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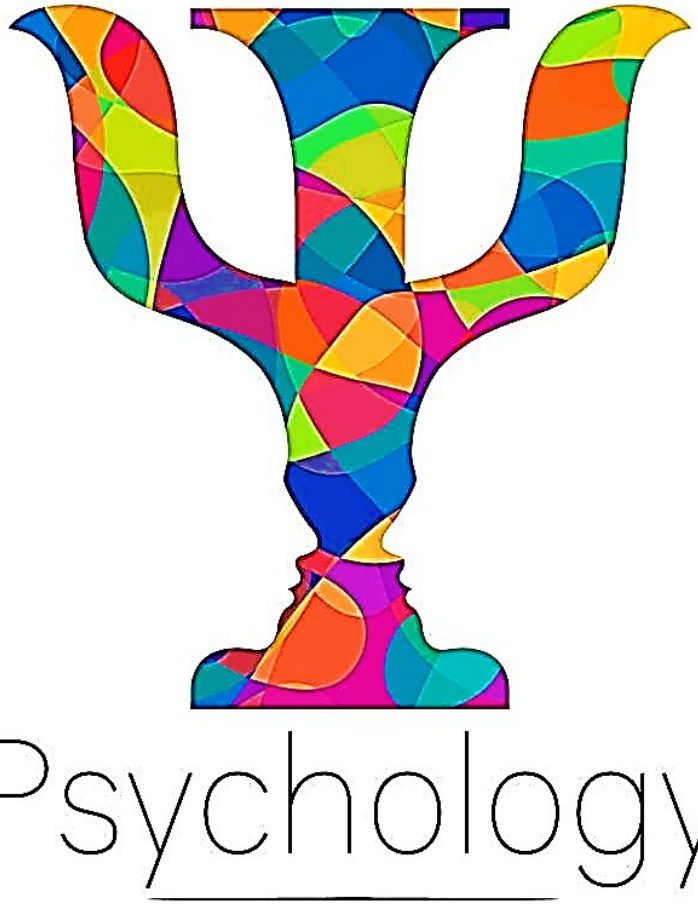
# PSYCHOLOGY

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# THE PSYCHOLOGICAL MEANING OF COLOR IN DESIGN: A SEMANTIC REVIEW*

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***Abstract***

*Color is a fundamental and pervasive element of human perception and a critical tool in various design disciplines. This review synthesizes the scientific literature on the psychological meaning of color within design contexts, encompassing graphic, web, interior, product, and marketing design. The study examines how color influences human emotion, cognition, and behavior, drawing upon theoretical frameworks ranging from biological and evolutionary perspectives to learned associations and context-dependent models, particularly the Color-in-Context theory. The methodology involved a systematic review of peer-reviewed journal articles, academic books, and conference proceedings, focusing on empirical research employing experimental, correlational, survey, and qualitative methods. Key findings indicate that colors such as red, blue, green, yellow, black, and white evoke complex, often dualistic psychological responses (e.g., red signifies both passion and danger; blue conveys trust but also sadness). These responses are significantly moderated by factors including the specific design context, cultural background, individual differences (age, gender, personality, experience), and the interplay of color combinations, saturation, and brightness. Methodological limitations within the field, such as inadequate color specification and control, underpowered samples, and oversimplification of stimuli, are identified. Practical implications for design professionals highlight the need for nuanced, evidence-based color strategies that consider context, target audience, and brand identity, alongside ethical considerations regarding potential manipulation and accessibility. The review concludes that while color demonstrably affects psychological functioning, the field requires further research with improved methodological rigor, a greater focus on moderating variables and complex color interactions, and the development of mid-level theories to bridge the gap between fundamental research and effective design application.*

***Keywords:*** *color psychology, design, perception, emotion, cognition, behavior, culture, context, color theory, human-computer interaction (HCI).*

## 1. INTRODUCTION

### 1.1. The Pervasive Influence of Color in Human Experience and Design

Color is an inescapable dimension of human visual experience, fundamentally shaping how individuals perceive and interact with their environment. It is far more than an aesthetic overlay; color functions as a powerful, non-verbal communication tool capable of signaling action,

influencing mood, altering perception, and even triggering physiological reactions (Rider, 2009). Its ubiquity extends across virtually every field of design, including graphic design, web and user interface (UI) design, interior design, product design, marketing, branding, and architecture (Sanvicente, 2024).

