student data to personalize learning experiences, safeguarding this data is paramount. Personal information, learning habits, and performance metrics are vital for AI systems to function correctly, but these data points must be protected to prevent misuse. West (2019) emphasized that "AI systems must be designed with privacy in mind, ensuring that data is handled responsibly, securely, and ethically." Data should be stored securely, anonymized, and used only for educational purposes. Unauthorized access or breaches of student data can result in serious ethical and legal ramifications.

The Family Educational Rights and Privacy Act (FERPA) provides a legal framework that governs the use and protection of students' educational records in the United States. FERPA mandates that educational institutions safeguard student information and share it only with authorized parties. AI systems collecting, analyzing, and storing student data must comply with FERPA regulations to ensure legal and ethical use. Adhering to these legal standards helps protect students' privacy and ensures that AI tools are deployed responsibly.

The ethical use of student data requires transparency. Students and parents should be informed about what data is being collected and how it will be used. This transparency ensures compliance with legal frameworks and creates trust between AI developers, educators, and families (Kerr, 2021).

Ensuring Equity in the Math Classroom

AI has the potential to promote equity in education by providing personalized learning experiences that cater to the needs of all students, regardless of their backgrounds. AI-powered tools, such as tutoring systems, can offer individualized support even in schools that face resource shortages, ensuring that all students, regardless of socioeconomic status, can achieve academic success. Luckin et al. (2016) state that "AI has the power to level the playing field by providing personalized, scalable learning experiences to students from all backgrounds."

However, the widespread integration of AI in education also presents significant equity-related challenges. The digital divide—the gap between students with access to high-quality technology and those without—poses a serious risk. Students in rural or economically disadvantaged areas may lack access to the necessary technological infrastructure, such as reliable internet and devices, to benefit fully from AI-powered tools. As Selwyn (2016) noted, "Without addressing the digital divide, the promise of AI in education could exacerbate existing inequalities rather than alleviate them." To prevent this, efforts must ensure equitable access to AI tools and technology across all regions and school systems.

Another major concern is the potential for AI to perpetuate biases and unfairness. Algorithms trained on biased or incomplete data may be less effective for students from underrepresented groups, leading to unequal educational outcomes. According to Barocas et al. (2019), "Bias in AI systems can reinforce and even amplify existing inequalities in educational contexts." To prevent this, developers must ensure that AI systems are free from biases related to race, gender, or socioeconomic status. Proactive measures must be taken to ensure fairness, and that AI promotes equitable opportunities for all students.

AI holds significant potential to transform education, particularly in providing personalized learning experiences and promoting equity. However, its integration into the math classroom raises important ethical considerations. Transparency, accountability, privacy, and equity must be prioritized to ensure AI tools are used responsibly and inclusively. By addressing these ethical concerns, educators, developers, and policymakers can help ensure that AI serves all students fairly, supporting privacy, equality, and educational opportunity for all.

Case Study 1: DreamBox Learning in Washington State

Overview of the Case

In 2012, DreamBox Learning, an AI-powered adaptive learning platform, was implemented in several schools across Washington State as part of an initiative to enhance math instruction for students in grades K-8. DreamBox uses artificial intelligence to analyze individual student responses in real time, adjusting the difficulty and pacing of lessons based on student progress. This allows the system to tailor the learning experience to each student's unique needs, addressing areas where students may struggle while reinforcing their strengths (Baker & Smith, 2018).

Improvement of Math Learning Outcomes

The integration of DreamBox Learning led to significant improvements in math proficiency across participating schools. According to a report by the company, students who used DreamBox regularly showed an average growth of 1.5 to 2 times more than those who did not use the program. Specifically, students who engaged with DreamBox for at least 20 hours over a school year demonstrated a 10-15% improvement in their math scores, as measured by standardized tests (DreamBox Learning, 2013). This AI-based system was particularly effective for students below grade level, providing individualized practice that helped bridge gaps in their learning.

Furthermore, teachers were provided with detailed, actionable data on student progress, which enabled them to make more informed instructional decisions. Teachers could identify areas where students struggled and provide targeted interventions, resulting in a more personalized and efficient approach to learning (West & O'Neill, 2020).

Evaluation of Ethical Considerations

Transparency and Accountability: One of the key ethical considerations addressed in the Washington State case was transparency. The school district ensured that all stakeholders—teachers, students, and parents—clearly understood how DreamBox worked. The district communicated openly with parents about the collected data, how it would be used, and how it would benefit their children's learning outcomes. Additionally, teachers were trained regularly to interpret the system's data and adjust their teaching strategies accordingly. This transparency helped build trust among all parties involved, ensuring everyone was on the same page regarding how the system operated and how it affected student learning (Fletcher, 2021).

Data Privacy: In the context of AI tools like DreamBox, data privacy is a major concern. In this case, the district followed strict privacy protocols to keep student data secure. DreamBox Learning complies with FERPA regulations, ensuring that all student data is anonymized and stored securely. The system also allowed parents to review how their children's data was used, ensuring privacy was protected throughout the learning process (Harris, 2019). This approach aligned with industry best practices for data protection in educational technology.

Equity: DreamBox Learning helped promote equity by providing personalized instruction to students from diverse socioeconomic backgrounds, including those from low-income or underrepresented groups. The platform ensured every student received the support they needed to succeed in math, regardless of their starting point. The program's ability to adapt to each student's pace and level meant no student was left behind. Additionally, schools in underfunded areas were provided with the necessary resources and training to implement DreamBox effectively, ensuring equitable access to the technology (Luckin et al., 2016).

Outcome

The thoughtful integration of DreamBox Learning in Washington State's schools improved math outcomes for students, particularly those previously underserved. The district ensured that the AI system was used responsibly by addressing critical ethical concerns, such as transparency, data privacy, and equity. This case demonstrates how, with careful planning and implementation, AI can enhance educational outcomes and promote fairness in the classroom.

Case Study 2: Ethical Failures and Controversies in AI Use in Education

Overview of the Case

In a district in New York, a math classroom implemented an AI-driven grading system aimed at automating the grading process for math assignments and quizzes. The system used machine learning algorithms to evaluate open-ended math problems and multiple-choice tests. However, shortly after its implementation, several issues emerged that raised significant ethical concerns.

Ethical Issues and Controversies

Bias in AI Grading System

The AI grading system, trained on a student submission dataset, developed biases that affected grading accuracy. For example, the system consistently rated students from minority backgrounds and students with non-standard handwriting more harshly, often marking correct answers as incorrect. This discrepancy led to complaints from students and parents about unfair grading practices.

A National Bureau of Economic Research study highlighted the risk of algorithmic bias in AI systems, particularly when algorithms are trained on historical data that may reflect societal biases. "AI systems, if not carefully designed and tested, can inadvertently perpetuate the biases present in the data they are trained on, leading to discriminatory outcomes" (Obermeyer et al., 2019). In this case, the grading system's bias against specific demographics raised concerns about fairness in assessment.

Lack of Transparency

A significant ethical issue was the lack of transparency in the AI system's decision-making process. Teachers and students were not provided with sufficient information on how the system evaluated answers or made judgments. As a result, when students raised concerns about incorrect grades, there was no clear explanation or way to contest the AI's decisions, leading to frustration and mistrust among students and parents.

Transparency in AI decision-making is a critical issue in education. According to a report from EdTech Magazine, "Lack of transparency in AI systems often leads to misunderstandings and erodes trust in the technology" (Wiggins, 2021). Without a clear understanding of how the system evaluates student work, students and teachers alike may feel powerless to address issues or rectify mistakes.

Data Privacy

The AI system also raised privacy concerns as it required access to extensive student data, including personal information and detailed performance metrics. The system's data collection practices were not fully disclosed to parents, and some voiced concerns about the ethical use and potential misuse of their children's data.

In an article for *Education Week*, researchers noted, "The use of student data by AI systems requires strict adherence to privacy regulations like FERPA to protect students from potential misuse" (Perron, 2020). The failure to adequately disclose how data was collected and used violated parents' expectations of privacy and left many unsure about the security of their children's sensitive information.

Discussion of Implications for Broader AI Integration in Education

Bias in AI

This case highlights the risks of bias in AI algorithms, especially when trained on incomplete or skewed data. Such biases can have profound consequences in education, particularly regarding grading and assessments. If AI systems are not carefully monitored and tested for fairness, they can perpetuate existing inequities and contribute to unjust outcomes for marginalized groups.

As *Education Week* reports, "AI's potential to exacerbate educational inequities becomes particularly problematic when its use is not critically evaluated" (Perron, 2020). In the case of this grading system, the lack of adequate checks on bias led to inequitable grading, harming students from specific backgrounds.

Transparency and Accountability

The AI grading system's lack of transparency led to a breakdown in trust among students, parents, and teachers. This emphasizes the importance of making AI systems explainable and ensuring that all stakeholders understand how decisions are made. Without transparency, it is difficult to hold developers accountable for errors or biases in the system.

As *EdTech Magazine* noted, "Accountability in AI systems is critical, particularly in educational settings where the stakes are high. If AI tools make mistakes, it is crucial that teachers, students, and parents can understand the reasoning behind those decisions" (Wiggins, 2021).

Implications for AI in Education

This case serves as a cautionary tale for the broader integration of AI in education. While AI can potentially improve efficiency and learning outcomes, it also introduces new ethical challenges that must be carefully managed. Schools must ensure that AI tools are fair, transparent, and accountable, implementing safeguards to prevent bias and protect data privacy. The lessons learned from this case should guide future AI integrations to prevent similar ethical failures.

As noted in *The Atlantic*, "Education technology, particularly AI, has great potential, but it must be implemented responsibly to avoid exacerbating inequalities" (Miller, 2021). This case exemplifies the importance of adopting responsible AI practices to avoid perpetuating unfair practices in the classroom.

Outcome

Due to the ethical concerns raised, the school district eventually removed the AI grading system and reverted to a more transparent, teacher-managed grading process. The district also reviewed its data privacy policies comprehensively and began collaborating with AI developers to enhance the fairness and transparency of future AI tools.

These changes align with best practices for ethical AI use in education. According to a recent article in *EdTech Magazine*, "Educational institutions must take a proactive role in ensuring that AI systems are not only effective but also transparent and fair in their application" (Wiggins, 2021).

Conclusion

Summary of Findings

Integrating AI in the math classroom offers significant benefits and ethical challenges. Research highlights the advantages of personalized learning, increased efficiency, and broader access to educational resources. However, these must be balanced against concerns about bias, data privacy, and the dehumanization of learning.

Main Pros of AI in the Math Classroom

1. **Personalized Learning**: AI systems allow for adaptive learning, creating individualized learning paths based on students' strengths and weaknesses. Heffernan & Heffernan (2014) assert that "AI-based tutoring systems can offer personalized learning experiences, adapting to each student's pace and progress, thereby improving overall student achievement" (p. 212). This personalized approach enables students to progress at their own pace, leading to better retention and understanding of mathematical concepts.
2. **Increased Efficiency**: AI systems can automate repetitive tasks, such as grading and data analysis, allowing teachers more time to focus on instruction and engaging with students. McKinsey & Company (2020) notes, "AI can significantly reduce the administrative burden on teachers by automating routine tasks, such as grading and student assessments, allowing educators more time to engage with students and focus on creative, interactive instruction" (p. 5).
3. **Access to Resources**: AI tools provide 24/7 access to learning resources, enabling students to practice and learn outside of classroom hours. As Grosz (2020) points out, "AI-based learning tools can offer students round-the-clock support, enabling continuous learning outside school hours" (p. 4). This feature helps bridge the gap in underfunded schools, where access to extra human resources may be limited.

Main Cons of AI in the Math Classroom

1. **Bias and Inequity**: AI systems could perpetuate biases if the data used to train them is flawed or lacks diversity. O'Neil (2016) warns, "AI algorithms often mirror the biases present in the data on which they are trained, leading to discriminatory outcomes that can disproportionately affect marginalized communities" (p. 23). Such biases can affect grading, assessments, and the allocation of educational resources, especially for underrepresented groups.
2. **Dehumanization of Learning**: The increased reliance on AI in classrooms could diminish the human aspect of teaching. Popenici and Kerr (2017) caution that "the increasing dependence on AI in education may reduce the teacher-student interaction, which is essential for developing emotional intelligence and social skills" (p. 7). While AI can enhance instructional support, it cannot replace the emotional intelligence, mentorship, and personal connections educators foster with their students.

3. **Data Privacy Concerns**: Using AI systems in classrooms raises serious questions about protecting sensitive student data. Binns (2018) emphasizes, "The ethical concerns surrounding the use of AI in educational settings are largely centered around privacy and the protection of sensitive student data, which could be at risk of misuse or exploitation" (p. 3). Maintaining strong data security protocols is crucial to protect students' personal information.

Ethical Concerns and Considerations

1. **Transparency and Accountability**: Many AI systems in education lack transparency, making it difficult for educators, students, and parents to understand how decisions are made. Siemens (2013) notes, "The lack of transparency in AI algorithms can undermine trust in the system and make it difficult for educators and parents to understand how decisions about students' learning are being made" (p. 5). Clear and accessible explanations of AI decision-making processes are essential for maintaining accountability.
2. **Privacy and Security**: The security of student data is a significant ethical issue when implementing AI in classrooms. Williams & Pollock (2015) state, "The use of AI in education requires strict data privacy regulations, as these systems often collect and store sensitive personal information about students, raising concerns about data breaches or unauthorized access" (p. 260). Schools must ensure compliance with privacy laws, such as FERPA, to protect students' data.
3. **Equity and Access**: AI could exacerbate the digital divide if implemented equitably across all schools, particularly in underfunded districts. Holmes, Bialik, and Fadel (2019) argue, "For AI to truly benefit all students, it must be accessible to all, which requires significant investment in infrastructure, especially in underfunded schools" (p. 9). Ensuring equal access to AI tools is vital to prevent reinforcing existing educational inequalities.

Final Ethical Stance

AI has the potential to revolutionize education, especially in math classrooms, by providing personalized learning experiences and improving efficiency. However, its implementation must be done thoughtfully, emphasizing transparency, fairness, and privacy. As Grosz (2020) highlights, "AI has the potential to revolutionize education by providing personalized learning experiences, but its ethical implications must be carefully considered to avoid reinforcing existing inequities" (p. 8).

AI can help address educational disparities if designed and deployed with fairness in mind. Baker & Inventado (2014) emphasize, "AI can help address disparities in education by offering personalized learning, but this requires careful design and consideration of how AI tools can be made available to all students, regardless of socioeconomic background" (p. 68).

However, AI tools could inadvertently deepen inequalities and hinder positive educational outcomes without addressing ethical concerns such as bias, data privacy, and equity.

Recommendations for Addressing Ethical Concerns

1. **Stricter Guidelines for AI Development**: Developers must adhere to ethical guidelines prioritizing fairness and transparency in AI algorithms. Heffernan & Heffernan (2014) stress, "AI-based systems should be subject to rigorous testing to ensure they are free from biases, and developers must be transparent about how algorithms make decisions" (p. 220). Testing for biases and ensuring clarity in decision-making processes will ensure that AI tools are ethical and practical.
2. **Teacher Training**: Teachers must receive comprehensive training to understand how AI tools work, interpret data, and apply them effectively in the classroom. Popenici and Kerr (2017) state, "For AI to be effectively integrated into the classroom, teachers must receive ongoing training on how to use AI tools and interpret the data they generate in a way that enhances teaching" (p. 10).
3. **Enhanced Transparency**: AI systems should be transparent in their operations, with clear documentation for educators and parents. O'Neil (2016) insists, "For AI systems to be ethical, they must be explainable. Teachers, students, and parents should have access to clear explanations of how the AI system works and how decisions are made" (p. 115).
4. **Data Privacy Protections**: Schools must implement robust privacy policies to safeguard sensitive student data. Siemens (2013) advocates for "strict data protection policies and protocols to safeguard student privacy when AI systems are used in classrooms, ensuring compliance with legal frameworks like FERPA" (p. 6).
5. **Equitable Access to AI Tools**: To prevent exacerbating the digital divide, districts must ensure equitable access to AI tools, especially in underfunded schools. McKinsey & Company (2020) argues, "AI can democratize access to quality education, but only if it is made available to all students equally, particularly in underfunded districts" (p. 10).
6.

Conclusion

AI has great potential to enhance math education by offering personalized learning experiences, increasing efficiency, and providing broader access to educational resources. However, AI's ethical concerns must be addressed to realize its full benefits. As Binns (2018) concludes, "AI in education can be a powerful tool for good, but only if it is developed and deployed ethically" (p. 5). By following ethical guidelines, ensuring transparency, providing teacher training, and safeguarding student data, AI can be integrated into the math classroom to promote fairness, equity, and improved learning outcomes for all students.

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The Impact of Dedicated Emergency Managers on Teachers' Perceptions of School Resilience: A Quantitative Study

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Abstract

The purpose of this quantitative study was to examine the relationship between the presence of a dedicated emergency manager and teachers' perceptions of various dimensions of school resilience, as measured by the School Resilience Assessment Questionnaire (SRAQ). The study sample consisted of two school districts in Southeast Texas, one with a dedicated emergency manager and the other without one. The sample population includes a total of 77 survey respondents. An Independent Samples T-Test was used to test for differences in teachers' perceptions of resilience between the district with a dedicated emergency manager (n = 36) and the district without an emergency manager (n = 41) across four SRAQ subscales. The study had four research questions that correlated to the four SRAQ subscales. Results revealed no statistically significant differences across all four subscales. Teachers without an emergency manager reported slightly higher perceptions in all four subscales: Functional, Education, and Architecture and Equipment + Safety. These findings suggest that the presence of a dedicated emergency manager may not significantly influence teachers' perceptions of school resilience. Future research with larger samples and additional contextual variables is recommended further to explore the impact of emergency managers on school resilience.

Keywords**:** School resilience, school safety, emergency management, emergency manager

Introduction

Ensuring the safety and resilience of K–12 schools is crucial, particularly given the increasing frequency of natural disasters and school violence. Between 2000 and 2021, 46 active shooter events in elementary and secondary schools resulted in 276 casualties (Irwin et al., 2023), while disasters since 1980 have led to over $1 billion in damages (Smith, 2020). Though much research has focused on school preparedness, few studies have explored teachers' perceptions despite their frontline role in crisis response and recovery. School safety increasingly involves the role of dedicated emergency managers, whose leadership can influence preparedness across mitigation, response, and recovery phases (Jensen & Kirkpatrick, 2022). However, research on how this leadership structure affects teachers' views of resilience remains limited. Mutch (2014) noted the need for deeper inquiry into how leadership roles shape school recovery and readiness. This study addresses that gap by exploring how the presence of an emergency manager affects teachers' confidence in their school's preparedness and resilience, helping to inform future strategies that center on both leadership and frontline perspectives.

The purpose of this quantitative study was to examine the relationship between the presence of a dedicated emergency manager and teachers' perceptions of various dimensions of school resilience, as measured by the School Resilience Assessment Questionnaire (SRAQ)(Mirzaei et al., 2021). The study compared teachers' perceptions of resilience in schools with a dedicated emergency manager versus schools without a dedicated emergency manager in K-12 public schools within the Southeast Houston, Texas region. The subsequent research questions were used to lead the study:

RQ1. Is there a significant difference between the perceptions of teachers regarding the role of a dedicated emergency manager in a school's effectiveness in responding to emergencies?

