THOUGHTS

Highlighting the Human Learner in Learning Environments

By: Ziho Kang • Sept. 11, 2023

Over the past few years, learning environments have undergone significant changes, especially due to the pandemic. There has been a shift in what is considered an appropriate learning environment and what elements should be prioritized to enhance student learning. Often, the most critical factors are the ones that are disregarded or overlooked entirely, which are the human factors.

At first glance, Human Factors can be a difficult research area to understand. Human Factors, also known as Ergonomics, encompasses the scientific discipline that examines the factors influencing human physical, mental, and emotional aspects to enhance human performance and achieve the objectives of a system. Human Factors consider a holistic approach and include both the cognitive and physical aspects of human behavior, such as decision-making processes, cognitive load, fatigue, situational awareness, visual and auditory perception, and physical posture, among others. In addition, Human Factors consider both individual and collective behaviors, such as social and organizational interactions.

According to the Human Factors and Ergonomics Society (HFES), it is concerned with applying what we know about people, their abilities, characteristics, and limitations to the design of products and equipment they use, environments in which they function and jobs they perform. The field is a combination of numerous disciplines, including engineering, psychology, sociology, biomechanics, industrial design, physiology, anthropometry, interaction design, visual design, user experience, and user interface design.

Within the realm of education, Human Factors finds practical application in investigating the learning environment to elevate students' learning performance. Human Factors can play a crucial role in optimizing the learning environment, enhancing pedagogies, and refining educational materials. The goal is to create an optimized setting that fosters effective learning and maximizes students' educational outcomes.

In the book, *Analyzing the Instructional Setting*, published in 1992, the authors state, "The environment exerts a powerful influence on learning and behavior, even though we may not be aware of it or may choose to disregard it," and also environment-based (facility)

Recently there have been significant gains made in our understanding and awareness of ergonomics as applied to the design and utilization of various kinds of environments where people perform tasks not dissimilar to those performed in schools and training centers. I believe that much of that information is readily transferable to the educational sector. In addition, there have been other studies conducted by myself, my students, and by other academicians and their students specifically assessing the merits of design features in educational facilities, which I believe if used collectively with the previously mentioned information are sufficient to make possible educational-facilities design decisions based on hard science.

The integration of cognitive and physical perspectives in the research process enables a comprehensive understanding of how humans interact with various elements, leading to more informed design decisions, improvements, and recommendations. Researchers from academia and industry convene at the Annual Meeting of HFES to share their research. In addition, research results are disseminated through *Human Factors: The Journal of the Human Factors and Ergonomics Society*, *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*, and other various journals and conference proceedings. Illustrative examples are as follows.

Noise Hinders Learning in Young Brains

An example of scientific research that impacts how Human Factors and Ergonomics principles can be leveraged on behalf of a learning environment is seen in a study published in the Journal of Neuroscience. The study demonstrates the negative effect background noise has on children's ability to track and understand what is being said by a teacher, for example. They struggled much more than adults to follow the speaker as noise increased from other voices in the background. This means the buzzing of fluorescent lights, the clamor from the playground, chatter in the classroom, footsteps from the hall, the droning of the HVAC system and the hum of a laptop fan are all contributing factors to background noise. Noise that, neurologically, may be preventing children's brains from learning.

The key to designing a classroom or other learning environment to meet acoustic concerns is addressing them early in the fundamental stages of planning and design. The signal-to-noise ratio needs to be improved to increase the intelligibility of the intended speaker, i.e., the teacher. Either the signal (teacher's voice) must be increased, or the background noise must be decreased. This can be accomplished by a microphone and speakers or with a design that positively favors the acoustics of a space and eliminates undesirable sound reflections. Decreasing background noise can be aided, even retroactively, by installing sound-dampening panels to reduce the noise filtering through the walls and the plenum space above the ceiling. Baffling and dampeners can be used to reduce airflow noise, and acoustic blankets can be wrapped around HVAC ductwork to minimize the sound of vibrations.

Smart Classrooms

Modern classrooms often blend physical and virtual spaces, utilizing various technologies to enhance the learning experience. However, it's important to consider whether introducing new technologies to the classroom is genuinely beneficial. During the design phase of a new product or technology, it's crucial to take into account Human Factors and Ergonomics. This means ensuring that the technology promotes sensory comfort and high auditory and visual acuity where applicable while also fitting within the physical dimensions of the classroom and allowing for personal space. It's also important to consider whether the technology adds to students' cognitive load and promotes positive social interaction and communication patterns. When it comes to digital devices, they should be user-friendly for both teachers and students while also considering potential issues with real-time data collection and how these devices are used both inside and outside of the classroom. The fact is the introduction of any new technology into a classroom will inevitably alter the nature of the learning environment in some way. The effectiveness should be explored through the lens of Human Factors and Ergonomics to ensure a proactive, learner-centered design process in schools.

Inside and Outside the Classroom

Ultimately, students can be positively impacted when Human Factors and Ergonomics are incorporated into (not only) product designs, lesson plans and classroom setups but also how the community is organized. A paper published in the journal *WORK* offered two conclusions: (1) that variability in student learning is prominently influenced by ergonomic design features, not only of classrooms and school systems but also of surrounding communities; and (2) a systems concept of learning environments, therefore, is required to support student learning, based on integrating educational with community ergonomics.

Recently, society has opened its eyes to the fact that learning environments outside the classroom are just as important, if not more so, than those inside.

During the pandemic, HFES published a list of ergonomic recommendations to address this new norm of remote or virtual schooling. The tips were designed to help reduce fatigue, pain and injury and to increase student attention and engagement. They include recommendations on workstation setup, including the technology involved, location, vision, hearing, air quality, etc.

Human Factors Helps Humans Flourish

When Human Factors and Ergonomics are applied to learning environments, the entire educational experience is enhanced and advanced for learners and their communities.

About the Author

Ziho Kang is a member of the Human Factors and Ergonomics Society (HFES). He is recognized in human factors as a recipient of the prestigious National Science Foundation CAREER Award. Kang is discovering new smart learning methods in the multi-person virtual reality space through the multimodal engagement analysis of eye movements, haptic interactions and brain waves. Kang's specialty is developing algorithms that can discover significant patterns from real-time and spatial-temporal eye movement networks, which can be used to inform the design of systems and develop training intervention methods. Prior and current research areas include air traffic control, weather forecasting, commercial advertisement, driving, piloting, Deepwater Horizon offshore oil drilling and education. Kang's four years of industry experience as an engineer at Samsung and the Korea Stock & Futures Exchange preceded his doctoral degree from the School of Industrial Engineering at Purdue University in 2012. He then served as a Postdoctoral Researcher in Computing & Informatics at Drexel University before serving as a faculty member in Industrial and Systems Engineering at the University of Oklahoma in 2014. He has been the institution co-PI at the Center of Excellence for Technical Training and Human Performance ($6 million) and the PI/Co-PI of nine projects ($1.8 million).

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