The initial encounter with color can have a remarkably swift and significant impact. Research suggests that individuals form judgments about products or people within as little as 90 seconds of initial viewing, and that color alone can account for up to 90% of this assessment. This rapid evaluation underscores the profound role color plays in establishing first impressions and highlights its potential economic implications for design effectiveness, branding, and product success. The sheer speed and weight of these color-based judgments strongly suggest that many psychological effects of color operate below the threshold of conscious awareness. Such rapid, high-impact assessments are unlikely to result from deliberate, analytical thought processes. Instead, they point towards automatic, associative, or affective mechanisms driving initial perception, often preceding more detailed cognitive evaluation. This largely subconscious influence is the source of color's potency as a design element, but it simultaneously introduces ethical considerations regarding its potential use for manipulation (Rauten, 2024).

### 1.2. Defining Color Psychology in the Context of Design

Color psychology is the scientific study of how hues (colors) and their properties (such as saturation and brightness) affect human cognition, affect (emotions and moods), behavior, and even physiological states (Cherry, 2024). It is an inherently interdisciplinary field, drawing insights from psychology, neuroscience, vision science, anthropology, sociology, marketing, art history, and various design disciplines (Hussain, 2021). Within the context of design, color psychology moves beyond mere aesthetics to investigate the measurable impacts of color choices on user or consumer responses. This includes effects on mood states, attention span, task performance, decision-making processes, brand perception, product evaluation, and physiological reactions such as changes in heart rate, blood pressure, and alertness levels (Arora & Warsi, 2024).

### 1.3. Historical Context and Evolution of Research

While the systematic study of color psychology is relatively recent, human fascination with color and intuition about its effects date back centuries. Early explorations were often philosophical or artistic. Johann Wolfgang von Goethe, in his *Theory of Colors* (1810), diverged from Isaac Newton's purely physical description of the light spectrum to propose links between color categories (e.g., "plus" colors like yellow and red-yellow) and emotional responses such as warmth and excitement (Mirzaei, 2025).

As psychology emerged as a distinct discipline, researchers began investigating color's effects

more formally. Kurt Goldstein (1942), building on Goethe's ideas and observations of patients, hypothesized that colors like red and yellow produce inherent physiological reactions manifesting as distinct emotional, cognitive, and behavioral patterns (e.g., arousal, outward focus, forceful action) (Unika Vaev, n.d.). Lois B. Wexner (1954) empirically explored associations between specific hues and mood-tones, finding consistent links. The mid-20th century saw figures like Faber Birren bridge the gap between artistic practice and scientific inquiry, authoring influential works that helped formalize the field.

The past decade, in particular, has witnessed a surge in research interest (Elliot, 2015). This contemporary work integrates insights from neuroscience (e.g., neuroaesthetics exploring brain responses to color), develops more sophisticated theoretical models like the Color-in-Context theory, and increasingly focuses on applied contexts such as marketing, branding, and human-computer interaction (HCI).

### 1.4. Overview of Major Theoretical Frameworks

Several theoretical perspectives attempt to explain how color influences psychological functioning. These can be broadly categorized:

- **Biological/Evolutionary Perspectives:** These theories propose that some responses to color are rooted in our biology or evolutionary history.

▪ *Wavelength Effects:* Early theories posited that the physical properties of light wavelengths directly impact physiology and emotion. Longer wavelengths (red, yellow) are often described as arousing, stimulating, or warm, while shorter wavelengths (blue, green) are seen as relaxing, calming, or cool. More recent work focuses on specific pathways, such as blue light's activation of the melanopsin system, which influences alertness and attention.

*Ecological Valence Theory (EVT):* Proposed by Palmer and Schloss (2010), EVT suggests that color preferences are not arbitrary but develop based on an individual's cumulative emotional responses to objects and environmental events associated with those colors (Khattak et al., 2021). For example, the common adult preference for blue might stem from positive associations with clear skies and clean water, while a dislike for brownish-yellow might relate to associations with decay or feces. This theory helps explain why preferences can change with age and experience.