RQ2. Is there a significant difference between the perceptions of teachers regarding the impact of architectural resilience factors, such as building design and safety measures, on school safety and disaster preparedness in schools with and without a dedicated emergency manager?

RQ3. Is there a significant difference between the perceptions of teachers regarding the availability and adequacy of emergency equipment in contributing to school resilience in schools with and without a dedicated emergency manager?

RQ4. Is there a significant difference between the perceptions of teachers regarding the role of emergency preparedness education in enhancing school resilience in schools with and without a dedicated emergency manager?

Literature Review

Evolution of Emergency Management and School Preparedness

Disasters can affect any community, regardless of size or location, often demanding coordinated responses across multiple agencies (Bajracharya & Hastings, 2020; Ryan et al., 2020). Historically, responses to disasters have been fragmented, lacking the necessary cooperation among local, state, and federal agencies (National Governors Association, 1979). In response to these inefficiencies, the federal government consolidated emergency response functions in the 1970s with the creation of the Federal Emergency Management Agency (FEMA) (Haddow et al., 2010).

In the decades that followed, emergency management adopted an “all-hazards” approach, expanding beyond natural disasters to include technological and human-made hazards. This evolution laid the groundwork for more integrated frameworks, such as the Integrated Emergency Management System (IEMS), which promoted a comprehensive and proactive approach to managing risks (Haddow et al., 2010).

School Resilience and Vulnerabilities

A student’s perception of safety is essential to their well-being and educational success (Yablon & Itzhaky, 2015). Resilience, a multifaceted concept, is commonly understood as the ability of a system to return to its normal condition after disruption (Hosseini et al., 2016). The United Nations International Strategy for Disaster Reduction (UNISDR, 2009) further defines resilience as the capacity of a community or system to resist, absorb, and recover efficiently from hazardous events.

Resilience in schools includes structural and non-structural elements, organizational processes, and community engagement (Mirzaei et al., 2019). Schools serve not only as centers of learning but also as vital community assets before, during, and after disasters (Hull, 2012). Key components of resilience include communication, social capital, and adaptive learning (Castleden et al., 2011; Son et al., 2020). A systems approach to preparedness, including planning, safe facilities, and training, is essential (Carlson et al., 2012; Shah et al., 2018). When integrated into K-12 education, resilience frameworks can positively shape youth development and community outcomes (Masten et al., 2008).

Although over 50 million children attend school daily in the U.S. (Kearns, 2021), schools are vulnerable to natural hazards that disrupt academics and damage infrastructure (Lai et al., 2016; Convery et al., 2014). Inadequate awareness of these risks can hinder readiness (Convery et al., 2014). Effective emergency response requires understanding local hazards and planning accordingly (Nickerson et al., 2006). Schools with designated preparedness coordinators and funding are generally more prepared (Horton et al., 2023; Rebmann et al., 2012). Leadership plays a critical role by prioritizing drills and simulations that promote a culture of safety.

School readiness is dynamic and evolves with new threats. Resilient schools actively reduce vulnerabilities and improve operational capacity (Mirzaei et al., 2020). Involving stakeholders like school nurses ensures health-related emergencies are considered in planning (Flaherty, 2012; Rebmann et al., 2012). Continuous adaptation is essential to keeping preparedness efforts effective.

Leadership, Organizational Culture, and Community Engagement

Strong leadership, organizational culture, and community engagement are foundational elements of school resilience, particularly in the context of crisis preparedness and response. Effective leadership in schools extends beyond routine management to encompass clear communication, rapid decision-making, and cross-system coordination, all of which are essential during emergencies (Reid, 2020; Klein & Schwanenberg, 2022; Knebel et al., 2012). Training and development of critical competencies, including procedural knowledge, decisiveness, and effective communication, enhance leaders' readiness to manage emergencies (Henstra, 2010; Albanese & Paturas, 2018; Gill et al., 2021; Hayes & Omodei, 2011). Transformational leadership styles, characterized by support, clarity, and optimism, further strengthen schools' crisis responses (Zhao & Jowett, 2022).

Community resilience relies on collaborative leadership, where trust, communication, and stakeholder participation are central to cultivating preparedness and effective governance (Bodas et al., 2022a; Antronico et al., 2020). As pivotal community hubs, schools play a significant role in both preparedness and recovery efforts (Haig, 2014; Cedering & Wihlborg, 2020; Mutch, 2016). Inclusive planning that engages educators, law enforcement, and local officials leads to enhanced preparedness outcomes, especially when structured frameworks like ICS and NIMS are implemented to align with best practices (Kano et al., 2007; Horton et al., 2023; Lopez et al., 2019; Nickerson et al., 2006; Bigley & Roberts, 2001). Ultimately, effective leaders nurture a culture of preparedness within their organizations through ongoing training, critical reflection, and continuous improvement (FEMA, 2013; Shah et al., 2018; Nicogossian et al., 2011).

Infrastructure and Physical Safety

School infrastructure plays a critical role in determining a school's capacity to withstand and recover from emergencies. Architectural design, building materials, and safety features have a significant impact on a school's resilience (Campos, 2020; Mirzaei et al., 2019). A holistic approach, including structural and non-structural elements, functional systems, and site selection, is necessary to build resilient schools (Mirzaei et al., 2021; Agarwal et al., 2023; Ronoh, 2018).

Several studies highlight global infrastructure vulnerabilities. In regions such as Kabul and Nepal, poor building codes and outdated construction methods leave schools highly vulnerable to seismic events. Retrofitting and enforcing building standards are key strategies to improve safety (Naseri & Kang, 2017; Dixit et al., 2014). Santa-Cruz et al. (2016) and Vahdat and Smith (2014) further emphasize the need for upgrading facilities to meet modern safety standards, especially in disaster-prone areas.

Resilient infrastructure also supports the broader role of schools as community shelters and crisis response centers. Secure, accessible facilities are essential during mass-casualty events and natural disasters (Graham et al., 2006; Oktari et al., 2018). Features such as reinforced structures, clear evacuation routes, and emergency stations enhance both preparedness and response effectiveness (Sarwono & Qolbi, 2024; Ingaramo & Pascale, 2020). Ultimately, infrastructure alone is not enough schools must also be able to adapt and mobilize resources in real-time. Still, investing in safe, well-designed buildings provides a strong foundation for school emergency resilience.

Resources, Training, and Preparedness Gaps

Resource availability and effective utilization are essential for school emergency preparedness. Schools must plan, stockpile, and manage supplies to ensure safety and continuity during crises. Proper management directly impacts a school's ability to respond and recover (Nganji, 2018; Acido & Kilongkilong, 2022).

Studies show that many schools lack sufficient emergency supplies, plans, or funding. Horton et al. (2023), Rebmann et al. (2016), and Kano and Bourque (2007) found widespread gaps in disaster preparedness, particularly regarding supply readiness. Cannon et al. (2022)

similarly reported that inadequate planning hindered post-disaster recovery efforts following major hurricanes.

Physical resources such as medical kits, AEDs, and backup power are also critical. Khan (2023) and Zusman and Marghella (2013) emphasize the importance of maintaining life-saving equipment and training staff in its use. Studies in disaster-affected areas, including Japan and Afghanistan, highlight the need for food stockpiles, waste planning, and infrastructure to support basic needs (Amitani et al., 2017; Naseri & Kang, 2017).

Funding remains a primary barrier to preparedness. Rebmann et al. (2016) and the Federal Commission on School Safety (2018) stress that without adequate financial support, schools struggle to maintain training, infrastructure, and emergency supplies. Research across sectors shows that public-private partnerships and federal incentive programs, such as FEMA's Community Rating System, can help overcome these barriers (Lurie et al., 2013). Investments in resilience yield long-term economic and social benefits even without a disaster (Fung & Helgeson, 2017; Tanner et al., 2016). Prioritizing preparedness today builds stronger, more adaptable schools for the future.

Methodology

Research Design

This study employed a cross-sectional survey design, which captures data at a single point in time and is effective for assessing attitudes, beliefs, and opinions (Creswell & Guetterman, 2019). The design was chosen to examine teachers' perceptions of school resilience about the presence of a dedicated emergency manager.

A non-probability convenience sampling method was employed, targeting teachers from two school districts, one with a dedicated emergency manager and one without. Each district either provided teacher contact information or directly distributed the survey to facilitate access to the sample population.

This approach enabled a focused comparison of perceptions without relying on snowball sampling. The aim was to capture a snapshot of how teachers view resilience efforts in their respective districts, shedding light on the potential influence of emergency management leadership structures.

Participants and Setting

The sample for this study consisted of teachers from two K–12 public school districts in Texas, one with a dedicated emergency manager and one without. Teachers were selected as the target population due to their critical role in implementing emergency preparedness measures and shaping school resilience. Participants included teachers across grade levels (elementary, middle, and high school) with varying years of experience, providing diverse perspectives on resilience practices.

Following approval from district administrations, recruitment was conducted via email invitations containing a link to the online survey. Teachers were required to review and agree to an informed consent form before participating. Only currently employed teachers in one of the two selected districts were eligible for participation. Findings may not extend to all Texas teachers or schools in other regions. Additionally, the voluntary nature of participation introduces self-selection bias, as those more engaged in emergency preparedness may be more inclined to respond.

Data Collection

This study was approved by the Lamar University Institutional Review Board (IRB). Data were collected from teachers in two Texas K–12 public school districts, one with a dedicated emergency manager and one without, to enable a targeted comparison of teacher perceptions of school resilience.

Prior to data collection, permission was obtained from both districts. In the district with an emergency manager, the researcher was provided teacher email addresses to distribute the survey directly. In the district without an emergency manager, the survey was shared through internal district email distribution lists. These procedures ensured adherence to district policies and minimized disruption to staff.

Teachers were invited to complete an anonymous online survey after reviewing an informed consent form, which outlined the study's purpose, voluntary participation, and data use.

No personal identifiers were collected by the survey platform (Qualtrics), preserving participant anonymity. All survey responses were stored securely in a password-protected cloud system, accessible only to the researcher. The data was cleaned and prepared for analysis to explore differences in perceptions between the two districts.

Data Analysis

After data collection, responses were exported to Excel for initial coding, cleaning, and issue identification, then imported into SPSS for statistical analysis. Descriptive statistics were generated to summarize the dataset. To address each research question, independent samples t-tests were conducted to compare mean responses between teachers from districts with a dedicated emergency manager and those without. A significance level of .05 was used to determine statistical relevance.

Separate t-tests were used to evaluate differences in teachers' perceptions across four dimensions:

- Effectiveness in emergency response
- Architectural resilience
- Adequacy of emergency equipment
- Emergency preparedness education

The independent variable was the presence of a dedicated emergency manager in the school district (yes or no), determined using public sources such as district websites or state databases.

The dependent variables were teachers' perceptions of school resilience, measured using the School Resilience Assessment Questionnaire (SRAQ) (Mirzaei et al., 2021). The SRAQ includes four subscales: Functional (Effect_Mean), Education (Effect_Educ), Architecture (Effect_Arch), and Equipment + Safety (Effect_SafetyEquip). These data points were used to assess the relationship between emergency management leadership and perceived school resilience.

Findings

Survey data from 77 teachers across two K–12 public school districts in Southeast Houston, one with a dedicated emergency manager and one without, were analyzed to compare perceptions of school resilience. After excluding responses with excessive missing data, final analyses included 41 respondents from the district without a dedicated emergency manager and 36 from the district with one.

The presence of a dedicated emergency manager served as the independent variable (coded dichotomously), and teacher perceptions were measured using the four subscales of the School Resilience Assessment Questionnaire (SRAQ). Independent samples t-tests were conducted to address each of the study's four research questions.

RQ1

Is there a significant difference between the perceptions of teachers regarding the role of a dedicated emergency manager in a school's effectiveness in responding to emergencies?

To address this, responses from SRAQ items 20–30 (functional subscale; Effect_Mean) were analyzed. Results showed no statistically significant difference in perceptions between teachers in districts with a dedicated emergency manager and those without (Table 1). Surprisingly, teachers in the district without a dedicated emergency manager reported slightly higher perceptions of effectiveness. The effect size was small (d = -0.42), and the null hypothesis was not rejected.

Table 1

Independent Samples T-Test for Functional Subscale (Effect_Mean) by Emergency Manager Presence

Group	n	M	SD	t	df	p	Cohen's d
Emergency Manager	36	4.0	0.67	-1.85	75	0.068	-0.422
No Emergency Manager	41	4.29	0.69				

$*p < .05$, $**p<.01$

RQ2

Do teachers' perceptions of architectural resilience factors differ between schools with and without a dedicated emergency manager?

Analysis of SRAQ items 13–19 (Effect_Arch) revealed no significant difference between groups (Table 2). Teachers in the district without an emergency manager reported slightly higher perceptions of building design and safety, with a small effect size (d = -0.28). The null hypothesis was not rejected.

Table 2

Independent Samples T-Test for Architectural Subscale (Effect_Arch) by Emergency Manager Presence

Group	n	M	SD	t	df	p	Cohen's d
Emergency Manager	36	4.23	0.69	-1.22	75	.227	-0.28
No Emergency Manager	41	4.41	0.57				

*p < .05, **p<.01

RQ3

Is there a significant difference in teachers' perceptions of emergency equipment availability and adequacy between schools with and without a dedicated emergency manager?

Analysis of SRAQ items 2–8 (Effect_SafetyEquip) showed no significant difference between groups (Table 3). Teachers in the district without an emergency manager reported slightly higher perceptions, but the effect size was negligible (d = 0.06). The null hypothesis was not rejected.

Table 3

Independent Samples T-Test for Safety and the Equipment Subscale (Effect_SafetyEquip) by Emergency Manager Presence

Group	n	M	SD	t	df	p	Cohen's d
Emergency Manager	36	4.39	0.54	-0.28	75	0.78	0.06
No Emergency Manager	41	4.42	0.49				

*p < .05, **p<.01

RQ4

Do teachers' perceptions of emergency preparedness education differ between schools with and without a dedicated emergency manager?

Responses to SRAQ items 9–12 (Effect_Educ) showed no significant difference between groups (Table 4). Teachers in the district without an emergency manager reported slightly higher perceptions of training, but the effect size was small (d = -0.12). The null hypothesis was not rejected.

Table 4

Independent Samples T-Test for Education Subscale (Effect_Educ) by Emergency Manager Presence

Group	n	M	SD	t	df	p	Cohen's d
Emergency Manager	36	3.87	1.14	-0.50	66.46	.62	-0.12
No Emergency Manager	41	3.99	0.91				

*p < .05, **p<.01

Implications

This study examined whether the presence of a dedicated emergency manager influenced teachers' perceptions of school resilience. The lack of significant differences suggests that simply appointing an emergency manager may not directly enhance how teachers perceive preparedness.

While prior research highlights the benefits of having emergency managers, particularly in coordinating preparedness education and resource availability (Kano & Bourque, 2008; Rebmann et al., 2012), this study found that teachers in the district without an emergency manager reported slightly higher perceptions across most dimensions. This suggests the need for a more comprehensive and integrated approach to building school resilience.

Districts should consider enhancing emergency preparedness through systemic strategies, such as improving staff training frequency and quality (Mutch, 2014), fostering a culture that prioritizes safety, and strengthening internal communication around emergency protocols. Leadership engagement is also critical; teachers are more likely to feel confident and prepared when district and school leaders actively support resilience efforts.

Finally, districts should assess resource allocation for emergency equipment and infrastructure improvements, recognizing that the presence of an emergency manager alone may not necessarily drive changes in perception. A holistic approach that includes leadership, culture, communication, and training may be more effective in shaping a resilient school environment.

Recommendations for Future Research

Given the small effect sizes and lack of statistically significant findings, further research is warranted to explore the role of dedicated emergency managers in school resilience. First, future studies should involve larger sample sizes to increase statistical power, as this study's sample (n = 77) may have been too limited to detect meaningful differences.

Generalizability was another constraint. This study focused on two districts in Southeast Houston, which may not reflect broader educational contexts. Future research should include a more diverse sample of districts across various regions, taking into account factors such as district size, socioeconomic conditions, local emergency management practices, and funding levels.

Additionally, the use of self-reported perceptions introduces potential bias. Teachers' views may not fully represent actual preparedness levels, as perceptions can be shaped by individual experiences or limited awareness of protocols. Future studies could include objective measures of preparedness alongside perception-based data.

The cross-sectional design also limits understanding of changes over time. A longitudinal approach may reveal whether the impact of a dedicated emergency manager becomes more evident with sustained implementation of preparedness strategies.

Researchers should also explore broader systemic factors such as organizational culture, training frequency and quality, communication effectiveness, and leadership involvement. Examining how specific emergency management activities, like staff training, drill implementation, or past incident experience, shape teacher perceptions would offer deeper insights. Qualitative studies could further enrich understanding by capturing the lived experiences of teachers and exploring why the presence of an emergency manager may not influence perceptions as expected.

Conclusion

This study examined whether the presence of a dedicated emergency manager influenced teachers' perceptions of school resilience across four dimensions: functional, educational, architectural, and safety + emergency equipment. Findings revealed no statistically significant differences between schools with and without an emergency manager, suggesting that this role alone may not substantially shape teacher perceptions.

These results point to the importance of broader systemic factors, such as organizational culture, leadership engagement, and the quality and frequency of emergency training, as potential drivers of perceived resilience. While emergency managers may support preparedness efforts, their presence may not directly influence how frontline educators assess readiness.

Despite its limitations, including a small sample and limited generalizability, this study contributes to the growing body of research on emergency management in educational contexts. It underscores the need for a more holistic approach to improving school resilience, one that integrates leadership, communication, training, and resource strategies. Future research should continue to explore these dynamics to inform more effective practices and ensure that schools are better equipped to protect students and staff in the event of an emergency.

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AI-Enhanced Pedagogy: Examining How Teachers Elevate Their Practice Though Innovative Lesson Design

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Abstract

Artificial intelligence (AI) is rapidly transforming education, offering new possibilities for lessors while also raising concerns about its implementation. While AI has been present in various industries, its integration into K-12 classrooms remains a developing area with both enthusiasm and skepticism. Through interviews with AI-using teachers, this phenomenological study examines how teachers engage with AI tools in lesson planning, exploring their perceptions, challenges, and the factors influencing adoption. The thematic analysis highlighted AI's role in assessment, differentiation, and innovative teaching. The findings also emphasize the importance of professional development and institutional support in fostering effective AI integration in classrooms. However, concerns emerged around data privacy, AI reliability, and academic integrity.

Keywords: Artificial intelligence in Education, lesson design, generative AI, pedagogy, AI-enhanced teaching, innovative teaching

Introduction

Integrating artificial intelligence (AI) in education marks a transformative shift in teaching and learning methodologies, with AI-driven tools revolutionizing the classroom through personalized tutoring, adaptive materials, and tailored assessments (Kadaruddin, 2023). Recent advancements, particularly in generative AI, have driven interest in AI's role in education (Huang et al., 2023; Kadaruddin, 2023). While AI augments educators' capabilities and alleviates their burdens, the role of educators is evolving rather than becoming obsolete (Noy & Zhang, 2023). Tools like ChatGPT have the potential to help teachers personalize learning, design lessons, and assess students more efficiently, reducing their workload. AI leverages new possibilities to enhance education by improving accessibility, engagement, and tailored student support. (Zhang et al., 2023). However, challenges remain, including concerns about responsible AI adoption, pedagogical frameworks, and teachers' attitudes toward AI (Wang et al., 2021; Chiu, 2021). Research on AI literacy for educators and stakeholders is still emerging (Gašević et al., 2023). This study addresses these gaps by examining how AI can empower teachers to create enriched learning experiences.