▪ *Comparative Approaches:* Some theories draw parallels between human and non-human animal responses. For instance, the display of red (associated with oxygenated blood) signals dominance or health in many species, potentially explaining why red enhances perceived dominance or competitiveness in humans. Relatedly, the evolution of human trichromatic vision may be linked to detecting subtle skin color changes (redness, yellowness) that signal health, emotion, or attractiveness (Elliot et al., 2007).

● **Learned Association Perspectives:** These frameworks emphasize the role of learning and experience in shaping color meaning.

○ *Social Learning/Classical Conditioning:* Many color associations are believed to arise through repeated pairings of a color with specific concepts, messages, or experiences within a culture or environment. Examples include red with stop signs or errors, green with nature or traffic lights, white with weddings in Western cultures, or black with mourning (Lin, Mottaghi, & Shams, 2024). These learned associations become deeply ingrained and can trigger automatic responses.

○ *Conceptual Metaphor Theory:* This theory posits that humans use concrete perceptual experiences, like color, to understand abstract concepts metaphorically. Common linguistic expressions reflect these links (e.g., "seeing red" for anger, "feeling blue" for sadness, "green with envy," associating lightness with positivity or goodness). These metaphors can influence judgments and social perceptions.

● **Contextual Perspectives:** Recognizing the limitations of universal associations, these theories emphasize the situation-dependent nature of color meaning.

○ *Color-in-Context Theory:* Proposed by Elliot and Maier (2012), this influential theory integrates biological predispositions and social learning but adds a crucial layer: context. It argues that the psychological meaning and subsequent effect of a color are fundamentally dependent on the physical and psychological context in which it is perceived. The same color can evoke vastly different, even opposite, responses depending on the situation. For example, red might enhance attractiveness in a romantic context but impair performance in an achievement context where it signals failure or danger. Similarly, blue might signal trustworthiness on a corporate logo but indicate spoilage on food (Elliot et al., 2007).

The evolution of these theoretical frameworks reveals a clear trajectory away from simplistic, universal claims about color meaning towards more sophisticated models. These newer models acknowledge the complex interplay between innate biological factors, extensive learning through cultural and personal experience, and, most critically for design, the specific context of perception. The Color-in-Context theory appears particularly pertinent, offering a framework to understand the often-contradictory findings in the literature and aligning well with the inherently contextual nature of design practice, where the function, audience, and surrounding elements drastically alter how a color is deployed and interpreted (Design Studio UI/UX, 2024).

### 1.5. Rationale and Objectives of the Current Review

Despite the recent surge in research activity, the field of color psychology, especially concerning its application in design, remains in a nascent stage of development. The literature is often characterized as fragmented, containing methodological weaknesses, and exhibiting a

significant gap between fundamental theoretical understanding and practical, evidence-based design implementation. Designers and marketers require robust knowledge about how color impacts human psychology to improve communication and user engagement, yet clear, synthesized guidance grounded in rigorous science is often lacking.

Therefore, this review aims to address this gap by providing a comprehensive, critical synthesis of the scientific literature on the psychological meaning of color specifically within the diverse contexts of design. The objectives are:

1. To systematically review and synthesize peer-reviewed literature concerning the psychological meaning—encompassing affective, cognitive, and behavioral responses—of color within various design domains (graphic, web/UI, interior, product, marketing, etc.).
2. To critically analyze the methodologies commonly employed in color psychology research relevant to design, evaluating their strengths and limitations.
3. To evaluate the evidence regarding the influence of key moderating variables, including context, culture, individual differences, and the effects of color combinations and properties (saturation, brightness).
4. To discuss the practical implications, potential applications, and ethical considerations arising from color psychology research for design professionals.
5. To identify current limitations, inconsistencies, and gaps in the existing body of knowledge, and to propose specific directions for future research that can advance the field and its applicability to design.

## 2. METHODS (LITERATURE REVIEW METHODOLOGY)

This review employed a systematic approach to identify, evaluate, and synthesize relevant academic literature on the psychological meaning of color in design.