The purpose of this qualitative, phenomenological study was to explore how artificial intelligence impacts lesson design for teachers in a southeast Texas school district. The following questions guided the research:

1. What are the perceived benefits and challenges of using AI tools for lesson design?

2. How does integrating AI tools influence teachers' instructional approaches, including lesson delivery and content presentation?

3. How does using AI-enhanced lesson design affect teachers' confidence and self-efficacy in delivering instruction?

Literature Review

In an era of technological innovation, the integration of AI into education emerges as a revolutionary force, reshaping the fabric of pedagogical practice. As educators confront this paradigm shift, they are tasked with embracing AI's potential and navigating its complexities to redefine their roles in the classroom (Essien et al., 2024). This wave of innovation promises to streamline teaching practices and fundamentally alter student-teacher interaction dynamics, ushering in a new era of tailored learning experiences (Zhang et al., 2023).

While the potential benefits of integrating AI in education are evident, concerns persist regarding its responsible adoption and the development of pedagogical frameworks to support its implementation (Su et al., 2023). Beyond the technical aspects of AI education, a pressing need exists to understand its broader implications on teaching methodologies and student learning outcomes (Velander et al., 2023).

Positive Impacts of AI in Education

As technology evolves, educators increasingly turn to AI-driven solutions to address classroom challenges (Floridi & Chiriati, 2020).

Additionally, AI in education plays a crucial role in promoting equity and inclusion by enhancing accessibility, affordability, and personalized support. It can bridge educational gaps, empowering diverse learners to thrive (Kolchenko, 2023). For instance, AI-driven systems like the Generalized Curriculum (AIGC) improve content quality and accessibility, increasing student engagement and retention (Zhang et al., 2023). Additionally, AI platforms lower financial and logistical barriers, ensuring equitable access to educational resources (Goel, 2020). AI-powered tutoring systems further support socio-economic equity by offering personalized interventions, improving learning outcomes, and addressing school readiness, especially for disadvantaged students (Ling & Chiang, 2021; Luckin & Holmes, 2016).

Finally**, t**eacher burnout significantly challenges education quality and retention rates (Chang, 2009). Administrative responsibilities such as email management, lesson planning, grading, and record-keeping contribute to teachers' workloads, often resulting in extended hours and heightened stress levels (Turner & Garvis, 2023). The automation of administrative tasks presents a promising solution to alleviate this strain (Bălănescu, 2019). AI technologies, such as ChatGPT, offer opportunities for automating tasks like course material generation and email management, effectively saving teachers time and effort (Noy & Zhang, 2023).

Concerns and Challenges of AI in Education

Integrating AI technologies into educational environments raises many ethical, pedagogical, and societal concerns. Ethical concerns such as data privacy and security are critical concerns in AI-driven education, as sensitive personal information is at risk of misuse or exposure, potentially leading to identity theft or unauthorized access (Sebastian, 2023). Studies show that users are increasingly aware of these risks, especially with large language models in education. Regulatory frameworks like the Children's Online Privacy Protection Act (COPPA) aim to safeguard data, ensuring that AI systems in educational contexts comply with privacy standards (Bryan et al., 2023). However, the extensive data collection and analysis required by AI tools raise challenges in maintaining secure practices. It is essential to prioritize fairness, transparency, and accountability in data handling to avoid ethical breaches and preserve trust in AI systems (Bryan et al., 2023; Caccamise et al., 2020).

Another ethical concern is that algorithmic bias in AI models presents significant challenges by perpetuating inequities in education, particularly when biases in training data lead to unfair outcomes such as inaccurate grading or inappropriate interventions (Gillani et al., 2023). These biases can disproportionately affect certain demographic groups, exacerbating existing disparities in educational access and achievement. Additionally, concerns about linguistic diversity and inclusivity, particularly for students with disabilities, need to be addressed to ensure AI systems support all learners (Morris, 2020; Alam & Mohanty, 2023). Achieving fairness requires not only addressing technical limitations in AI models but also engaging in broader discussions around diversity, inclusion, and governance in AI development (Chi et al., 2021). Ensuring that AI systems are designed with transparency and ethical guidelines is crucial for fostering a more equitable educational environment.

Pedagogical concerns surrounding AI integration in education include overreliance on technology, loss of human connection, and resistance to change. Overreliance on AI may degrade human cognitive abilities, stunting creativity and independent thinking as students become increasingly dependent on AI for information processing and decision-making (Zhou & Luo, 2024). The shift toward AI-driven teaching risks diminishing the essential human connection in education, as AI tools replace the deep, personal interactions between teachers and students that are vital for certain learning experiences (Baker, 2016). Teachers also face challenges in maintaining autonomy, as AI-driven systems often limit their ability to closely monitor and engage with students in meaningful ways (Caccamise et al., 2020). Furthermore, resistance to AI adoption is common, with educators and students often lacking the necessary technical literacy to effectively utilize AI in the classroom. Many educators report insufficient professional development opportunities to incorporate AI into their teaching, which hinders its integration into instructional practices (Prothero, 2023; Chiu & Chai, 2020). Overcoming these concerns requires addressing the balance between technology and human interaction, providing targeted training for educators, and fostering a more thoughtful integration of AI into educational environments.

Finally, societal concerns surrounding AI integration in education highlight significant socio-economic challenges, such as the digital divide, access disparities, and the potential impact on employment (Mahlanga, 2021). The digital divide exposes gaps between students assumed and actual digital literacy levels, with many educators overestimating students' proficiency despite the availability of technology (Velander et al., 2023). Additionally, a shortage of skilled support staff complicates the deployment, management, and maintenance of AI systems in schools (Holmes & Tuomi, 2022). These disparities require a comprehensive approach that addresses both technological and socio-political issues, such as the lack of qualified teachers and the need for scalable infrastructure to support AI integration (Jang & Lee, 2023; Owoc et al., 2021).

As AI continues to advance, it reshapes pedagogy and redefines the essential skills required for students to succeed in the digital age (Chaka, 2023). Educators must not only incorporate AI tools into their teaching but also adapt to the broader shift in how education is delivered and experienced, leading to a reevaluation of academic roles and responsibilities (Hodgson et al., 2022).

Methodology

Research Design

A phenomenological approach was the most suitable for examining the experiences of teachers who had undergone professional development in AI and applied it to enhance their teaching methods. This methodology enabled an in-depth exploration of how these educators perceived the integration of AI in their teaching practices. By exploring their narratives, a deeper understanding of the evolving dynamics between AI technology and teaching methodologies was achieved. Utilizing a phenomenological approach offered distinct advantages for researchers aiming to extract meaning from educators' diverse experiences (Creswell & Guetterman, 2019).

Participants and Setting

The study employed maximal variation sampling. Participants were selected from multiple grade levels and subject areas, ensuring a range of teaching experiences. To achieve this, the researcher worked with the district to identify teachers in a technology cohort who had received AI training. This approach enriched the research by representing varied viewpoints on AI integration in education.

Eleven teachers from a large southeast Texas school district were selected. The district, which serves 48,000 students across 49 campuses, provided these teachers with quarterly professional development on technology applications, including AI. The group included seven elementary and four secondary teachers from subjects such as STEM, special education, Career and Technology, and core academic areas. All had over five years of teaching experience, with AI proficiency levels ranging from beginner to advanced. First-year teachers were excluded to focus on those with established teaching practices, ensuring a meaningful exploration of AI's impact on pedagogy.

Data Collection

The data collection process involved individual interviews lasting approximately forty-five minutes. Participants were contacted via email using a list of teachers provided by the district who had participated in the district technology program. During the interviews, the researcher posed open-ended questions to participants to explore their experiences with AI and how it influenced their teaching competence and practices. The questions were customized to encourage detailed responses, aiming to uncover insights into how AI enhanced teachers' skills, confidence, and innovative practices, thereby improving teaching methods.

To ensure consistency and accuracy in data collection, all interviews were audio-recorded and transcribed verbatim. Transcribing the recordings allowed for thorough qualitative data analysis, enabling the researcher to extract key themes and patterns relevant to the research questions.

Regarding ethical considerations, the researcher implemented measures to safeguard privacy, anonymity, and confidentiality throughout the research process. Participants received clear information about the study's purpose, procedures, and potential risks and benefits. The researcher obtained informed consent from all participants before their involvement in the study, and participants retained the right to withdraw from participation at any time without penalty.

Additionally, data collected was anonymized and securely stored to prevent unauthorized access or disclosure.

Data Analysis and Trustworthiness

A systematic approach was used to classify, code, and organize themes from the collected data. Transcripts were first analyzed in Word using the comment feature to tag statements by theme and research question. These were then imported into Excel for organization and refinement, allowing patterns to emerge. Initial coding assigned descriptive tags to data segments, forming the basis for theme development. To address inconsistencies, the researcher revisited the data, consulted experts, and conducted member checks to validate interpretations (Saldaña, 2021).

To ensure trustworthiness, credibility was reinforced through member checking and triangulation, comparing themes across data sources. Dual coders improved reliability, while transferability was supported by thick descriptions of the research context. Dependability was maintained through an audit trail, and a code-recode strategy verified consistency. Confirmability was strengthened by a reflexive journal documenting researcher bias and external audits reviewing the analysis process (Saldaña, 2021). These measures ensured the findings accurately reflected participants' experiences.

Findings

Research Question 1

The first research question focused on the perceived benefits and challenges of using AI tools for lesson design. The interviews showed four themes regarding the benefits: *simplified accessibility, collaborative idea generation, improved quality and professionalism,* and *efficiency in time and task management*. Three themes related to challenges were revealed: *limited knowledge of its practical use, concerns over ethical issues like cheating and data safety*, and the *risk of AI providing inaccurate information*.

Benefits

Seven out of eleven teachers highlighted how AI tools, such as speech-to-text features, word prediction, and support for English language learners, make it easier to accommodate diverse students. One teacher specifically noted that word prediction software has been especially beneficial for her dyslexic students. Additionally, another teacher emphasized the importance of accessibility, stating, "Accessibility is important for my students and colleagues with certain disabilities. I value the accessibility features [AI] offers." This teacher elaborated, "I can input a video and then use AI to use these special features, whether that be adding the text within the videos so that the students can access it. Because my students have special needs, there's a lot of adapting and modifying the curriculum." These insights collectively illustrate how AI can simplify accessibility and enhance educational experience for all students.

Nine out of eleven teachers used AI as a springboard for idea generation in lesson planning and design, seeing it as a creative partner that offers fresh ideas and perspectives to enhance their lessons. As one teacher shared, "For me, it's just been the best springboard." Another added, "I've used it a lot more for generating stuff and coming up with better ideas or expanding." Interestingly, one of the two who didn't use AI for idea generation expressed hesitation over ownership of ideas but still used AI to refine her original concepts, while the other teacher, new to AI, relied on traditional planning methods but admitted she would likely try idea generation with AI in the future.

The final two themes, improved quality and professionalism and efficiency in time and task management, were consistently highlighted throughout the interviews. There was unanimous agreement among participants that these are strong benefits of using AI in lesson design, with AI helping to elevate the quality of instructional materials while saving valuable time for teachers to focus on more critical tasks. One teacher noted, "It helps ease the workload," while another described AI as "definitely a time saver and a save my sanity saver." As one teacher put it, "I'd rather spend more time with students."

Table 1

Perceived Benefits of Using AI for Lesson Design

Theme	Responses .
Simplified Accessibility	"Things like being able to provide captioning and videos that don't come with them helps my learners be able to follow along with text if they can't understand the audio." "For example, being able to provide my students with reading disabilities the opportunity to draft writing using word

	predictive software, that is a method of differentiation for me.”
Collaborative Idea Generation	“Absolutely I have found I have gotten some really fun ideas that will give me a spark of what I want to take and make it my own so that that's been really cool when I've come up with things.” “The other thing is sometimes when I'm just kind of out of juice and ideas just to kind of throw in some ideas for like ChatGPT or a couple the tools on Khanmigo and magic School, it's just nice to not have to do the brainpower of just thinking of, like sentence stems for a certain topic. I could just throw that in within 30 seconds and it's there.”
Improved Quality and Professionalism	“I find it really useful when you get to the point in the day where your brain is not functioning anymore. It's not really up to speed, and you're like, oh, I have to respond to that parent e-mail. And I had to respond to it where I sound intelligent and professional, and I can't really piece that together. And I can go in and put a prompt into AI and it helps create that for me.” “For me it’s great. It definitely makes it so much easier to design those engaging visuals.”
Efficiency in Time and Task Management	“Yes, time saving. It's a lot of time saving with the tedious task like. Like Rubrics just to create the wording and stuff with rubrics is one of my favorite things.” “I feel honestly one of the biggest things is just taking something off my plate sometimes that I feel like it's one less ball to juggle. It's one less moment where you're sitting trying to figure out how to make something relevant to your kids or how to really hook them on something that's coming up.”

Challenges

Three key challenges have been identified that contribute to teachers' hesitation in adopting AI: *limited knowledge of its practical use, concerns over ethical issues like cheating and data safety*, and the *risk of AI providing inaccurate information*. Many teachers feel unprepared to effectively integrate AI into their teaching due to a lack of strong understanding of its tools and applications. This knowledge gap creates uncertainty and hinders adoption, as 7 out of 11 teachers mentioned that their limited knowledge, especially about prompting AI, is a barrier. One teacher explained, "One of the biggest hurdles is really knowing what to put in so that you're getting what you want to come out." Participants with more training noted that this challenge often stems from other teachers being hesitant to try AI themselves. As one person said, "The teachers aren't playing with it themselves, so they don't understand."

Theme	**Response**
Limited Knowledge of the Practical Use of AI	“My only limitations are what I can imagine it to do.” “I think the biggest thing for when you're first starting to use it is knowing how to prompt it. Like really specifically giving it what you want.”
Ethical Concerns	“It's very easy to have a bias in an AI response unknowingly based on what you ask and how you ask it ... and how it’s programmed that determines what you get back.” “I think there's still a lot of confusion surrounding what AI is, and there's a lot of apprehension across our district still and our state just in how to implement it ethically.”
Inaccurate Information	“Well, I don't trust AI. AI is a tool to get me started and to help find the right words or to rephrase things or to start, you know, taking information and compiling it into a usable format.” “I would also say just make sure that you're reading over it, because like I said, it's not always perfect. It is still computer generated. It's not coming from a human. There are still issues. You know, I find little things all the time that I have to change and fix.”

Ethical concerns, such as cheating and data privacy, raise significant questions about AI use in the classroom. Teachers worry about protecting student information and maintaining academic integrity, with 7 out of 11 teachers citing issues related to ethics, including cheating and copyright concerns. Despite these challenges, many teachers expressed a willingness to tackle these issues through student lessons and peer education. As one teacher explained, "Let's explore these ideas, try them, and figure out why they're problematic." Another added, "I use pre-created but false websites, like the tree octopus, to teach students the importance of verifying sources from multiple angles."

Teachers are concerned about the reliability of AI, as it sometimes generates incorrect or misleading information, making it difficult to fully trust the technology. Five out of seven teachers noted this issue, expressing a lack of confidence in the accuracy of AI-generated content. One teacher explained that this misinformation often led to spending extra time verifying information, saying, "I still feel like I need to verify things... I don’t take things at face value, and sometimes I feel like AI takes just as much time because I want to make sure, one, it aligns with what I’m supposed to be teaching, and two, it's true."

Table 2

Perceived Challenges of Using AI for Lesson Design

Research Question Two

Research question two focused on how integrating AI tools influenced instructional approaches. Four themes emerged from the analysis of the interviews including: *enhanced assessment practices, streamlined differentiation, innovative lesson design*, and *high-quality lesson materials.* Generative AI improved the quality of assessments by enabling more personalized and dynamic evaluations, allowing teachers to better measure student understanding and performance. Seven out of eleven teachers used AI for enhanced assessment practices, focusing on creating quiz questions, rubrics, and providing feedback. This helped them deliver more personalized evaluations and better measure student understanding. As one teacher noted, “Last year, we used the basic PSP (Performance Standards Project) rubrics for GT. They were awful, and both parents and teachers found them confusing when it came to grading the projects.

Now, I'm using AI to help rewrite them," illustrating how AI is also streamlining and clarifying grading practices.

Eight out of eleven teachers used AI tools to streamline differentiation by customizing reading levels, offering English language learner support, and providing accommodations like speech-to-text. This allowed them to tailor instruction more effectively to meet diverse student needs. As one teacher expressed, "I think it's huge for differentiation, but I really think that if it's embraced correctly, it will really help us".

All 11 teachers used AI to create more innovative lessons, whether through engaging hooks, hands-on activities, or project-based learning. By incorporating dynamic content, they were able to engage students more effectively and foster greater participation and interest in learning. One teacher shared how AI sparked creativity in a lesson on myths and legends: 'I put in my TEKS and myths and legends, and AI came up with the idea for students to create their own creature or character and write their own myth—something I hadn't thought of before. It even provided a template for brainstorming and a checklist for the story elements, making the whole process easier and more engaging' (see Appendix D). Another teacher used AI to generate 360-degree images, creating a virtual lab for students to explore metals, offering an immersive and interactive learning experience (see Appendix E).

All 11 teachers used AI to enhance professionalism in lesson presentations by creating polished slides with generated images, student exemplars, and improved wording. This empowered them to produce high-quality instructional materials that increased clarity and impact in the classroom. One teacher shared, "An easy example is Google Slides. I use visuals to reach all my learners in every lesson I teach, and AI helps me conveniently create presentations." Another teacher emphasized how AI supports professional communication, explaining, "I find AI really useful when I'm exhausted ... but still want to sound intelligent and professional. I can input a prompt into AI, and it helps craft the message for me".

Table 3

Influences of AI on

Theme	**Response**

	Response
Enhanced Assessment Practices	"You can upload pdf into quizzes, and it will make whatever game or activity you want just from a document. It's a game changer." "I was able to just, you know, get really specific with the quizzes and do a little check for understanding after they were doing things so that I know, oh, they're getting confused on this. There were a lot of good higher order thinking questions in [the quizzes], and it helps me see how and where I need to better focus to help these 7th graders be prepared for the 8th grade STAR test next year with all these constructed responses now."
Streamlined Differentiation	"I think it just goes back to really being able to make it individualize quickly for each student, whether it be adapting it to their reading level, whether it be adapting it for their language, whether it be taking a story, and quickly changing it to making it applicable for that student or lesson." "It makes differentiation so much quicker and easier than if I had to do it on my own. I would probably say if you were going to ask me the one thing I love about AI, it would be the beauty of making differentiation simple and effective and useful without having to have seven different lesson plans. And it's amazing from that standpoint."
Innovative Lesson Design	"I think it just goes back to really being able to make it individualize quickly for each student, whether it be adapting it to their reading level, whether it be adapting it for their language, whether it be taking a story, and quickly changing it to making it applicable for that student or lesson."

	"It makes differentiation so much quicker and easier than if I had to do it on my own. I would probably say if you were going to ask me the one thing I love about AI, it would be the beauty of making differentiation simple and effective and useful without having to have seven different lesson plans. And it's amazing from that standpoint."
High-Quality Lesson Materials	"I use AI when I'm making presentations to make it more engaging for the students, and then they actually take ownership of the AI and when they're creating presentations, they can implement some of those tools as well."