### 2.1. Search Strategy

A comprehensive search was conducted across multiple academic databases, including PsycINFO, PubMed, Scopus, Web of Science, and Google Scholar. Additionally, relevant archives for design and human-computer interaction research, such as the ACM Digital Library and IEEE Xplore, were consulted. The search utilized combinations of keywords and subject terms, including: "color psychology", "colour psychology", "color meaning", "color perception", "affective response color", "cognitive effects color", "behavioral effects color", "color design", "graphic design", "web design", "UI design", "interior design", "product design", "marketing color", "branding color", "color theory", "color context", "cultural color", "color preference", "color harmony", as well as specific color names (e.g., "red", "blue", "green", "yellow", "black", "white"). While the primary

focus was on research published within the last 20-25 years to capture contemporary theories and methodologies, seminal works foundational to the field were included for historical context.

**2.2. Inclusion and Exclusion Criteria**

Studies were included if they met the following criteria: (a) published in peer-reviewed journals, academic books or book chapters, or rigorously reviewed conference proceedings; (b) investigated psychological responses (affective, cognitive, or behavioral) to color; (c) focused on contexts relevant to design or presented findings with clear implications for design; (d) employed empirical research methods (e.g., experimental, correlational, survey, qualitative, mixed-methods) or were systematic reviews of such research; and (e) were available in English. Exclusion criteria included: (a) non-academic sources; (b) studies focusing solely on physical/physiological aspects without psychological relevance; (c) research exclusively on clinical color therapy; (d) abstracts only; and (e) non-English publications.

**2.3. Data Extraction and Synthesis Approach**

A narrative synthesis approach was adopted (De Medeiros Dantas et al., 2022). Key information was extracted from each source, including: author(s)/year; theoretical framework; objectives; methodology (design, participants, stimuli, measures); core findings on color effects (specific colors, moderators); limitations; and design relevance. Information was organized thematically according to the IMRAD structure, focusing on converging evidence, inconsistencies, and overall patterns.

**2.4. Methodological Quality Assessment**

The methodological rigor of included empirical studies was assessed based on criteria relevant to color psychology. Key criteria included: clarity of color specification (e.g., standardized coordinates); control of viewing conditions (illumination, background); sample characteristics and size; validity of measures (scales, tasks); control for confounds; and transparency/reproducibility.

## 3. RESULTS (SYNTHESIZED FINDINGS FROM LITERATURE)

This section synthesizes the empirical findings from the reviewed literature, focusing first on the psychological effects associated with core colors frequently utilized in design, and second on an analysis of the research methodologies employed in these studies.

**3.1. Empirical Findings on Core Colors in Design Contexts**

The literature reveals complex and often multifaceted psychological associations and effects for key colors. These are summarized below, emphasizing findings relevant to design applications.

- **3.1.1. Red:**

  - *Associations:* Red consistently evokes strong, often dualistic associations: positive (passion,

excitement, energy, love, power, confidence, warmth) and negative (danger, anger, aggression, warning, errors, failure, intensity) (Rocky Mountain College of Art + Design, 2025).

○ *Affective/Physiological Responses:* Red is physiologically arousing, increasing heart rate and alertness. It is linked to appetite stimulation. Overuse can cause anxiety or agitation (Insights Psychology, 2025).

○ *Cognitive/Behavioral Impacts:* Red effectively captures attention (Bytyçi, 2020). It signals urgency (used for CTAs, warnings, sales). Perception of red before achievement tasks can impair performance (Unika Vaev, n.d.), potentially due to failure associations. Conversely, in affiliation contexts, red can enhance perceived attractiveness. It is linked to perceived dominance. Some evidence suggests red aids memory (Hecks, 2025).

● **3.1.2. Blue:**

○ *Associations:* Blue is overwhelmingly associated with positive concepts like calmness, serenity, stability, trust, reliability, security, professionalism, and wisdom. It also carries associations with sadness ("feeling blue"), coldness, and aloofness.

○ *Affective/Physiological Responses:* Blue generally induces relaxation and calmness. Physiologically, it's linked to lowered blood pressure/heart rate (Rockfon, 2022). Blue light exposure can increase alertness. Blue is frequently reported as the most preferred hue.

○ *Cognitive/Behavioral Impacts:* Blue enhances perceptions of trustworthiness and competence, widely used in corporate branding (finance, tech). It may enhance concentration and productivity. In UI design, it fosters a calm, secure experience (Design Studio UI/UX, 2024).

● **3.1.3. Green:**

○ *Associations:* Green holds strong associations with nature, growth, health, harmony, balance, tranquility, safety, and environmentalism. Negative associations include envy, sickness, and boredom (Insights Psychology, 2025). Green-yellow shades are often perceived negatively (Appear Online, 2025).

○ *Affective/Physiological Responses:* Green is widely considered calming and relaxing, reducing stress. It may lower blood pressure/heart rate.

○ *Cognitive/Behavioral Impacts:* Green can promote balance and security. Research suggests it enhances creativity, focus, and memory, and reduces mental fatigue. It's frequently used in branding for health, wellness, and eco-friendly products. Its presence in work/learning environments is considered beneficial (Springer, 2022).

● **3.1.4. Yellow:**

*Associations:* Yellow is strongly linked to happiness, optimism, warmth, energy, and creativity (Sanvicente, 2024). Negative connotations include caution, warning, cowardice, anxiety,

and sickness (especially green-yellow). Yellow is often among the least preferred colors by adults.

○ *Affective/Physiological Responses:* Yellow is perceived as energetic and stimulating. Its high luminosity can cause visual fatigue. Overexposure has been anecdotally linked to increased frustration (Cherry, 2023).

○ *Cognitive/Behavioral Impacts:* Yellow is highly visible and attention-grabbing, used in warning signs and highlights. It may stimulate mental processes (Jandal, 2024). Yellow often presents readability challenges. In branding, it conveys youthfulness and fun (e.g., McDonald's) (Varma, 2024).

● **3.1.5. Black:**

○ *Associations:* Black is strongly associated with power, sophistication, elegance, luxury, authority, and mystery. Negative connotations include death, evil, mourning, fear, sadness, and aggression (World Design Council, 2024).

○ *Affective/Physiological Responses:* Often evokes negative emotions. Extensive use can feel oppressive or make spaces appear smaller (Kaya & Epps, 2004).

○ *Cognitive/Behavioral Impacts:* Black is used in luxury branding (fashion, tech) to convey elegance and premium quality. Its association with aggression is observed in sports. Black backgrounds can enhance adjacent colors (Morton, n.d.). Black may be least effective for memory retention.

● **3.1.6. White:**

○ *Associations:* White is predominantly associated with purity, cleanliness, simplicity, peace, goodness, and modernity. Negative associations include sterility, coldness, and emptiness. In some Eastern cultures, it symbolizes mourning.

○ *Affective/Physiological Responses:* Generally, elicits positive emotional responses. Can create feelings of freshness. Bright white can cause glare and visual fatigue (Dacillo, n.d.).

○ *Cognitive/Behavioral Impacts:* White is a cornerstone of minimalist design, creating spaciousness and clarity. In branding, it signifies simplicity and sophistication (e.g., Apple). White backgrounds enhance visibility of other colors.

● **3.1.7. Other Significant Colors (Briefly):**

○ *Orange:* Energetic, enthusiastic, warm, creative, attention-grabbing. Can seem cheap.

○ *Purple:* Luxury, royalty, wisdom, creativity, mystery. Can imply snobbery.

○ *Pink:* Softness, romance, femininity, calmness. Can connote weakness.

○ *Brown:* Earthiness, stability, reliability, comfort. Can appear dull.

○ *Gray:* Neutrality, balance, calmness, sophistication. Can seem dull or depressing (Iyer, 2023).

The consistent finding of dualistic (positive/negative) interpretations for nearly every color strongly supports context-dependent frameworks like the Color-in-Context theory. Meaning is constructed based on context, combinations, culture, and experience, necessitating a nuanced design approach.