Research Question 3

Research question three examined how AI-integrated lesson design impacts teachers' confidence and self-efficacy. Three key themes were identified: e*nhanced content knowledge, professional growth*, and *collaborative support*.

Teachers leverage AI to deepen their understanding of the subject matter and ensure that lessons are relevant to their students. This enhances their knowledge and enables them to create more engaging and effective learning experiences. Ten out of eleven teachers interviewed admitted that using AI has helped them prepare with relevant content knowledge, providing insights on subjects they were less familiar with and finding ways to connect the content to their students. One teacher noted, "It sure has made it more relevant, you know, and updated with what's occurring now."

The use of AI in lesson design encourages teachers to explore new pedagogical strategies and stay updated with the latest educational technologies. This professional development fosters a culture of continuous learning, boosting their confidence in implementing innovative approaches. Six out of eleven teachers cited that using AI has helped them grow professionally. One teacher expressed, "My philosophy is that AI is here. It's here to stay, and it's not going anywhere, so we might as well make the best of it." Another added, "It's a wonderful tool. I mean, we've been teaching for a long time. A lot of things have changed in the way we search for information and maneuver around it, so we can become better demonstrators and teachers."

AI serves as a collaborative partner for teachers, providing resources and insights that enhance their teaching practices. This supportive role helps teachers feel less isolated in their work, ultimately improving their self-efficacy as they navigate challenges in the classroom. All eleven teachers expressed varying levels of support from planning lessons with AI, including brainstorming and getting unstuck. One teacher shared, "I just needed it to support my thinking so I could move on to the next phase." Another noted the boost in confidence to work independently, stating, "I'd say I feel more confident and less stressed about differentiation." [With AI] I feel like I have the freedom and the ability to really get those kids what they need."

Table 4

Impact of AI-enhanced Pedagogy on Confidence and Self-Efficacy

Theme	Response
Enhanced Content Knowledge	"Relevancy is key for me. In STEM, making it relevant to my students is crucial—it shows them that what we're doing relates to actual real-life jobs. There's a purpose behind our lessons. Being able to help my students make those connections makes me feel like what I'm teaching is meaningful and highlights the real-world significance of our work."
	"Even for robotics, I needed a quick overview of the anatomy of a root robot. I could have spent time digging for information—I did for a bit—but after five or ten minutes, I thought, 'This is dumb.' So, I just had a discussion with ChatGPT and was able to go back and forth until I had a working understanding of the anatomy of a root robot."
Professional Growth	"I think it's worth diving in, and I'm more than willing to embrace the discomfort. Years ago, I heard a quote that said, 'Get comfortable being uncomfortable.' I believe that's the best way to grow and improve myself."
	"Last year, when AI was first introduced, I was definitely uncomfortable—actually, I was a lot uncomfortable. However, jumping in and really working with it has made a significant difference in how I use it and understand its functionality."
Collaborative Support	"They are great assistants. Sometimes, I have a crazy idea of something I want to do, and when I share it with people, they look at me like, 'You want to do what with second graders?'

> But with AI, I feel like it’s less judgmental and more supportive, saying, 'Yeah, you can totally do that with second graders. Here’s how.’”
> “Yes, a lot of people think these types of projects can't be graded. They ask, 'How am I supposed to grade a makerspace?' I find that the rubric tools, especially Khanmigo, feel almost like working with a co-teacher. I prefer this to just receiving a standard rubric. It’s more like a conversation—when I’m typing back and forth, it feels supportive, like, 'Yeah, that sounds great. Anything else you'd like to add?' It’s still my idea, but with that extra assistance, it feels like I have another person helping me.”

Implications

The findings of this study highlight the critical role of professional learning in successfully integrating generative AI into instructional strategies. Research shows that teachers' confidence in using AI is directly linked to the level of training and support they receive (Kadaruddin, 2023). Despite AI’s growing presence in education, only 10% of educators feel prepared to incorporate it into their teaching, and 87% have received no AI-related professional development (Prothero, 2023). To bridge this gap, schools must invest in ongoing professional learning opportunities. Peer-led training fosters collaboration and helps demystify AI tools, making them more accessible and practical for educators (Wang et al., 2021). Exposure to a variety of AI tools allows teachers to identify those that best align with their teaching styles and subject areas. Districts should also assess existing software for AI features and collaborate with IT departments to ensure appropriate access (Chiu et al., 2021). Additionally, effective AI use requires proficiency in crafting prompts. Training should emphasize real-world scenarios to help teachers refine their AI interactions and optimize generated content (Floridi & Chiratti, 2020).

Beyond professional learning, ethical considerations must be addressed through clear district-wide protocols. Many teachers hesitate to adopt AI due to uncertainty about data privacy, academic integrity, and AI bias. Establishing clear guidelines on responsible AI use, including safeguards against cheating and data misuse, is essential (Alam & Mohanty, 2023). Teachers should also be trained to recognize and mitigate biases in AI-generated content to ensure equitable learning experiences (Gillani et al., 2023). Additionally, educators need guidance on copyright and intellectual property concerns related to AI-generated materials, including proper attribution and ownership issues (Neysani et al., 2024).

Finally, AI presents an opportunity to transform traditional lesson design, shifting toward more dynamic, student-centered learning experiences. Teachers can use AI to foster higher-order thinking by designing lessons that emphasize problem-solving, creativity, and critical analysis. AI-powered tools can enhance engagement through interactive projects and simulations, allowing students to explore complex concepts in innovative ways (Baidoo-Anu & Ansah, 2023). By addressing these key areas—professional learning, ethical considerations, and instructional innovation—schools can maximize the benefits of AI while ensuring its responsible and effective implementation in classrooms.

Recommendations for Future Research

While this study offers valuable insights into how trained teachers use AI for lesson design, further research is needed to explore how educators with little or no training engage with AI. Future studies could examine how access to professional development impacts teachers' confidence and willingness to adopt AI tools (Wang et al., 2021).

Additionally, research should investigate why some teachers hesitate to integrate AI, whether due to ethical concerns, lack of practical knowledge, or skepticism about AI's reliability (Velander et al., 2023). Understanding these barriers could inform strategies to encourage wider adoption. Another important area of study is how AI-driven differentiation and accessibility tools support special education students. Examining their effectiveness in creating personalized learning experiences could highlight AI's role in promoting equity and inclusion (Morris, 2020).

Finally, longitudinal studies could assess the long-term impact of AI on student achievement and teacher development, providing deeper insights into its effectiveness in education (Gašević et al., 2023).

Conclusion

The conclusions from this study suggest that the integration of AI tools in lesson design can improve teachers' instructional practices by streamlining processes and enhancing the quality of teaching materials. AI's role in supporting accessibility for diverse learners, fostering collaboration in idea generation, and promoting efficiency in time and task management demonstrates its ability to augment teachers' professional capacities. The data supports that these tools can free up time for educators to focus on student engagement and personalized instruction (Zhang et al., 2023). However, challenges remain, such as limited familiarity with AI's practical applications, ethical concerns like data privacy, and issues surrounding the reliability of AI-generated content. These factors contribute to teachers' hesitancy in fully adopting AI in their lesson design. The data indicates that greater training and support would be necessary to overcome these barriers and encourage more confident use of AI in the classroom (Owec et al., 2021). Overall, while AI offers promising benefits for enhancing pedagogical practices, further professional development and a focus on ethical considerations are essential to maximize its effectiveness in educational settings (Kadaruddin, 2023).

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Teachers' Perceptions of Digital Game-Based Learning on Student Engagement, Motivation, and Learning Outcomes in K-12 Social Studies Education: A Systematic Literature Review

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Abstract

This systematic review explores patterns in how K–12 social studies teachers navigate digital game-based learning (DGBL) amid the realities of technology integration and discipline-specific instruction. Drawing on 10 qualitative and mixed-methods studies published between 2015 and 2024, the review follows PRISMA guidelines and employs Braun and Clarke's (2006) reflexive thematic analysis to identify trends in teacher perceptions related to student engagement, motivation, and learning outcomes. Findings reveal that while DGBL is not seen as a panacea to disengagement, many teachers recognize its potential as a supplement to instruction, offering interactivity, authenticity, and curricular relevance. Educators emphasized its ability to foster multidimensional engagement, stimulate curiosity, and build disciplinary and transferable skills; yet, implementation remains limited by structural constraints such as limited time, rigid pacing guides, and a lack of high-quality, standards-aligned games. These challenges do not reflect teacher resistance, but rather the practical realities of teaching within constrained systems. Teachers demonstrated an intentional approach to game integration, prioritizing alignment with learning objectives, instructional relevance, and the role of teacher facilitation in guiding gameplay. This study's findings suggest that social studies educators are especially attuned to the affordances and limitations of digital technologies in a content area often marginalized in K–12 education. To support thoughtful implementation, this review proposes a conceptual model emphasizing alignment across pedagogy, infrastructure, and curricular goals; insights underscore the need for sustained teacher support, standards-aligned game design, and structural flexibility to ensure equitable access to technology-enhanced instruction in social studies classrooms.

Keywords: K12 Social Studies Education, Digital Game-based learning, teacher perceptions

Introduction

Social studies educators navigate increasingly complex instructional environments shaped by evolving curricular demands, accountability pressures, and diverse student needs. Within this context, fostering meaningful student engagement with social studies content can be challenging, particularly when students perceive the subject as disconnected from their personal experiences or future goals (Akhan et al., 2023; Levinson, 2012). Traditional, didactic instructional methods remain prevalent, but the movement toward active, student-driven learning continues to gain momentum. While still developing as a classroom practice, digital game-based learning (DGBL) offers meaningful possibilities for enhancing instruction through interactivity, immersive narratives, and critical inquiry.

Despite increased teacher interest, integrating DGBL into K–12 social studies classrooms remains inconsistent, often constrained by practical considerations such as time, access, and alignment with curricular objectives (Erdem & Pamuk, 2020; Karaman et al., 2022). These constraints necessitate the importance of exploring innovative strategies like DGBL that may offer new pathways for deepening student engagement and understanding within the social studies content area.

Throughout the literature, DGBL has successfully supported student engagement, motivation, and learning outcomes, often attributing those increases to game features such as immediate feedback, progress tracking, and reward systems that enhance intrinsic and extrinsic motivation (Annetta, 2010; Landers, 2014). Competition is also often highlighted as a motivating feature in DGBL (Chen & Chang, 2020), though its effectiveness remains contested. Some researchers argue that competition works best in well-structured subjects like math or science, where outcomes are clearly defined, while less structured domains, such as social studies, may benefit more from cooperative strategies (Chen et al., 2020). These findings suggest that competitive elements in DGBL should be aligned with the cognitive demands of the subject matter.

Because of their interactive nature, digital games naturally promote active engagement, a key element of DGBL (Annetta, 2010). However, neither engagement nor motivation are fixed constructs, and their relationship to game-based learning can vary depending on context and implementation. Engagement in DGBL extends beyond cognitive effort to include students' emotional responses, personal attitudes, and sense of connection with the content. In a qualitative study by Gilbert (2019), it was found that students who played the digital game *Assassin's Creed* developed empathy and a sense of connection to historical figures. Students often valued these emotional experiences over traditional instruction, expanding understanding of engagement beyond cognitive or behavioral dimensions and recognizing that emotional engagement can meaningfully influence students' interest in historical content while also building student agency in their learning (Worthington, 2018). Similarly, Charsky and Ressler (2010) found that while playing *Civilization III* sustained or increased learner motivation, adding concept map scaffolds reduced it. They concluded that this decrease in motivation was due to a diminished sense of autonomy and engagement, which are central to sustaining motivation in gameplay. In addition to enhancing motivation and emotional engagement, DGBL supports improved learning outcomes across various contexts. Andersson (2023) found that while players and observers experienced vocabulary gains, active players reported higher cognitive effort and slightly greater retention. Likewise, Wang and Huang (2023) emphasize the role of interactivity in promoting deeper engagement and learning in digital game-based environments.

While prior studies have explored various facets of DGBL and teacher perceptions, this review uniquely examines the influence of DGBL on teacher implementation practices in the K-12 social studies context. In response to this gap, this systematic literature review examines K-12 teachers' perceptions of student engagement, motivation, and learning outcomes when using DGBL in social studies classrooms. Using Preferred Reporting for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Page et al., 2021) and Braun and Clarke’s (2006) reflexive thematic analysis, the study synthesizes existing literature to explore the perceived effectiveness of DGBL in supporting both direct and indirect learning outcomes, aiming to answer the following research questions:

1. What are K-12 teachers' perceptions of student engagement and motivation in digital game-based learning in social studies education?
2. What are K-12 teachers' perceptions of student learning outcomes in digital game-based learning in social studies education?

By centering teacher perspectives, this review highlights the practical implications of DGBL in classroom instruction and its potential to inform both pedagogical decisions and future educational game development for social studies.

Literature Review Methodology

This literature review follows the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to ensure transparency and rigor in guiding the search and selection of studies on K–12 social studies teachers' perceptions of digital game-based learning (DGBL) and its influence on student engagement, motivation, and learning outcomes (Page et al., 2021). The methodology section of the PRISMA guidelines mandates thorough documentation of specific components. These components include defining eligibility criteria, documenting information sources, disclosing search strategies, outlining the selection and data collection processes, listing data items sought, explaining the risk of bias assessment methods, specifying effect measures, detailing synthesis methods, and clarifying certainty assessment techniques (Page et al., 2021).

Search Strategy

Before commencing the search, the search terms were carefully chosen. Synonyms of search terms were identified by conducting ERIC searches targeting the primary themes of the research questions, encompassing K-12 teachers, perceptions, digital games, engagement, motivation, and learning outcomes. Following this, truncation techniques were applied to synonymous terms to expand the search scope. To maintain focus and clarity, the search process was conducted in stages, beginning with studies related to engagement, followed by motivation, and finally learning outcomes. Although the searches were conducted separately, the researchers recognize the interconnected nature of these constructs and accounted for their overlap during analysis. As a result, some studies were expected to address multiple research questions simultaneously.

Google Scholar, EBSCO, and ERIC databases were utilized to collect literature for the sample; synonyms were integrated to ensure widespread coverage, while Boolean operators were employed to refine the results to be in line with the research objectives. For instance, the initial search for K-12 teacher perceptions of digital game-based learning on student engagement was formatted as follows:

> ((K-12 OR elementary OR high school OR junior high school OR kindergarten OR middle school OR secondary education OR grade OR grade) AND teacher AND (percept OR view* OR attitud* OR belief* OR perspect*) AND (cognitive

engage* OR affective engage* OR behavioral engage* OR involv* OR participat* OR interact*) AND (academic gam* OR serious gam* OR computer gam* OR educational gam* OR video gam* OR simulation gam* OR online gam* OR game-based gam* OR heuristic gam*))

The same approach was employed for searches pertaining to the research questions on motivation and learning outcomes to retrieve relevant articles. Truncated synonyms for engagement were substituted with those identified for motivation and learning outcomes, ensuring consistency in the search methodology across all research areas. Once results were generated, filters were applied to ensure the articles were in English and published between the years 2015 and 2024.

Inclusion and Exclusion Criteria

The article selection process was structured in two distinct phases. Initially, articles underwent screening based on predefined filtering criteria. This involved carefully evaluating titles and abstracts to ascertain their relevance to teacher perceptions, association with K-12 education, publication in peer-reviewed journals or conference proceedings, and their relation to engagement, motivation, or student learning outcomes. If it was apparent that an article would fall into the exclusion criteria during the initial phase, it was removed before proceeding to the secondary phase.

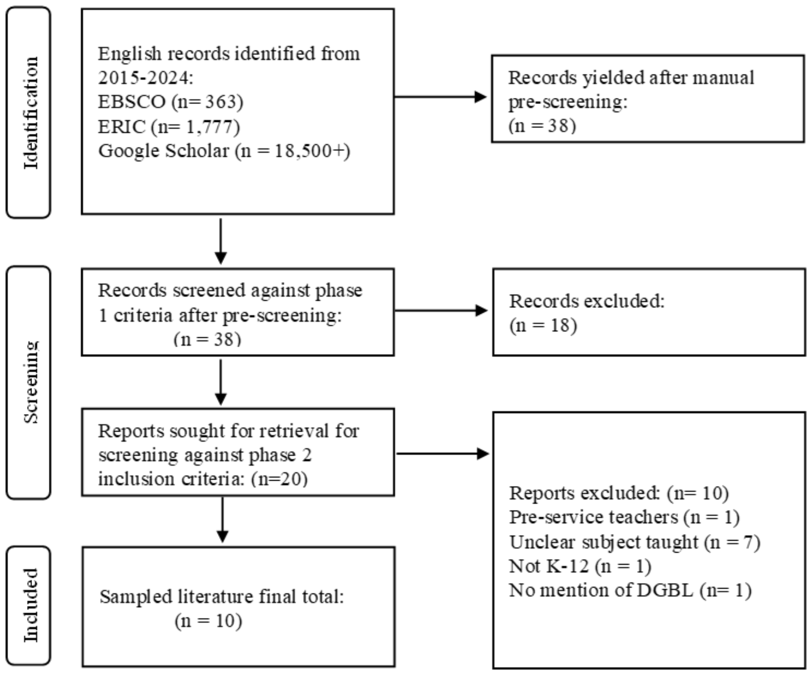
During the second phase of the selection process, a more thorough evaluation was undertaken. This entailed confirming whether the studies addressed a social studies subject, specified the type of DGBL employed, and ensuring the origin of teacher perceptions was for in-service teachers. Additionally, exclusion criteria were established to maintain the study's focus on teacher perceptions of DGBL in K-12 social studies education and relevance. Articles were excluded if they were (1) unrelated to K-12 social studies, (2) focused on mobile learning applications, or (3) presented perspectives from pre-service teachers. By focusing on K-12 in-service teachers, the research sought to capture their depth of classroom experiences to better understand the practical implications of DGBL in authentic educational settings. Similarly, the exclusion of purely quantitative studies enabled a more in-depth thematic exploration of teacher perspectives, consistent with the study’s qualitative focus, while studies centered on mobile learning applications were excluded, given the predominance of laptops as the primary one-to-one device in most technology-enhanced classrooms (Kajeet, 2024). These criteria ensured the selected articles directly addressed the research questions regarding in-service K-12 social studies teachers' perceptions of digital game-based learning. Search Results

Throughout the literature collection process from Google Scholar, EBSCO, and ERIC, potential articles were added to an Excel spreadsheet with their references and inclusion criteria. Initial screening identified 38 articles. After the search, phase one inclusion criteria were applied. Articles were alphabetized, duplicates removed, downloaded to Dropbox, and inaccessible ones excluded. Methodologies, results, and conclusions were reviewed to verify phase one criteria, resulting in 20 selected articles.