**(Table 1: Summary of Psychological Effects of Key Colors in Design Contexts)**

| Color | Common Positive Associations/Emotions | Common Negative Associations/Emotions | Key Cognitive/Behavioral Effects (Examples in Design) |
|---|---|---|---|
| **Red** | Passion, excitement, energy, love, power | Danger, anger, aggression, warning, error, failure | Grabs attention, signals urgency (CTAs, sales), stimulates appetite (food branding), impairs cognitive task performance (achievement context), enhances attraction (mating context), signals dominance |
| **Blue** | Calmness, trust, stability, reliability, security, professionalism | Sadness, coldness, aloofness | Builds trust (corporate/financial/tech branding, UI), promotes relaxation (interiors, healthcare), may enhance concentration/productivity, generally preferred hue |
| **Green** | Nature, growth, health, harmony, balance, tranquility, safety | Envy, sickness, boredom, inexperience | Calming/reduces stress (interiors, wellness design), enhances creativity/focus |

| | | | |
|---|---|---|---|
| | | | (work/learning spaces), signals eco-friendliness/health (branding) |
| **Yellow** | Happiness, optimism, warmth, energy, creativity | Caution, warning, cowardice, anxiety, frustration, sickness. | Highly visible/attention-grabbing (warnings, highlights), can cause eye fatigue, difficult readability, conveys youth/fun (branding) |
| **Black** | Power, sophistication, elegance, luxury, formality, mystery | Death, evil, mourning, fear, sadness, oppression, aggression | Conveys luxury/premium quality (branding), associated with aggression (sports), can make spaces feel smaller, enhances adjacent colors |
| **White** | Purity, cleanliness, simplicity, peace, modernity, safety | Sterility, coldness, emptiness, isolation, mourning (some cultures) | Creates sense of space, foundation of minimalist design, conveys simplicity/tech (branding), can cause glare/eye strain |

*Note: Associations and effects are highly context-dependent.*

### 3.2. Analysis of Research Methodologies Employed

The empirical study of color psychology utilizes a range of research methodologies, each with strengths and weaknesses.

- **Prevalence of Methodologies:**
- *Experimental Designs:* Frequently used to investigate causal links between color stimuli and responses (e.g., color effects on test performance, UI engagement, physiological measures , VR environments, cognitive tasks ).

*Correlational Research:* Identifies statistical associations without manipulation (e.g., personality and color preference (Xia et al., 2021), color-emotion links (World Design Council,

2024). Limited by inability to establish causation (Eriksen Translations, 2020).

- *Surveys and Questionnaires:* Common for assessing subjective responses (preferences, emotions, attitudes) using various scales (ranking, Likert, semantic differential, SAM (World Design Council, 2024).
- *Qualitative and Mixed Methods:* Provide deeper insights via interviews, focus groups, thematic analysis (Mirzaei, 2025). Mixed methods combine approaches (Mirzaei, 2025).
- *Observational and Archival Methods:* Less common; involve naturalistic observation or analysis of existing data (e.g., logo colors, sports outcomes) (Eriksen Translations, 2020).
- **Methodological Strengths and Limitations:** Experiments offer causal inference but may lack ecological validity. Correlational studies explore natural relationships but cannot determine causation. Surveys are efficient but rely on potentially biased self-reports (Eriksen Translations, 2020). Qualitative methods offer depth but limited generalizability.
- **Specific Methodological Critiques in Color Psychology Literature:** Recurring criticisms include (Rider, 2009):
- *Inadequate Color Specification:* Frequent failure to precisely define stimuli using standardized systems (Munsell, CIE L*a*b*, sRGB) or spectral data, hindering replication and comparison (Rider, 2009).
- *Lack of Control Over Viewing Conditions:* Poor control/reporting of ambient lighting, backgrounds, viewing distance, screen calibration (Elliot, 2015).
- *Insufficient Statistical Power:* Small sample sizes increase error risk and potentially inflate effect sizes (Elliot, 2015).
- *Limited Ecological Validity of Stimuli:* Over-reliance on simple abstract stimuli (colored squares) may not generalize to complex design contexts (Park University, 2024).
- *Ambiguity of Concepts:* Lack of consistent operational definitions for terms like "color harmony" (Arora & Warsi, 2024).
- *Narrow Focus on Hues:* Disproportionate focus on basic hues (esp. red), neglecting saturation and brightness (Elliot, 2015).