Subsequently, the phase two criteria were applied to the remaining 20 articles to confirm their adherence to secondary inclusion criteria. Phase two criteria (social studies education, qualitative/mixed-methods, non-mobile digital games, in-service teacher perspectives) were then applied to these 20 articles using the same spreadsheet. Given this study’s interest in the nuanced perceptions of in-service teachers, the review focused exclusively on qualitative and mixed-methods research to preserve context-rich interpretations of DGBL practice. Thorough reading confirmed alignment, resulting in 10 articles meeting all criteria (Figure 1)

Figure 1

Search Strategy Process Flowchart



Data Synthesis and Analysis

Finally, Braun and Clarke's (2006) non-linear, iterative six-phase thematic analysis was employed to synthesize and analyze the data, emphasizing researcher reflexivity in theme construction (Ayre & McCaffery, 2022). Braun and Clarke's (2006) reflexive thematic analysis method delineates six distinct phases, providing researchers with a framework for conducting the appraisal, synthesis, and analysis stages of thematic analysis in a systematic manner. The six phases outlined by Braun and Clarke's (2006) reflexive thematic analysis approach are as follows:

1. Familiarization with the data
2. Generating initial codes
3. Searching for themes
4. Reviewing themes
5. Defining and naming themes

6. Writing up the analysis

Coding was completed by the author using MAXQDA software, with reflexive memoing conducted throughout the process to support theme development. This approach involved continuous data appraisal throughout all phases for rigorous qualitative data analysis and in-depth pattern exploration.

Findings

The following section presents findings from the 10 identified studies aligned with the two research questions. It explores K–12 social studies teachers' perceptions of DGBL concerning student engagement and motivation and addresses their views on student learning outcomes associated with the pedagogical strategy. Seven themes emerged across both research questions: four related to the first question on student motivation and engagement, and three tied to the second question concerning student learning outcomes (see Table 1).

Table 1

Summary of Research Question Findings

Research Question 1 Findings	Research Question 2 Findings
1) The use of DGBL in social studies education contributes to active student engagement across dimensions which enhances student motivation	5) Teachers' game selection preferences relate to constructive alignment to learning objectives
2) Competitions and challenges embedded into DGBL activities support cognitive engagement through emotional and social engagement	6) DGBL facilitates the development of skills both within and outside of social studies
3) Authentic learning sparks student interest and sustains student engagement	7) Teacher facilitation is essential to maximizing learning in DGBL environments
4) DGBL is not viewed as a cure-all to existing student disengagement and demotivation	

To contextualize the thematic findings, Table 2 summarizes the key characteristics of the 10 studies reviewed, including country, journal, and study title, and grade levels addressed. These studies collectively represent internation perspectives on teacher perceptions of digital game-based learning. In this review, the term *secondary* refers to both middle and high school grade bands (grades 6–12). Notably, only one of the identified studies focused on K–12 as a whole; the majority concentrated on secondary education, with teacher perspectives emerging primarily from either middle or high school contexts and suggesting a need for additional research on DGBL in elementary social studies classrooms, as well as more comprehensive studies encompassing the full K–12 spectrum.

Table 2

Overview of Literature Sample

Year	Author(s)	Country	Title	Publisher	Grade Band
2015	Sáez-López, J. M., Miller, J., Vázquez-Cano, E., & Domínguez-Garrido, M. C.	United States & Spain	Exploring application, attitudes and integration of video games: MinecraftEdu in middle school	*Educational Technology & Society*	Middle School
2017	Huizenga, J. C., ten Dam, G. T. M., Voogt, J. M., & Admiraal, W. F.	Netherlands	Teacher perceptions of the value of game-based learning in secondary education	*Computers & Education*	Secondary
2017	Mozelius, P., Hernandez, W., Sällström, J., & Hellerstedt, A.	Sweden	Teacher attitudes toward game-based learning in history education	*International Journal of Information and Communication Technologies in Education*	Secondary
2020	Somen, T., & Goksu, M.	Turkey	Teacher opinions on the use of educational games in social studies course	*International Journal of Progressive Education*	Secondary
2021	Altun, A. & Görmez, E.	Turkey	An investigation of teachers' attitudes towards the utility of digital games in the social studies courses	*Pakistan Journal of Distance & Online Learning*	K-12
2022	Cannatella, P.	England	Student and teacher perceptions of the value of *Total War: Saga* in motivating KS3 students in an all-boys state school	*Journal of Classics Teaching*	Middle School
2022	Gampell, A., Gaillard, J. C., Parsons, M., & Le Déc, L.	New Zealand	'Serious' disaster video games: An innovative approach to teaching and learning about disasters and disaster risk reduction	*Journal of Geography*	Secondary

2022	Karaman, B., Er, H., & Karadeniz, O.	Turkey	Teaching with educational games in social studies: A teacher's perspective	*Turkish Online Journal of Educational Technology*	Secondary
2022	Lee, H., Shim, H. M., & Kim, H. G.	South Korea	Effect of game-based learning using live streaming on learners' interest, immersion, satisfaction, and instructors' perception	*International Journal of Serious Games*	Middle
2023	Chen, C. & Jenks, A.	Taiwan	Unlocking the potential: Analyzing the impact of online games on high school history education and learning outcomes	*Jurnal Ilmu Pendidikan dan Humaniora*	High

Research Question One

To explore the initial research question, “What are K–12 teachers' perceptions of student engagement and motivation in digital game-based learning in social studies education?”, this review uncovered four central themes.

The use of DGBL in social studies education contributes to active student engagement across dimensions which enhances student motivation

All 10 studies affirmed teacher perception that DGBL in social studies fosters active student engagement across cognitive, behavioral, social, and emotional dimensions. This multifaceted engagement plays a crucial role in bolstering student motivation (Altun & Görmez, 2021; Cannatella, 2022; Chen & Jenks, 2023; Gampell et al., 2020; Huizenga et al., 2017; Karaman et al., 2022; Lee et al., 2022; Mozelius et al., 2017; Somen & Goksu, 2020; Sáez-López et al., 2015). Teachers view DGBL as promoting interaction and interest, reinforcing learning over time, and enhancing its educational value in social studies.

Gampell et al. (2020) and Sáez-López et al. (2015) highlight teachers' perceptions that DGBL enhances student interaction and engagement. In Sáez-López et al.'s (2015) study, students, teachers, and parents reflected on using *Minecraft* to explore ancient architectural structures. Through the *Edmodo* platform, students engaged in detailed discussions, utilizing domain-specific vocabulary, regarding a reconstruction of the Pantheon, reflecting high engagement. Similarly, Gampell et al. (2020) found that teachers saw DGBL as fostering collaboration, especially among students who might not usually work together; collaboration was linked to greater focus, stronger engagement, and increased student motivation.

Teacher perspectives on DGBL's ability to engender initial interest in subject-specific social studies content arose within Cannatella (2022), Huizenga et al. (2017), and Mozelius et al. (2017). Mozelius et al. (2017) found that teachers valued DGBL's potential to promote tangential learning, where students pursued topics beyond the core curriculum. Similarly, Huizenga et al. (2017) reported that many teachers recognized DGBL's capacity to ignite interest in historical content. Cannatella (2022) offered a personal lens, noting that both the author and a participating teacher traced their initial interest in history to historically themed commercial games. While these games often included encyclopedic content, they rarely satisfied the curiosity they initiated, which suggests that students' desire to learn more engenders affective investment.

Altun and Görmez (2021) and Karaman et al. (2022) found that teachers viewed DGBL as a motivational tool that made abstract concepts more concrete, engaging students in active and enjoyable learning. Through semi-structured interviews, Karaman et al. (2022) recognized that teachers saw educational games as empowering students to take ownership of their learning. In contrast, Altun and Görmez (2021) found that while many teachers view digital games as valuable for increasing student motivation, their implementation often varies, with some educators using them more as classroom incentives than as pedagogical tools. Interestingly, Chen and Jenks (2023) emphasized DGBL's role in improving learning accessibility, which may contribute to the increased behavioral engagement reported by teachers in Lee et al. (2022).

Competitions and challenges embedded into DGBL activities support cognitive engagement through emotional and social engagement

Although acknowledged in only three of the 10 studies, a clear pattern emerged highlighting the significance of competition and challenges in digital game-based learning (DGBL) environments (Huizenga et al., 2017; Lee et al., 2022; Somen & Goksu, 2020). Teachers supported these elements to boost cognitive engagement through enhanced emotional and social involvement.

Huizenga et al. (2017) found competition to be a strong driver of engagement with several educators reporting the use of competition as a motivational tool, recognizing that student pride often fueled competition as students worked to outperform peers. Competition also encouraged greater involvement and inquiry as was observed by one civics teacher within the same study who remarked on competition bolstering content-related discussions as students recognized that game success depended on content mastery (Huizenga et al., 2017). Somen and Goksu (2020) echoed this notion.

In-game challenges also fostered engagement. The study by Huizenga et al. (2017) revealed student willingness to band together to defeat a common enemy, prompting student social engagement through questions and contributing to deeper subject understanding.

Cannatella's (2022) action research using *Total War: Saga* showed students collaborating to overcome AI-driven obstacles. Students implemented specialized vocabulary as they collaboratively strategized, applying content knowledge to improve their performance. Chen and Jenks (2023) found that digital games improved teacher-student exchanges while also encouraging meaningful dialogue. Not all perceptions of competition as a game element were positive; for instance, Lee et al. (2022) noted one instructor's concern that students might prioritize gameplay over content. However, this was not a recurrent concern within the other studies that touched upon the competition game element.

Authentic learning sparks student interest and sustains student engagement

Four of the 10 studies demonstrated that authentic learning components within games effectively stimulate and maintain student interests (Gampell et al., 2020; Huizenga et al., 2017; Mozelius et al., 2017; Somen & Goksu, 2020). Specific genres of games, such as simulations, enable learners to experience real-life situations within controlled and safe virtual environments. In the case of DGBL, this results in students experiencing theory in practice, where mistakes act as catalysts for knowledge acquisition.

Educators from Huizenga et al. (2017) highlight how simulation games like Bizzkids Production Company and Plaza Challenge immerse students in authentic contexts, demonstrating the value of theoretical concepts in practical settings. For example, economics teachers note that students grasp the relevance of index numbers and economic decision-making through in-game scenarios (Huizenga et al., 2017). A history teacher in Mozelius et al. (2017) noted that authenticity supports engagement beyond economics. One educator recommended games involving student choice, explaining that such choices offer insights into historical eras or scenarios and replicate the autonomy students would have within a real-world context.

Teachers shared that DGBL suits social studies due to authenticity in the Somen and Goksu (2020) study, where teachers agreed that educational games help students engage with abstract ideas and concretize social studies topics. One teacher noted that connecting social studies to everyday life boosts the effectiveness of educational games. In Gampell et al. (2020), educators using digital games to teach natural disasters expressed that geography aligns well with authentic game-based learning, noting that geography's spatial nature supports interactive and experiential learning, which makes it ideal for game integration.

DGBL is not viewed as a cure-all to existing student disengagement and demotivation

While educators hold optimistic views about DGBL's potential to enhance engagement, five of the 10 studies acknowledge its limitations and agree it is not a complete solution (Chen & Jenks, 2023; Gampell et al., 2020; Lee et al., 2022; Mozelius et al., 2017; Somen & Goksu, 2020). Digital games represent just one of several tools within an educator's toolkit, with educators across the five studies recognizing potential challenges in implementation.

Some teachers express concerns about students lacking intrinsic motivation, which contrasts with DGBL's generally positive portrayal in the literature. In Mozelius et al. (2017), educators point to issues such as poor self-discipline and students focusing on non-educational elements of games. Somen and Goksu (2020) similarly cite concerns around student disengagement, interpersonal conflict, and time constraints, which may present an obstacle to DGBL integration. Despite recognizing motivational benefits, teachers largely agree that DGBL cannot fully resolve student disinterest in social studies. Additionally, Chen and Jenks (2023) raise potential technological challenges, though they report these were minor and easily resolved. In contrast, Somen and Goksu (2020) suggest that such barriers could negatively impact DGBL's effectiveness, especially for less technologically confident teachers.

Concerns around classroom management are also common. In Lee et al. (2022), teachers worry about student behavioral engagement during extended game sessions. Teachers in the Somen and Goksu (2020) study expressed concerns about maintaining classroom control when utilizing these games. Mozelius et al. (2017) recommend shorter sessions to address attention span issues. This finding represents the need for clear strategies to support classroom management and maintain student focus during DGBL activities.

Research Question Two

In response to the second research question, "What are K–12 teachers' perceptions of student learning outcomes in digital game-based learning in social studies education?" this review identified four key findings.

Teachers' game selection preferences relate to constructive alignment to learning objectives

Seven of the 10 studies indicate that teachers prioritize high-quality digital games that align with learning objectives when selecting DGBL experiences (Cannatella, 2022; Gampell et al., 2020; Karaman et al., 2022; Lee et al., 2022; Mozelius et al., 2017; Sáez-López et al., 2015; Somen & Goksu, 2020). This pattern suggests that while engagement is valued, alignment with curriculum goals is precedent, especially since time constraints and dense curricula also limit DGBL integration in social studies classrooms.

Teachers across several studies emphasized that games must be directly relevant and educationally substantive. In Sáez-López et al. (2015), Minecraft represented a strong option for aligning with lesson objectives. Mozelius et al. (2017) stressed the importance of historical accuracy, with one teacher refusing to use games containing inaccuracies. Similarly, Somen and Goksu (2020) found teachers valued games that matched subject content, skill levels, and student interests. A dearth of suitable games also presents a challenge. Both Lee et al. (2022) and Karaman et al. (2022) reported that teachers struggle to find appropriate resources as these studies acknowledged a lack of DGBL options that meet curriculum needs. Gampell et al. (2020) supported this by showing teachers favor games that are engaging, skill-building, and culturally relevant. Karaman et al. (2022) also noted that alignment with grade level and curriculum is a key consideration.

In addition to alignment, teachers expressed concern about limited classroom time. Somen and Goksu (2020) and Mozelius et al. (2017) highlighted how time constraints restrict the effective use of DGBL, while Lee et al. (2022) emphasized the risk of non-educational games diverting focus from objectives. Thus, successful integration depends on access to games that are educationally relevant and feasible within time-limited classroom settings.

DGBL facilitates the development of skills both within and outside of social studies

Six of the 10 studies suggest that teachers view DGBL as a tool for building both subject-specific and transferable skills (Cannatella, 2022; Huizenga et al., 2017; Karaman et al., 2022; Mozelius et al., 2017; Sáez-López et al., 2015; Somen & Goksu, 2020). Educators noted that DGBL enhances content understanding while also developing skills relevant across disciplines and real-world contexts.

Creativity emerged as a particularly valued outcome. Teachers in Sáez-López et al. (2015) and Huizenga et al. (2017) recognized digital games fostered creativity, even though the term was not formally defined. DGBL was seen as helping students form conceptual connections and understand complex relationships, supporting creative expression.

Mozelius et al. (2017) and Cannatella (2022) highlighted that games improve comprehension of abstract or difficult concepts through visualization. For instance, games were used to explore revolutions or systems like democracy and dictatorship. Cannatella (2022) noted students using historical vocabulary and showing deeper interest when playing *Total War*, demonstrating DGBL's role in fostering critical engagement and disciplinary language use.

Teachers also reported that DGBL supports the development of problem-solving and critical-thinking skills. Somen and Goksu (2020) emphasized that educational games help solidify abstract concepts, while Karaman et al. (2022) found DGBL contributes to communication, empathy, and critical thinking by actively involving students. Skills related to collaboration and teamwork also surfaced across studies, especially during competitive challenges, where students were more likely to work together than in traditional settings.

Teacher facilitation is essential to maximizing learning in DGBL environments

In four of the 10 studies, educators emphasized that while DGBL is a valuable tool, it should not be used in isolation but rather alongside teacher facilitation and other instructional methods (Chen & Jenks, 2023; Gampell et al., 2020; Huizenga et al., 2017; Lee et al., 2022). Digital game use does not replace the responsibilities of an educator. Rather than replacing instruction, teachers remain integral to guiding gameplay, offering feedback, and reinforcing curricular objectives (Kangas et al., 2017). This facilitative role aligns with constructivist principles, where learners build understanding through active engagement and reflection (Gampell et al., 2020).

Facilitation includes offering guidance and feedback during gameplay (Kangas et al., 2017). In Huizenga et al. (2017), students received in-game feedback and relied on classroom discussions and teacher support to process learning. Teachers also played a role in coordinating student collaboration. Similarly, Chen and Jenks (2023) found that DGBL encouraged discussion and collaboration with the teacher occupying a central role in these environments. Gampell et al. (2020) emphasized that effective integration of gameplay requires combining it with social learning and reflection, which in turn depends on teacher involvement. Since many games were commercial and lacked built-in educational design, teacher guidance was essential to ensure students made meaningful connections between gameplay and curriculum goals. Educators in Lee et al. (2022) shifted from initial skepticism toward using games instead of textbooks, supporting DGBL to expand and deepen textbook content. Gampell et al. (2020) echoed this view, reinforcing the importance of blending DGBL with traditional methods.

Discussion

The purpose of this systematic literature review was to examine how K–12 teachers perceive DGBL in terms of its influence on student engagement, motivation, and academic achievement. Interpreting these findings requires situating them within both the current landscape of game-based learning integration and the broader curricular positioning of social studies in K–12 education. Together, these contexts help illuminate how disciplinary demands and structural conditions shape the implementation of DGBL in meaningful and distinct ways.

Often marginalized in favor of tested subjects like math and reading, social studies typically receive less instructional time and fewer resources, particularly in early grades and under accountability-focused policies. This curricular marginalization was echoed in the present review, where teachers consistently cited systemic limitations such as time constraints, pacing guides, and difficulty finding standards-aligned games as barriers to integrating DGBL. Rather than deterring innovation, however, teachers demonstrated openness to DGBL not as a novelty, but as a strategic response to longstanding challenges in engaging students with content often perceived as abstract or disconnected (Akhan et al., 2023).

The perspectives identified within this article suggest that social studies educators, perhaps because of the subject's underprioritized status, are especially attuned to leveraging tools like DGBL to foster motivation, collaboration, and meaningful learning experiences. Doornbos et al. (2024) reinforce this pattern from a disciplinary perspective, showing that while teachers frequently cite lack of time as a barrier, this often reflects deeper structural conditions such as limited planning support, pressure to prioritize tested content, and perceived student unpreparedness; these findings suggest that decisions around social studies instruction are shaped less by reluctance than by the systemic pressures teachers must navigate, which may explain why participants in the present review expressed strong support for DGBL despite constrained conditions. While earlier research has often attributed inconsistent DGBL use to teacher reluctance, pedagogical discomfort, or limited capacity, the present review suggests a more complex picture (Palha & Matić, 2023).

Equally significant is the recognition of disciplinary concerns around historical accuracy and curricular alignment, which further shapes how DGBL is evaluated and implemented in social studies classrooms. These concerns align with broader findings from Sáez-López et al. (2015) and Gampell et al. (2020), both of which emphasize the importance of thoughtful game selection and teacher facilitation in ensuring that DGBL supports instructional goals rather than distracts from them. This approach echoes McCall's (2016) call to treat games as interpretive text, acknowledging the trade-offs between fantasy and historical authenticity while emphasizing the importance of critical engagement (Petousi et al., 2023).

In this sense, it is advisable for social studies educators to adopt a media literacy orientation when adopting digital games, treating digital games as narrative constructions to be examined, questioned, and contextualized alongside more traditional historical sources (Kellner & Share, 2005; McCall, 2016). When teachers model this perspective, they help students distinguish between entertainment and historical fact, using gameplay as an opportunity to deepen understanding rather than reinforce misconceptions. This approach aligns with the National Council for the Social Studies' (2021) recommendation that media literacy be a core component of social studies instruction, encouraging students to critically evaluate media representations and sources.

At the same time, DGBL is not viewed as a panacea for student disengagement. Teachers consistently emphasized that while games may initially capture student interest, sustained engagement depends on pedagogical framing, content alignment, and classroom context (Chen & Jenks, 2023; Gampell et al., 2020; Lee et al., 2022; Mozelius et al., 2017; Somen & Goksu, 2020). Studies by Cannatella (2022), Huizenga et al. (2017), and Mozelius et al. (2017) similarly highlight DGBL's capacity to spark interest in social studies topics, with Mozelius et al. further emphasizing its role in encouraging tangential learning beyond the core curriculum. Collectively, these insights support the notion that DGBL can enrich social studies education not by replacing traditional instruction but by making learning more interactive, meaningful, and responsive to disciplinary goals and student interests when purposefully integrated and critically facilitated.

This review's findings should be interpreted in light of several limitations. Most notably, only ten studies met the inclusion criteria, which reflects both the selectivity of the review process and the limited research available on DGBL in social studies education. Still, the decision to restrict the search to peer-reviewed articles published between 2015 and 2024 may have excluded earlier studies that could offer valuable insights. Moreover, only English-language articles were included due to the author's language proficiency and concerns about translation accuracy, introducing potential language bias. Although the review included studies from multiple global regions, Europe and Asia were disproportionately represented, with fewer studies from North America. This small and geographically imbalanced sample may limit the extent to which the findings represent the full spectrum of teacher experiences with DGBL across diverse educational contexts.

Conclusion

This review highlights that while many K–12 social studies teachers see real value in DGBL, particularly for boosting student engagement, motivation, and learning, they also remain aware of the day-to-day obstacles that can make implementation difficult. Several key barriers to consistent integration arose throughout the review, including limited instructional time and access to high-quality and standards-aligned games. These barriers do not diminish DGBL's perceived value. Rather, they underscore the need to translate teacher interest into sustainable practice through targeted support and structural change.

Addressing these challenges will require educational leaders and policymakers to expand access to high-quality, standards-aligned DGBL resources and invest in sustained professional development that supports pedagogical integration and informed game selection. In addition, creating collaborative professional learning communities can provide teachers with ongoing opportunities to exchange strategies, reflect on practice, and build confidence. Structural change may also involve reevaluating curriculum pacing guides, instructional time allocations, and accountability measures to create space for innovation. Without systemic flexibility, even the most well-supported teachers may struggle to meaningfully incorporate game-based approaches into their instruction (Palha & Matić, 2023).

Rather than treating game-based learning as a novelty, supporting its thoughtful integration as any pedagogical strategy can empower teachers to use it intentionally and effectively. Importantly, teachers emphasized that DGBL should not be positioned as a universal solution to student disengagement but rather as one tool within a broader instructional repertoire (Chen & Jenks, 2023; Gampell et al., 2020; Lee et al., 2022; Mozelius et al., 2017; Somen & Goksu, 2020). When implemented with care, aligned to standards, responsive to student interests, and supported through professional growth, DGBL can foster more meaningful learning experiences and increase student connection to social studies content.

Although past research often cited technology access as a significant barrier to DGBL, the studies reviewed did not foreground these concerns (Hébert et al., 2021; Kangas et al., 2017). This likely reflects samples from schools with improved baseline access, particularly following pandemic-era shifts. Notably, six of the ten studies were published after 2020. Still, this absence does not suggest the digital divide has closed; persistent disparities in broadband access, device availability, and infrastructural support, particularly in low-income and rural areas, continue to shape the uneven implementation of digital learning initiatives (Lopez, 2025).

As illustrated in Figure 2, effective integration of DGBL in social studies classrooms relies on an interconnected system of supportive infrastructure, pedagogical practice, and student outcomes. Rather than a fixed intervention, DGBL should be viewed as an iterative instructional approach shaped by teacher agency, curriculum design, and school-level conditions. Sustained professional development, flexible implementation time, and access to high-quality, standards-aligned games are critical infrastructure supports that empower teachers to make pedagogically sound decisions.

Figure 2

Conceptual Model of Purposeful DGBL Integration in K–12 Social Studies

These include aligning games with learning objectives, embedding authentic tasks and challenges, and facilitating reflective engagement with content. When supported and implemented intentionally, DGBL fosters multidimensional engagement, motivation, and the development of disciplinary knowledge and transferable skills. Ultimately, the findings point to the significant role of institutional backing and purposeful instructional planning in fully realizing the benefits of DGBL in social studies education for student outcomes.

Based on the findings of this study, several recommendations surface. Firstly, future research should explore the long-term effects of DGBL on student learning and retention through longitudinal studies. Further investigation is also needed into the design of DGBL activities that align with curriculum standards while fostering student curiosity (Cannatella, 2022; Erdem & Pamuk, 2020; Syawaluddin et al., 2020); this includes examining the influence of different game genres on learning outcomes rather than solely on motivation or engagement. Furthermore, research on effective strategies for integrating DGBL into instructional practices and addressing curriculum constraints in social studies education would further enhance its classroom applicability (Palha & Matić, 2023). Additionally, studies focusing on the role of teacher professional development in DGBL implementation could inform the creation of targeted training programs to support educators (Meredith, 2016). Finally, examining the intersection of DGBL with emerging technologies such as virtual and augmented reality may offer innovative approaches to increasing student engagement and enriching learning experiences (Riner et al., 2022).

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Exploring Equity in Education

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Abstract *This paper presents evidence on the controversial approach of implementing equity in various aspects of education. It examines different facets of equity, beginning with the framework, classroom dynamics, educators, policymakers, professional development, and the exploration of diversity and inclusion to understand where equity truly lies. The aim of this study is to provide background information on equity and its manifestation within educational components, drawing from various research strategies and perspectives. The goal is to develop a clear understanding of what equity should look like at the state, district, or classroom level to foster student achievement for all learners. The review encompasses a wide range of individuals involved in educational research, with a particular emphasis on equity. Focusing primarily on evidence gathered from the Department of Education journals, this literature review highlights key findings regarding equity in education. From this analysis, I have concluded that the focus of equity should be directed towards all levels of education, emphasizing strategies and discussions to bridge the existing equity gap. A significant takeaway from the review is that equitable practices across various components of education can help close the gap in student achievement and enhance productivity. Such practices promote fairness for districts, teachers, and students, ensuring that necessary funding is allocated to meet the needs of all students, thereby improving their educational outcomes.*

Keywords: equity, importance of equity, differentiated Instruction, AI

Introduction

What is equity?

Equity in education is about ensuring that every student has the chance to achieve academic success. Jackson et. al, states “Seeing equity as a process means treating all students equally, without regard to race, ethnicity, or economic background. On the other hand, seeing equity as a product means differentiating instruction based upon students’ needs in order to promote equal learning outcomes” (Jackson et al., 2015). This concept often requires differentiation and adjustments that address each student's unique challenges and disadvantages. Barana notes, “Equity does not mean that all students have equal results; instead, it means that differences in their backgrounds do not affect their different outcomes” (OECD, 2020). The

Organization for Economic Cooperation and Development emphasizes equity in education as rooted in fairness and inclusion" (Field et al., 2007; Barana et al., 2024). This can be examined through socioeconomic status, learning disabilities, or limited opportunities, which affect students' educational experiences in varied ways. Yildamir states, "A fair education system can mitigate unemployment, alleviate income disparities, and advance social justice, paving the way for a more equitable and sustainable future for both individuals and society at large" (Yiladmir, 2024). Understanding the impact of equity can lead to positive outcomes for those who implement equitable practices in the classroom. By integrating these practices with economic strategies, we can enhance academic growth and promote student success. Jackson et al. mention that "The National Council of Teachers of Mathematics (NCTM) asserts that to teach in an equitable manner, teachers and schools must maintain 'high expectations and strong support for all students'" (NCTM, 2000, p. 11). This means mathematics teachers should create opportunities for all students to engage with challenging mathematics, regardless of their "personal characteristics, backgrounds, or physical challenges (p. 12)" (Jackson et al., 2015). In simpler terms, equity is a practice that includes all students, promoting inclusion in education. This approach brings together teachers, parents, and customized instruction to help each child meet academic expectations.

Importance of Equity in Instruction and Curriculum

The significance of various research strategies in student instruction is well-documented. Yiladamir emphasizes that "These processes facilitate the assessment and adjustment of educational policies based on data and evidence, which is crucial for maintaining the principle of equity… Tailoring support to individual students is essential to meet their unique needs and challenges, ultimately promoting success in their learning journey" (Yue, 2018; Yiladamir et al., 2024). In the exploration of technology integration in instruction, elementary students utilized specific programs aimed at promoting educational equity through technology. Shamir et al. note, "In this study of technology in the classroom, significant positive results were found in both kindergarten and first grade. Consistent with prior research (Gormley & McDermott, 2014), notable differences in usage were observed among ethnic groups despite equal access within the school district. While there were significant disparities in overall usage between ethnicities, improvements in literacy skills were noted for all students" (Shamir et al., 2018). This suggests that technology has a positive impact on instruction for elementary students, as globalization evolves and access to education expands, aligning with a student-centered approach.

The exploration of Automatic Formative Assessment presents an equitable approach to instruction, as it involves teachers utilizing feedback, data, and delivery within the instructional framework. The study by Barana et al. revealed that "the ANOVA test demonstrated that the experimental modality significantly impacted the improvement in results between pre- and post-tests ($F = 19.23$, $p < 0.001$)." This data enables us to calculate the effect size of the experimental activities, which reflects the efficacy of the intervention" (Barana et al., 2024). This evidence suggests that Automatic Formative Assessment is an effective strategy to support students in mathematics instruction and improve socioeconomic challenges. The Equity and Access Rubrics for Mathematics Instructional Framework encompasses several key components, including positioning students as capable individuals, providing social coaching, fostering connections and engagement, and creating a nurturing environment. These elements contribute to delivering equitable lessons and effective instruction for teachers. According to Wilhelm et al., "Of the four focal practices, social coaching had the highest mean (m=3.01, see Table 3), and the score distribution is significantly higher than for the other practices (see Figure 1). A mean score of about 3 for social coaching indicates lessons where the teacher offered specific suggestions for social participation, along with occasional explanations for those recommendations. The second-highest mean (m=2.46) was for proactive practices, which involve supporting a nurturing environment by actively building relationships and fostering a positive classroom culture; this score falls between levels 2 and 3. At level 2, the teacher made at least one significant effort to connect with students, such as sharing personal information about their life" (Wilhelm et al., 2022). This highlights the importance of empowering students through meaningful relationships and enhancing their confidence by engaging with others to promote equitable instruction.

Understanding Equity in the Classroom

Creating an equitable classroom environment allows students to feel supported and nurtured, providing them with growth opportunities. Pedagogical partnerships play a vital role in enhancing equity within this setting. According to Marquis et al., "Pedagogical partnerships, which support student-faculty collaboration on teaching and learning initiatives, can facilitate attitudinal and practical shifts in postsecondary education" (Bovill et al., 2016; Mercer-Mapstone et al., 2017, Marquis et al., 2021). This study highlights how participants perceive the impact of collaboration in their classroom. The findings revealed that "Several participants reported feeling their work had contributed to greater equity, with the potential to affect the experiences of other students. Such perspectives were primarily reported by SaLT students, who had engaged in partnerships focused on developing, analyzing, or enhancing courses" (Marquis et al., 2021). Nachbaur states "Regarding teacher support, it would be relevant to know which type of teacher support is most effective at reducing socioeconomic achievement gaps (e.g., academic vs. social-emotional support, proactive vs. reactive support). In a similar vein, the conditions under which cognitive activation increases socioeconomic achievement gaps need to be clarified (e.g., differences between school tracks). Regarding extended day programs, school-based homework supervision deserves more attention" (Nachbaur, 2024). In correlation the input of student perspective in classes can also shift to their input in assignments in the classroom. Hobbs et al., points out that "When faculty learn of equity gaps in their classes, it can be difficult for them to determine the source of the inequity. An examination of disaggregated data across different assignments in a course can provide faculty with actionable information. Identifying assignments that result in inequitable patterns of performance can lead to evidence-based assignment modifications. Demonstrating that different patterns of equity exist across different assignment types can be the first step toward engaging faculty in disaggregating assignment grades in their classes" (Hobbs et al., 2021). Furthermore, this evidence aligns to the pedagogical partnership as it shows the relationship of teacher and students in the classroom collaborating. As Hobbs et al. Relates in stating "As faculty review patterns of equity and inequity at the assignment level and discuss their assignments with students…"(Hobbs et al., 2021). There exists a feedback and review relationship that fosters an equitable learning environment for students, enabling them to address and contribute to academic challenges. Amaral et al., states that "actively incorporating the 'whole' person concept into our teaching methodologies will inevitably humanize interactions in the classroom. This is how equity enters the classroom. Teacher-student relationships should be viewed as individuals who "belong" in the same learning environment, much like members of a community" (Amaral & Windchief, 2019). The study emphasizes that through storytelling, students and teachers can engage in computational and critical thinking, fostering cultural awareness and mindfulness within the classroom. Amaral et al. establish the framework by stating, “The aim of this project is to identify workable and replicable material from a computer science perspective. This process begins with the understanding that the messages and symbols found in American Indian stories are rich with cultural and historical significance” (Amaral & Windchief, 2019). This viewpoint provides educators with essential insights for promoting inclusion and diversity in their lessons, ultimately fostering classroom cohesion and enhancing teacher-student relationships. Implementing classroom equity practices marks the beginning of cultivating an inclusive and diverse community. Hernandez et al. illustrate this in their study, which suggests, “By asking students if they need more examples and collaborating, faculty participants were considering students' needs. Student participants also recognized the sincerity in their faculty member's efforts to help them grasp the material and succeed” (Hernandez et al., 2024). Encouraging a student-driven classroom, rather than relying solely on teacher input, creates opportunities for a more equitable learning environment. Additionally, they provide insights into how faculty can validate the classroom experience, stating, “Student-centered teaching includes incorporating a more multicultural curriculum where students' lived experiences are acknowledged and linked to their learning (E. E. Doran & Singh, 2018). Furthermore, faculty who employ culturally relevant teaching methods engage students in the learning process” (E. E. Doran, 2021, as cited in Hernandez, 2024). As teachers work towards meeting state assessment expectations that evaluate their fidelity to student-centered approaches, fostering confidence and nurturing environments becomes crucial. This transition allows students to emerge as leaders in the classroom, while teachers assume a supportive role in the learning journey.

Differentiated Instruction

Controversial conversations cover various dimensions of different types of students, including socioeconomic status, gender, race, and culture. Here, the focus shifts to the importance of differentiation in instruction. In the differentiation, AI can be a focus as it can if used correctly help many students. It emphasizes that all students' diverse needs have to align with equitable practices to drive student achievement. Prast et al. discuss the student perceptions of differentiation in mathematics instruction by analyzing how their performance changes. Prast et al., findings state "...students had largely positive attitudes about differentiation and achievement grouping. Students appreciated it when the amount and difficulty of tasks and instruction were adapted to their current achievement level and did not like either too easy or too difficult work. While the majority of students across achievement groups wanted to retain the achievement grouping system and reported high liking of their achievement group, students placed in low achievement groups reported to learn less from their group and more often had the desire to be in a different group" (Prast et al., 2023). Al-Shaboul et al. research insights from teachers' perspectives on how they feel about implementing differentiation in their instruction. Al-Shaboul et al., concludes "Based on the data collected from the interviews, teachers showed a strong belief in the importance of differentiated instruction and its impact on students' achievement and the need to apply differentiated instruction in their education. The most emerging themes relevant to obstacles facing the application of the differentiated instruction were teachers' overload, overcrowded classes, shortage in time, and the need for extra effort in preparation and planning due to the disproportionality between content and time" (Al-Shaboul et al., 2021). Herner-Patnode et al. examine strategies in mathematics to address the diverse needs of all students, ensuring that the approach to reaching all students shows equitable opportunity. Herner-Patnode et al. states "When teachers demonstrate their understanding and respect for students' cultural and developmental backgrounds, students will engage in lessons that increase student interest in the content and motivate students to capture more subject matter (Choi, 2013; Dimick, 2012; Ensign, 2003; Martell, 2013; Robbins, 2001). Understanding students' needs and backgrounds should be the first step in the lesson design process as culturally responsive pedagogy and culturally relevant teaching has been "demonstrated repeatedly to have positive impacts on student outcomes" (Aronson & Laughter, 2016, p. 196; Herner-Patnode et al., 2021). According to Anthony et al., several perspectives are presented regarding the framework and implementation of differentiation, particularly concerning whether it includes equitable practices, "Here we can learn from the multicultural education equity movement that values academic, cultural, spiritual, and physical wellbeing as educational outcomes. In the New Zealand context, Averill (2018) and Berryman et al. (2018) advocated for culturally responsive pedagogy that respects diversity and understands "students' potential for learning and growth through the exploration of those differences" (Berryman et al., 2018, p. 7). Indeed, working in the multicultural education space, Kieran and Anderson (2018) and Valiandes et al. (2018) proposed frameworks for blending intercultural education with differentiated instruction" (Anthony et al., 2019). Utilizing differentiated instruction, which can encompasses flexible grouping, alignment with frameworks, and insights from both teachers and students, will enable the implementation of more equitable practices in teaching that cater to all diverse learners.

Inclusivity and Diversity

The classroom structure should embrace diversity, but inclusive practices may vary across different environments based on community needs. Gupta emphasizes, "Our beliefs and thoughts shape the experiences we have in our environment. By acknowledging the diverse needs of our student body, we can create a curriculum that serves everyone rather than favoring just one group. By considering the various demands of our students, we can develop a curriculum that benefits all, not just a majority. Research indicates that diversity experiences play a more significant role than academic experiences in fostering critical thinking skills... (Gupta, 2023). The importance of equity is beyond classroom practices, as the curriculum should be designed to align with teachers' efforts to engage all students while maintaining a clear vision. Gupta points out that:

> *The local contexts in which teaching, and leaming take place (school, classroom) are part of a larger context of communities embedded in a nation. Such spaces must make an effort to bridge the equity-related gap between research, teaching, and learning. These spaces provide opportunities for the new generation of scholars whose work intersects with issues of equity, diversity, & privilege. This model of diversity and equity will work best and is most effective when it meets the school in its existing environment and builds further from there. We must reconsider how we handle diversity in the workplace, in classrooms, and in our communities. Policies, processes, and practices related to diversity may be necessary, but they should not substitute for reality. To critically examine the current polarization at all levels, including in schools, the workplace, and our communities, we need to undergo an ideological transition in our own thinking (Gupta, 2023).*

Diversity and inclusion are fundamental to providing equitable educational opportunities for the community. The role of teachers in implementing inclusive instruction is crucial in ensuring that their practices are effective and meaningful. Horverak suggests “To handle these challenges, teachers applied strategies as creating structure, giving acknowledgement, raising consciousness, facilitating for activities, making students participate in decision-making and being conscious about the adults' role as authoritative, as well as collaborating with colleagues and parents. These strategies may all contribute to an inclusive learning environment, which means that the students are engaged and participate in decision-making, they are part of a community, and they profit socially and in subjects” (Haug, 2014; Horverak 2023). Inclusive classrooms are designed to create welcoming learning environments, particularly emphasizing the inclusion of students with disabilities within the group. Pak argues “However, it is beyond the scope of CCSS and other standards to specify how teachers support students who perform below grade-level standards (Van Boxtel, 2017). It is therefore the task of educational leaders to help shape how in-service teachers equitably support SWDs in standards-based classrooms through the messages they communicate about inclusion and differentiation, and through the support (e.g. PD, curricular materials) they provide to educators to actualize these messages. (Pak, 2020). Diversity highlights the importance of equitable education, which plays a crucial role in addressing the equity gap found within communities. Pak states “Treated this way, differentiation is less about accommodating various ability levels with standardized outcomes as the end goals, and more about cultivating learning environments that uplift intersecting identities and goals. These differentiation principles would seek to equalize opportunities for students whose experiences with marginalization and oppression 100 often remain invisible in the classroom“ (Pak, 2020). Johnson suggests “Teachers should not fear exposing children of all ethnicities to diverse stories because I have found that the parents, administration, and most importantly the students appreciate reading about people with different backgrounds. I engage my students in meaningful discussions that help them bridge the gaps across cultures and backgrounds, so they feel connected to one another and a part of our classroom and community.” (Johnson, 2024). In other words, diversity extends beyond just teacher-to-student interactions; it also encompasses the various contexts that students engage with and observe daily. This exposure is essential for enhancing their understanding of inclusivity and promoting an equitable environment.

Furthermore, she points out “I use the Social Justice Standards as a Framework for anti-bias teaching. As I select stories to read aloud to my students, I carefully consider the standards, which are divided into anchors emphasizing themes of identity, diversity, justice, and action. These standards offer prompts, scenarios, and clear learning objectives tailored to these themes. (Johnson, 2024). This demonstrates to teachers a precise and measurable method for helping students grasp the concept of diversity while aligning with educational standards. Inclusion manifests in numerous ways within the educational landscape, and the author Kesik emphasizes the aspect of inclusion related to the gender and socio-economic background in Turkey, she states:

> *Although there have been tremendous improvements in ensuring the access of students into schooling, it is revealed that educational inequalities regarding to gender, socio-economic background, disability, refugee, religious and ethnic backgrounds, etc. continue to exist and several students are excluded from education system due to several reasons all around the world. As a developing country, Turkey has pursued a similar course and significant steps were taken regarding the increasing the attendance rates of students into schooling in the last decade through the policies and practices which were also stated by the participants of this research and these steps brought positive results especially in favor of female students. In fact, the statistics published by MoNE (2022) indicate that the schooling rates of female and male students are close to each other and gender disparities have been reduced to large extent. However, it is important to note that the schooling rates of student do not always reflect the truth exactly (Acedo, et all. 2009) and ensuring the access of female students into schooling alone does not mean inclusiveness. As it is already known, female students have experienced various challenges regarding inclusion in education for ages and have not been included in the educational processes equally compared to their male peers. (Kesik, 2022)*

This highlights the impact of gender on inclusion, which is closely linked to equity regarding a specific gender and access to education. It gives insight into further understanding that in educational systems, there are female students that are from other countries who come to the U.S. with less experience of an educational background compared to their male counterparts.

As a result, they often begin their studies at a disadvantage, facing unfamiliarity and a knowledge gap relative to their peers, which affects their ability to perform at the same level as others in the group. Essary states “Training interventions and gender research may encourage gender equity if the focus is on exploring how to improve the quality of education for both boys and girls. Currently, much international gender equity research focuses on girls' needs in the classroom. If too much focus is placed on girls, the pendulum may shift and perceptions and practices towards boys may display more inequities (Weaver-Hightower, 2003), or vice-versa.(Essary & Hoot, 2017)”. Dräger argues “To summarize, the existing evidence suggests that early achievement gaps are larger in Germany followed by the United States, the United Kingdom, and finally the Netherlands. Considered alongside the evidence from PISA concerning inequalities at age 15 (Table 1), there is a good case that cross-national differences in childhood socioeconomic inequality are already apparent by the time children begin school and remain largely, although not perfectly, stable over time” (Dräger et al. 2024). This research indicates that families experience a gap in support for their students as they enter school, largely influenced by their socioeconomic status. It further highlights the necessity of implementing equitable practices that encompass diversity and inclusion, addressing not only gender and race but also the socioeconomic backgrounds of communities that the students are in. Brown states “Placing more students who share similar racial, language, gender and sexual identities, ethnicities, and religious backgrounds in the same classroom can be a more equitable practice than it may initially seem. The support that fellow students can lend to one another is critical to their feelings of belonging, especially when controversial conversations occur” (Brown, 2023). .As the emphasis on equity spans gender, race, and socioeconomic status in education, it is perceived in various ways. However, all these factors should contribute to shaping a better future to address the equity gap, which is also linked to student outcomes.

Professional Development and Training

In our discussions about equity in education, it's essential to emphasize the significance of training for teachers and staff. This training should focus on implementing equitable practices that are free from bias and do not create inequities for students. Spooner points out “While the scope of this study is small, its implications on educational leadership preparation in Ontario is significant. The salient theme of identity as an avenue of connection reveals an important area of coverage toward which the PQP should dedicate greater efforts. It is clear from all participant stories that racial (and gender) identity have immediate and direct impacts on education leadership practice and engagement with the school community" (Spooner, 2024). Braun et al., suggests "The method of leadership development investigated in this study is designed to enable educators to see and understand systemic inequities, as well as their own and others' beliefs and assumptions, in order to implement strategies that address the underlying causes of inequities to transform both learning and schooling systems" (Braun et al., 2017). Furthermore, in the study it shows the effectiveness of using practices to build improvement in leadership towards achieving equity by "…a number of significant relationships were found between specific Core Leadership Practices that were implemented by leaders and teams in schools and improved learning outcomes. Overall, it was found that when the leadership teams implement and increase the presence of the Core Leadership Practices in their schools (Table 4, last row of means of all the practices), there is a statistically significant positive increase in growth for the marginalized focal groups and for the peer groups" (Braun et al., 2017). Alternatively, Littenberg-Tobias et al., discussed ways to implement equity using digital simulation for teachers as a way of closing the gap within several implications that are shown in professional development. Littenberg-Tobias et al., states "One advantage of fully automated digital simulations, without human actors, is they are inexpensive to produce and can be flexibly deployed enabling learners to access them remotely at the time and location of their choice. Particularly for in-service professional learning where time and resource constraints are a constant concern, fully digital simulations may be a practical compromise expanding access on this urgent topic to more teachers" (Littenberg-Tobias et al., 2021). Additionally, the authors Wood et al. suggests Interrelated to the idea that there are two distinct subgroups of SBAE teachers, professional development activities related to IDE should be developed with differentiation in mind. As is done in classrooms with diverse types of students, differentiating professional development for SBAE teachers can provide a more meaningful experience. For example, SBAE teachers reluctant to engage in professional development topics related to IDE might find more value in discussing a more comprehensive approach to recruitment and retention to impact more students for the good" (Wood et al. 2023). The author's viewpoint originates from agricultural education; however, integrating inclusion, diversity, and equity among educators can elicit a range of reactions and feedback. This variability highlights the importance of tailoring your strategies and approaches when introducing equitable practices in professional development, especially when some may welcome the change while others believe the current framework does not require any adjustments.

Policy and System Level Considerations on Equity

In education, equity is understood not just in professional development but is also integrated into practices and strategies that aim to include equitable practices in policies and systems within the educational framework. Bingham et al. discuss "Data in the study also give voice to the importance of accessing all funds available in the formula-funding system and thus the concern that some school districts may not be accessing the full funding available to them. It is a common factor for funding to be unavailable to districts due to some economic anomaly. It is of little use to districts to have available funding and not have the ability to obtain or access and use these funds. This anomaly widens the inequity gap and further complicates the problem of equitable funding for school districts" (Bingham et al., 2007). In simpler terms, the allocation of funds that districts can utilize is assessed through the lens of fairness, as some districts vary significantly from others. Additionally, socioeconomic status influences the amount of funding available and the accessibility of those funds within each district. Bulkley states "Many noted that the lack of state action with regard to issues of information, enrollment, and transportation placed heavy burdens on families wishing to participate in choice programs, particularly families of historically marginalized and underserved students. Reported state inaction addressing school quality – such as failure to ensure qualified teachers and funding to support the needs of the most vulnerable students – raised further concerns about the ability of school choice policies to meet the needs of diverse students" (Bulkley et al., 2021). The authors reflect on the equitable practices of various states, aiming to address the underlying inequitable approaches regarding the information shared with parents. It highlights the concerns surrounding marginalized students being directed toward charter schools and school choice programs, often with minimal information about the expected quality of education and teacher certification preparedness. This issue stems from specific states that establish policies and are funded through the states and privately. Furthermore, Bulkley et al., "Similarly, one participant in Michigan indicated that schools of choice often served historically marginalized students, which they viewed as a result of schools in communities of color facing particular challenges because of "the original sin" of "a highly segregated education system." It is possible that similar conceptions of inequity made some state policy makers more likely to take policy actions that directly enhance equity and access for historically marginalized students" (Bulkley et al., 2021). This elaborates on the notion that the inequitable policies surrounding various school choice options highlight the disparities among ethnic groups in low socioeconomic areas. It raises significant questions regarding the intentions behind charter schools and school choice programs available to families that follow equity in its framework. Chu discusses "Consequently, the strategies proposed by states to address the equity gaps focused on developing more equitable funding formulas and producing and placing experienced and effective teachers and leaders in classrooms and schools in order to reduce the resource and opportunity disparities among districts and the students they serve. Meanwhile, the accountability policies included in the ESSA plans overwhelmingly focused on outcomes where educators were held accountable for producing state-mandated results, such as student achievement and growth scores and graduation rate, as the primary indicators of equity policy impact" (Chu, 2019). In simpler terms, fairness requires that teachers fulfill certain criteria to secure funding and demonstrate equity within districts for compliance purposes. Furthermore, Chu concludes "The variations in equity definitions have important implications for related programs and provisions that influence students' educational experiences. The majority of the state ESSA plans favor a stance on equity focusing on equitable access to funding and educators, i.e., educational inputs. This position, however, seems to be at odds with states' emphasis on student learning achievement measured by standardized tests as the primary indicator of equity in outcome. States also overwhelmingly prefer a standards-based, outcome-driven accountability system, which has been dominating education policies and reforms since the 1980s despite conflicting scholarly evidence. Contrary to the policy intent, such limited focus and measure of equity may reproduce and exacerbate the structural inequities experienced by students from high-poverty families, students of color, English learners, and other marginalized and minoritized student populations, as well as the schools that serve them" (Chu, 2019). As the policy and funding hinge on this understanding, if certain districts fail to meet standardized testing goals due to the presence of low-income families, it would create inequity in funding. This situation would compel districts to seek alternative methods to provide evidence of student achievement growth and rigorously pursue solutions. Schools might look for new ways to check how well students are doing that are better than just using standard tests. They could use things like portfolios, which show students' work, projects that students create, or regular assessments that give a full picture of how students are learning and growing. Furthermore, schools could push for changes in rules that help low-income families. By sharing information that shows why some students struggle, they could help get more fair funding that takes into account financial challenges. This complete approach would not only address current inequalities but also help create a learning environment where every student gets the support and resources they need to do well. When considering low-income students and their achievement, it is also important to recognize gifted students and how their needs fit into equity considerations. Brown and Whishney points out "When there are scarce resources for educational funding in the United States. and globally, conflicts occur over who should be educated. Where this is the case, gifted students are left out of the funding allocation and priorities. In other countries, such as Singapore and South Korea, that are more monolithic with less divisive demands for funding, gifted learners are included within the educational priorities, reform efforts, and guidance provided to schools" (Brown & Whishney, 2017). The emphasis has highlighted students facing academic challenges and the need for equity. However, this attention can detract from students who exceed standards and expectations, particularly in low socioeconomic areas, where they may risk being overlooked by their peers. Quality education is essential for all students, including gifted and talented English language learners and those from low-income families. Therefore, policymakers need to comprehend the importance of allocating sufficient funds for teacher retention to ensure access to quality educators and attention to all students. Adamson & Darling-Hammond suggests:

> To address the inequities outlined here, the Congress could do several things:
>
> First, congress could equalize allocations of ESEA resources across states so that high-poverty states receive a greater share than they currently do under a formula that favors wealthier states (Liu, 2006; Miller & Brown, 2010)... Second, the federal

> government could better enforce existing ESEA comparability provisions for ensuring equitable funding and equally qualified teachers to schools serving different populations of students... Third, congress could require states to report on resource indicators to accompany their reports of academic progress for each school, reflecting the availability of well-qualified teachers;strong curriculum opportunities; books, materials and equipment (such as science labs and computers); and adequate facilities. Finally, congress could evaluate progress on such resource measures in state plans and evaluations under the law and require states to meet standards of resource equity – including the availability of well-qualified teachers – for schools identified as failing… (Adamson & Darling-Hammond, 2012).

Ensuring that every student has access to the necessary resources and support creates an environment where all learners can succeed. The analyzing aspect in the context of policy holders creates an approach that includes recognizing and addressing diverse learning styles, cultural backgrounds, and individual challenges in districts. For quality teachers, equitable practices involve providing professional development opportunities, fair compensation, and a supportive community that encourages collaboration and growth. When equity serves as the foundation of educational systems, it leads to more inclusive and effective learning environments in which everyone can thrive and contribute their unique talents and perspectives for student outcomes.

Conclusion

In conclusion the exploration of equity highlights the urgent need to assess all levels of the educational system. This encompasses the framework of equity, as well as the factors that can hinder student learning, including socioeconomic status, race, gender, and ethnicity. To address these barriers, equitable practices in the classroom are essential. Utilizing differentiated instruction and promoting inclusion enhances the understanding of equitable practices by implementing tailored instructional strategies and assessments that cater to diverse learners.

An inclusive environment is created when all learners feel supported through collaboration between teachers and students, who work together to identify specific needs and address misconceptions arising from inequity. At the district and staff levels, it is crucial to adopt best practices for embedding equity into professional development for teachers. This approach improves their understanding of diverse learners and fosters a culture of equity. To accurately address equity, we must first examine it at the state level, focusing on policy and systemic considerations. Research emphasizes the importance of policies that prioritize equity and advocate for equitable funding and resources for low-socioeconomic areas. Collaboration between state and local agencies is vital to promote equity effectively. When these efforts align, they can significantly impact education by establishing a clear vision of equity. This research calls educators, policymakers, and communities to action, emphasizing the necessity of equity in education. Such efforts can positively influence students with learning disabilities, English language learners, gifted and talented students, and ultimately all students' achievement in grades, tests, and overall performance. We must as educators keep exploring ways including AI to advocate for the students.

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Engaging Minds, Empowering Futures: AI's Role in Student Learning

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Artificial Intelligence is no longer just a tool to allow companies to complete projects faster and more efficiently. It has been integrated into people's daily lives through the use of digital assistants, as it can answer any question one has at the touch of a finger or the sound of a person's voice. "History tells us that humans are always looking for something faster, easier, more effective, and convenient to finish the task they work on; therefore, the pressure for further development motivates humankind to look for a new and better way of doing things" (Tai, 2020, p.340). However, many questions begin to surface regarding artificial intelligence and its place in education. Some believe it is a useful tool for educators and students, as it can help simplify classroom management and foster self-confidence in students to perform at a higher level. Meanwhile, others feel artificial intelligence may be taken advantage of and used as a crutch to complete assignments and damage the development of soft skills needed for success in the workplace. In this article, the positive and negative effects of artificial intelligence in education will be explored. Furthermore, strategies on how to engage minds while exploring students' future with AI will be shared.

Key words: education, AI, artificial intelligence, education technology, gamification, student learning, student engagement

Introduction

Many people have been curious about AI. They have used a variety of prompts to help them complete simple tasks. From updating resumes to creating a meal plan, Artificial Intelligence has been a back-pocket tool to help remove taxing assignments from one's mental load. But how is it impacting fields such as education? The following research will address AI's impact on student learning and engagement.

The Origins of Artificial Intelligence

To understand the development of artificial intelligence over time, we must understand its origin and how it came to fruition. Artificial Intelligence is "...attributed to John McCarthy in 1955" who "defined AI as a machine that could behave as though it were intelligent" (Robinson, 2022, p.333). As scientists became more familiar with this technology and worked to see what its capacity is, AI has developed and sharpened the way it produces content and rapidly answers any given question. As this has taken place, scientists have found ways to integrate AI into our daily lives in order to provide simple solutions that have required complex research to accomplish this big task. For example, researchers Tenhundfeld (et al., 2022) concluded through Mutchler's (2017) and Dubiel et al. ‘s (2018) work that “since Apple released Siri in April of 2011, the prevalence of VPAs has increased with competitors like Amazon’s Alexa, Microsoft’s Cortana, and Google Assistant joining the fold. While the capabilities of such systems are ever-changing, they are most used for retrieving general information, such as the weather forecast, playing music/videos, and even telling jokes” (Tenhundfeld, 2022, p.1). Having these virtual assistants at our sides has seamlessly allowed AI to enter our lives and create subconscious roots in our society. Whether it is Siri, Alexa, Google Assistant, or more, the popularity of artificial intelligence through smartphone use or home technology has grown exponentially. These virtual assistants have undeniably extended their reach to a global scale and will only continue to find ways to connect with new people. Creators of such products have been able to generate this growth by adding these AI capabilities to items people require for daily living. Researchers Philipp Sprengholz and Cornelia Betsch (2022) have found through the studies done at Juniper Research (2019) that:

> in recent years, an increasing number of people have started using virtual assistants on both mobile phones and home appliances, including smart speakers and smart televisions. As of 2019, more than three billion virtual assistants were available on devices worldwide. Forecasts suggest those virtual assistants will overtake the world population by 2023 (p. 1227-1228).

Artificial intelligence is being found in all types of appliances, including refrigerators, home security, thermostat systems, lighting, and more. As the rise of AI continues to spread, it is unsurprising how AI may impact other industries, such as the food and medical industries. For example, researchers Katharine Legun and Karly Burch have investigated the plan apple farmers have in place to implement AI into their apple-picking process. Legun and Burch (2021) state “how apple growers are anticipating new robotic technologies intended to use artificial intelligence (AI) to automate aspects of the farm, paying particular attention to the ways that anticipation relates to preparatory assembling and reassembling of landscapes, work, and institutions" (p. 380) to continue providing quality crops while maintaining their efficiency. This research proves if the produce we find in the grocery store has found a use for artificial intelligence in their system works and promotes efficiency, it is fair to say AI has grown roots within society and has encouraged further longevity in its use.

Artificial intelligence has also changed the way the medical field operates. This was especially evident during COVID-19 when A1 was brought onto the stage to encourage mask-wearing and monitor health statuses. This can be seen through researchers Xuebin Yue, Hengyi Li, and Lin Meng (2022), who presented "...an AI-based prevention embedded system against COVID-19 in daily life by keeping the function of the emergency method. The system consists of two functions: mask-wearing-status detection and social-distance measurement. Mask-wearing-status detection employs YOLO and realizes the detection and classification of three mask-wearing statuses: corrected-wearing, non-corrected-wearing, and without-wearing. Social Distance measurement equips a depth camera for measuring the distance between humans. The system gives an alert when people do not wear a mask correctly or do not keep their social distance" (p.152). This study itself demonstrates the power artificial intelligence can hold and how it has the power to correct human behavior and promote accountability amongst civilians. If AI can make a successful impact within society while dealing with a new disease and assist people in navigating their lives in such a confusing time, its value becomes greatly transparent.

AI's Introduction to Education

But what about AI's impact on Education? To understand how it has built the world of education, it is important to know the beginning of education and the effective teaching methods that were used before artificial intelligence. Researcher Isola Rajagopalan (2019) stated how "teaching is regarded as both an art and a science. As an art, it lays stress on the imaginative and artistic abilities of the teacher in creating a worthwhile situation in the classroom to enable students to learn. As a science, it sheds light on the logical, mechanical, or procedural steps to be followed to attain an effective achievement of goals" (p.5). There is a fine balance teachers must reach to effectively lead their students. It requires a blended effort of the arts and sciences, and recognizing the needs of their students, which are all starkly different. An educator may have one group or class of students filled with multiple needs from learning disabilities, English learners, behavioral challenges, and more. Finding effective processes that can meet the needs of these students is a large task filled with layers of complexity. In their research, Rajagopalan (2019) emphasizes the thoughts of Morrison (1934) and Dewey (1934) who stated, "teaching is intimate contact between a more mature personality and a less mature one which is designed to further the education of the latter" (p.5). As the students in the classroom and their needs evolved, so have the methods educators use in the classroom. For example, in the 1990s, teachers found effective ways to create this "intimate contact" as new technologies were being released and introduced into education. It was observed that:

> the industry went from CBT (Computer-Based Training) and rudimentary synchronous learning applications to sophisticated e-learning platforms that combined the best of both. Many argued the days of traditional learning were numbered and computers and the Internet would make teachers and classrooms obsolete (Dunning et al., 2006, p. 2)

Yet, as e-Learning matures, the many significant benefits of these technologies are beginning to be realized and find their place as an adjunct to traditional, pedagogical approaches (Dunning et al., 2006). Computer-based programs thrived and gave students a platform to learn practical skills that would enhance their future success. A variety of benefits exist by integrating technology into education, such as how it "…provides a practical, cost-effective foundation for lifelong learning which reshapes our notions of when and how we learn. ―Learning on demand provides education tailored to solve an immediate and specific need for learning that is time sensitive" (Dunning et al., 2006, p.2). Finding solutions such as these through means of technology has allowed researchers and inventors to create new programs with more advanced technology, thus encouraging similar results. As we fast forward to the 21st century, it is incredible to see the tremendous growth within technology and how it impacts the classroom today.

Artificial intelligence has been introduced in a multitude of ways, including Grammarly, ChatGPT, and the development of merging AI into existing programs. Researchers Olaf Zawacki-Richter, Victoria I. Marín, Melissa Bond & Franziska Gouverneur (2019) state:

> according to various international reports, Artificial Intelligence in Education (AIEd) is one of the currently emerging fields in educational technology. Whilst it has been around for about 30 years, artificial intelligence (AI) applications in education are on the rise and have received a lot of attention in the last couple of years (p. 1)

Furthermore, Zawacki-Richter (et al., 2019) states, "AI and adaptive learning technologies are prominently featured as important developments in educational technology in the 2018 Horizon report…with a time to adoption of 2 or 3 years" (p. 1). As artificial intelligence has been integrated into the classroom, it has evolved into an engaging resource for students to use through different educational games and programs. Although there proves to be value in joining artificial intelligence and education in one space, there are concerns about how it could impact student learning in the long run. How a student learns goes beyond their time in the classroom. It shapes the way they may decide to begin a project or influence their thought process behind planning. Without this practice, it is a concern about what is to become of future generations and the quality of life they may lead. For this reason, both perspectives regarding artificial intelligence, how it is being integrated into school districts, and how it could impact the field of education altogether must be investigated.

How AI helps Education

Teaching requires a balance between the arts and the sciences for education to be effective. Educators have been able to identify a way to create this balance even with the use of artificial intelligence. Artificial intelligence has impacted on the way students learn by providing interactive programs that help them stay engaged with their learning and learn at a faster rate. This is evident in the research performed by Inmaculada García-Martínez, José María Fernández-Batanero, José Fernández-Cerero, and Samuel P. León (2023) who have " identified that the different EAI modalities not only affect the quantity of what students learn, but also lead to higher levels of motivation, which is demonstrated by a greater willingness to be involved in their learning" (p.188). Educators need to know how to choose tools to enhance their students' learning experience and provide resources to expand their education. Programs with integrated artificial intelligence must have the ability to keep students' attention and give them the intrinsic desire to continue learning for their own gratification. It is a universally recognized fact among educators that getting students to this point of consistent motivation can be difficult. In fact, this lack of motivation can result in a reduction in learning outcomes and a negative atmosphere in the classroom. And although, " …standardized outcome assessments have been widely used to evaluate learning and inform policy…the critical question on how scores are influenced by students' motivation has been insufficiently addressed" (Liu et al., 2012, p.352). So how are educators counteracting this challenge today?

Researchers Alf Inge Wang and Rabail Tahir (2020) found in Butler's (1992) and Murray's (1991) studies that "educational research has shown that students who are actively involved in the learning activity will learn more than passive students" (p.1). It is understood that the more involvement a student has in their learning, the more engaged they will be in class. Therefore, the use of technology and artificial intelligence within the classroom will increase the hope of positive results. Recent studies have not disappointed, as they have reflected an uptick in student engagement and participation. This has been accomplished using many educational programs providing interactive games powered by the capabilities of artificial intelligence. Kahoot is one example that has been an integral game combining games with student learning, and "it is among the most popular game-based learning platforms, with 70 million monthly active unique users and used by 50% of US K-12 students" (Wang & Tahir, 2020, p.1). By blending a competitive format where students are motivated to win first place, students get the opportunity to prove what they know and do so in a stimulating way.

Additionally, Wang and Tahir (2020) found in Fotari et al.'s (2016) work when quantifying the impact of integrating games such as Kahoot into the classroom, "the results revealed many positive effects for the gamified approach, including improved class attendance, less late arrivals to class, higher downloads of course material, improved classroom dynamics, and higher final grade (61% for gamified vs. 53% for traditional)" (p.8). Kahoot encourages students to take the reins in their learning and supports teachers in creating a resource to fit the needs of each student. Studies have found "artificial intelligence (AI) systems offer effective support for online learning and teaching, including personalizing learning for students, automating instructors' routine tasks, and powering adaptive assessments" (Seo et al., 2021, p.1). Students and teachers can familiarize themselves with the power of AI by exploring the Kahoot feature to "...search any topic in the Kahoot! creator and [their] generative AI will automatically create Kahoot questions matching your chosen topic" (Kanaris et al., 2023, pg. 1). Integrating this function encourages students to expand their horizons and use new forms of technology to guide their learning. Overall, results such as these should not be overlooked, accompanied by the support it provide for students and teachers.

Another important way to view artificial intelligence in education is to reflect on the ways it serves as a guiding post for students when beginning a new task. The biggest obstacle students face in school is getting started. If a student does not understand how to begin a task or feels overwhelmed by the idea of it, they may feel discouraged before even beginning. As stated by researchers Manuela Ferreira, Ana Paula Cardoso, and José Luís Abrantes (2011), "Motivation should be seen as a very important factor in the learning process. The motivated student has the inner strength to learn, to discover and capitalize on capabilities, to improve academic performance, and to adapt to the demands of the school context" (p.1707). Educators can use these programs to help their students build positive self-esteem in the classroom and show them they can complete a challenge successfully and increase their motivation for learning. For this reason, artificial intelligence can prove to be of tremendous value because it can help to increase student confidence and give them a strong springboard to leap into new possibilities.

Additionally, it is important to reflect on the ways artificial intelligence has helped educators to create simple routines, allowing them to be more organized and begin their day with clarity over chaos. It is no surprise that educators have a challenging job, as many times with limited resources, time, and support. It can be a large task to manage seamlessly the variety of students who come with their own specific needs. So apart from using artificial intelligence to support student needs, it can also help educators save time when it comes to creating resources. By using AI to help in creating interactive games, tests, etc., teachers can put greater focus on building positive relationships with their students and building engaging lessons for the classroom. To take advantage of these resources, though, it is important that teachers:

> learn how to use appropriate AI-driven technologies such as adaptive learning systems and intelligent agents to facilitate their daily teaching management and practices to collaborate with different parties (e.g., parents, colleagues), enhance personalized learning to understand students' learning progress and needs, and conduct various tasks such as offering automatic feedback, self-diagnosing, and promoting online collaboration among learners (Ng et al.,2023, p.143).

Teachers cannot expect to use artificial intelligence in their lessons with students if they are not familiar with the technology themselves. There are multiple benefits to using AI, but it is clear that "despite these educators' positive expectations of AIED, researchers have indicated that before adopting AI in the classroom, teachers first need to learn how to use technology and, most importantly, how to successfully integrate it into their curricula" (Ju et al., 2022, p.4). Doing this further emphasizes how artificial intelligence and education complement one another and not only assist students in their educational journey but also widen the skills of their educators. This is vital as the classroom and the needs of its students will only continue to evolve. Ultimately, being informed about artificial intelligence and its capacities within the classroom can allow educators to be better equipped to meet their students' needs and influence the making of more confident and well-rounded students.

How AI wounds Education

How might artificial intelligence cause a disservice to the field of education? There is a plethora of concerns as to how it could negatively impact students and what it could mean for educators in the future. One of the biggest concerns lies in the power of ChatGPT. Introduced in November 2022, Temsah et al. (2023) defined through Adamopoulou and Moussiades' (2020) and Jin and Kruppa's (2022) research:

> ChatGPT as "...a new artificial intelligence platform created by OpenAI… this artificial intelligence chatbot uses a neural network machine learning model and generative pre-trained transformer (GTP) to pull from a significant amount of data to formulate a conversation-style response in various written content, for a multitude of domains, from history to philosophy, science to technology, banking, marketing, entertainment, in the form of articles, social media posts, essays, computer programming codes and emails (p.1).

This technology is incredibly advanced, and its capabilities are endless. Although this shows growth within the technology community, it also poses a threat to authenticity within Education. Because of the way it is attuned to creating human-like responses, it may be difficult to decipher what original work is created by a student versus an assignment completed using ChatGPT for the entirety of the project. Rather than acting as an aid to students, artificial intelligence can encourage inactivity and cause students to view AI as a resource that does their work for them. This creates a potential danger for AI to take away important skills students need to learn through experience and begin a negative ripple, affecting student development.

If students are relying on this technology for their success, how might this impact their self-confidence and ability to self-empower? Zhao et al. (2021) found that Rosenberg (1965) stated, "Self-esteem is the evaluation of an individual's beliefs and attitudes toward his or her abilities and values" (p.2). As students develop, so does their personality and sense of self. Furthermore, Zhao et al. (2021) discovered that:

> Self-esteem during adolescence tends to be unstable because of the many changes occurring in the adolescents' roles and responsibilities. Self-esteem tends to decline in early adolescence and recover in the middle and later stages of adolescence (Trzesniewski et al.,2003). Adolescents with high levels of self-esteem tend to experience positive self-experiences (Peng et al., 2019), high-quality interpersonal relationships (Cameron and Granger, 2019), and better physical and mental health (Li et al., 2010, p 2).

When a student can create something with their own hands, it builds a sense of pride and accomplishment. Losing this opportunity and relying on artificial intelligence to complete an assignment could bring feelings of guilt and shame. If a student does not feel competent to complete an assignment, they may resort to using artificial intelligence and not completing the assignment.

This could lead to another danger, having the potential to impact a student's credibility and success in school and in the workplace. This danger would be plagiarism. Recent studies have noted "detecting fabrication… is difficult since the work is completely made up and falsified, not plagiarized from other authors. In relation to artificial intelligence (AI), determining whether a piece of writing was fabricated and plagiarized from an AI-based technology presents a challenge to researchers" (Elali & Rachid, 2023, p.1). Technologies such as EasyBib and Grammarly exist to detect direct plagiarism, but with artificial intelligence in the mix now, it becomes difficult to decipher if a student has created authentic work altogether. Although this poses a threat to the education industry it is important to understand "utilizing an AI for research is not an inherently malicious endeavor" (Elani & Rachid, 2023, p.2) and can be useful to " [ask] an AI to grammar-check work or write a conclusion for legitimate results found in a study are other uses an AI may incorporate into the research process to cut out busywork may slow down the scientific research process" (Elani & Rachid, 2023, p.2). Through further research though it has become evident "the issue arises when one utilizes data that are not existent to fabricate results to write research, which may easily bypass human detection and make its way into a publication. These published works pollute legitimate research and may affect the generalizability of legitimate works" (Elani & Rachid, 2023, p.3). Students need to consider the impact that using AI could have on their lives. Conforming to this new technology could put them at risk for potential plagiarism, especially when students find themselves at a vulnerable time in their lives. Mental health is defined as "... a state of mental well-being that enables people to cope with the stresses of life, realize their abilities, learn well and work well, and contribute to their community. It is an integral component of health and well-being that underpins our individual and collective abilities to make decisions, build relationships and shape the world we live in" (World Health Organization, 2022, p.1). When the balance is disrupted, it can cause an individual to say or do something uncharacteristic of them. It is clear "educators recognize that AI can automatically produce output that is inappropriate or wrong. They are wary that the associations or automations created by AI may amplify unwanted biases. They have noted new ways in which students may represent others' work as their own" (US Department of Education, 2023, p.1-2). Therefore, learning the risks of using such programs is vital for students so they do not put their education or reputations on the line and find themselves in irreversible circumstances.

Furthermore, artificial intelligence in education poses concerns about the future of educators and whether there will be a time when in-person teaching is a thing of the past. The COVID-19 pandemic impacted every person on a global scale. Every element regarding daily living, such as work and school, was impacted greatly. During this time, many students and parents were concerned about how schools would pivot to continue providing education during these circumstances. Many school districts turned to online school options to provide quality learning for students while still upholding social distancing protocols. This distance learning forced schools to integrate new technologies into their programs and provide options for students where they could continue their schooling in a safe environment. This has opened up multiple discussions about what education will look like within the next few years.

For example, researcher D.T.K. Ng et al. (2023) confirmed through Kexin et al. (2020) that "artificial intelligence in education (AIED) technology has gained its popularity during the pandemic. Studies have started discussions on how AI reshapes education to reduce teachers' workload by automating some non-teaching related tasks, enhancing data analysis and optimizing online teaching" (p.137) Because of the capabilities AI has, we may wonder if in-person teaching will become a dying practice. To answer this concern, a notable statement from Ng, et al., (2023) says "a major part of teachers' responsibilities is to create meaningful learning environments to deepen students' learning experiences and boost their capacities" (p.138). So, although AI can act as support for educators in the classroom, it is premature to conclude if it will outrun the need for real teachers, but not an impossible idea.

Goals and Complementary Teaching Methods

The overall goal of sharing this research is to inform and educate on what artificial intelligence is and the perspectives that are shared regarding AI in Education. In our ever-changing world, it is important to be educated on matters such as these because it allows students to know what they can expect in their classroom and the potential technology they will need to be familiar with to find success in school and beyond. Many times, students are under the impression that what they learn in the classroom will not be of much use in a professional environment. This is exemplified by researcher Ville Bjork (2018), who mentions how "while on work placements, university students are sometimes told that their on-campus training has no concrete use in the 'real world'. This instance of the idea of academia and the real world illustrates how this idea encourages students to believe that on-campus training is irrelevant in working life. In so doing, this idea creates a gap between what students 'study' on campus and what they 'do' at work placements known as the academic-real world gap or the theory-practice gap" (p.1).

This can be discouraging because students would expect to learn lessons to set them up for success and prepare them for life after school. Despite this concept, students should not feel deflated. When a recent graduate is starting a new position and finds themselves in new and uncharted territory, they have only one option to keep their head above water, which is to use the skills and resources they are familiar with to help keep them afloat. Creating some form of a foundation for themselves will act as a catalyst for the students to spring from. Overall, this will encourage growth as they learn new skills within their job to better equip them for success as a professional. But the only way this can be accomplished is for students to be given a base–to be given resources they can rely on before being put in these circumstances. For many students, this opportunity is given primarily in school. This is not to say a student would be forced to recall how to use the Pythagorean Theorem or know the powerhouse of a cell; rather, it is specific hard and soft skills a student has learned in school that will have a tremendous impact in the workplace. For example, practicing skills such as time management, public speaking, and essay writing may help with a recent graduate's first work project, presentation, and ability to provide a good first impression. Gaining exposure in school to different technologies and inventions, such as artificial intelligence, gives students a chance to understand the programs they may be working with in the future and helps them build success.

Educators must do their best to introduce artificial intelligence into their classrooms as a helpful resource, but must teach their students how to use it effectively. There are a variety of reasons for artificial intelligence to be helpful, but the programs and lessons implementing AI must have a surrounding sense of relevancy to keep students motivated. This is evident in Central Michigan University's Josh Lukkonen (2003), who states, "the students themselves must have some investment into the lessons you are planning/using" (p.53). If a student is not able to make a connection between what they are learning and how it could benefit them inside and outside of the classroom, the impact made could be meager. Recent studies conducted by "…the Proceedings of the National Academy of Sciences, [show], though students felt as if they learned more through traditional lectures, they actually learned more when taking part in classrooms that employed so-called active-learning strategies" (Reuell, 2019, p.2). Active-Learning strategies are defined as "methods [which] ask students to engage in their learning by thinking, discussing, investigating, and creating. In class, students practice skills, solve problems, struggle with complex questions, make decisions, propose solutions, and explain ideas in their own words through writing and discussion" (Cornell University, 2023, p.1). The skills developed through these strategies are one of artificial intelligence's attempts to mimic natural intelligence. This should increase awareness in educators who use artificial intelligence in the classroom, but understand the critical skills needed to be learned by students.

If this is accomplished, students can learn more and will find greater value in their time spent at school while still broadening their familiarity with modern technology. A recent survey revealed "...the average educated American forgets about 40% of what they learned [in school] and uses just 37% of the knowledge and skills in their everyday lives on average" (Renner, 2019, p.1). With the implementation of new learning methods and understanding of the responsibility that belongs to educators, the percentage of valued learning can undoubtedly increase over time. Students may not always remember the topic at hand, but they will retain the skills they learned behind a certain lesson, especially if relevancy is kept at the forefront of learning. Overall, using these methods can act as a bridge between those who believe in the power of AI in Education and those who fear it.

Summary:

So, what is the impact of artificial intelligence on Education? As stated at the beginning of this paper, it has helped students to be more engaged in the classroom and become technologically savvy. The more practice students receive with these technological advancements now, the more they will be able to thrive and better perform in the future when these technologies are part of their daily routines. On the other hand, through the following research, it is clear that artificial intelligence does have repercussions as well in how it can impact students and their education. For example, resources such as Chat GPT may encourage plagiarism and discourage students from completing their work. This can prompt laziness and the inability to start and complete a task or project, which is an essential skill to maintain to find success in anything a future student does. This is a skill that will not only help students in the academic and corporate world, but it is also a quality that can help students when making big life decisions. Having the grit and perseverance to complete a task from start to finish independently is no mission to easily conquer. You cannot consistently rely on an artificial intelligence program to make constant decisions for you. Additionally, relying on these products to do one's work for them can stunt creativity and the ability to bring a person's idea or dream to fruition. As previously discussed in this paper, it is evident that if artificial intelligence is taken advantage of and begins to replace natural intelligence from humans, this could put current and future students in danger. As the future leaders of our society, students must practice decision-making and express their needs effectively. If technology is relied on too much, what is to be determined of society's status in the future? Teachers must use their role of power and influence to guide students in seeing the way artificial intelligence has its place in society. AI is an intuitive and important tool to know how to use but should never be viewed as a replacement for natural intelligence.

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