**(Table 2: Methodological Approaches in Color Psychology Research)**

| Methodology Type | Description | Example Study Focus | Key Strengths | Key Limitations/Critiques |
|---|---|---|---|---|
| **Experimental** | Manipulation | Effect of red | Strongest for | Potential artificiality; |

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|---|---|---|---|---|
| | of color variables to determine causal effects on responses. | on test performance (Elliot et al., 2007); Color scheme impact on UI engagement (Mirzaei, 2025). | causal inference; Allows variable control. | Difficulty in color control; Ethical constraints (Eriksen Translations, 2020); Limited ecological validity (Park University, 2024) . |
| **Correlational** | Observation and measurement of statistical relationships between variables. | Color preference and personality (Xia et al., 2021); Color-emotion associations (World Design Council, 2024) . | Explores natural relationships; Useful when experiments impractical (Eriksen Translations, 2020). | Cannot infer causation; Third-variable problems; Dynamic relationships (Eriksen Translations, 2020). |
| **Survey/ Questionnaire** | Collection of self-reported data on preferences, attitudes, emotions. | Assessing color preferences (Rider, 2009); Measuring emotional responses (Kaya & Epps, 2004). | Efficient for large samples; Good for subjective states; Various scales (Unika Vaev, n.d.). | Reliance on self-report (biases); Limited depth; Sensitive to format (Eriksen Translations, 2020); May miss unconscious effects. |
| **Qualitative** | In-depth exploration of experiences, | Understanding reasons for color choices | Rich, contextual understanding; | Findings often not generalizable; Subjectivity; Time- |

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|---|---|---|---|---|
| | meanings via interviews, focus groups. | (Swasty & Adriyanto, 2017); Exploring cultural meanings. | Explores complexity; Generates hypotheses. | consuming. |
| **Mixed Methods** | Integration of quantitative and qualitative approaches. | Experiment + qualitative analysis (Mirzaei, 2025). | Comprehensive understanding; Triangulation. | Complex design/implementation; Requires diverse expertise; Data integration challenges. |
| **Archival/ Observational** | Analysis of existing data or observation of behavior in natural settings. | Analyzing branding color trends; Observing color choices (Eriksen Translations, 2020). | High ecological validity (observation); Uses existing data (archival). | Limited control; Causality difficult; Observer bias; Data limitations (Eriksen Translations, 2020). |

*Note: This table summarizes common approaches and their general characteristics within color psychology research relevant to design.*

## 4. DISCUSSION

The synthesized findings confirm color's potent influence in design on affect, cognition, and behavior, but reveal a complexity beyond popular portrayals.

### 4.1. Interpretation and Synthesis of Findings

Colors like red, blue, green, yellow, black, and white carry associations triggering measurable responses (Arora & Warsi, 2024). Red's arousal (Mirzaei, 2025), blue's calmness (Mirzaei, 2025) , red/yellow's attention-grabbing nature (Insights Psychology, 2025) , and blue's link to trust (World Design Council, 2024) are recurring themes relevant to design.

However, effects are rarely simple. The dualistic associations (Red: passion/danger; Blue: trust/sadness) highlight that meaning is constructed, not inherent. This complexity aligns with

contemporary theories. While basic physiological responses (warm vs. cool) or universal experiences (EVT (Rider, 2009) explain some tendencies, they fail to capture context-specific and cultural meanings. The Color-in-Context theory (Unika Vaev, n.d.), emphasizing situation-dependent interpretation, provides a robust framework, explaining contradictory findings (e.g., red's opposing effects in achievement vs. affiliation). Context acts as a primary filter, modulating or determining color's psychological impact in design.

**4.2. Influence of Moderating Variables**

Variability necessitates examining moderating factors.

● **4.2.1. The Critical Role of Context:** As per Color-in-Context theory (Unika Vaev, n.d.), the situation (physical and psychological) is paramount. Red's negative impact on cognitive tasks occurs in achievement contexts (failure priming (Elliot, 2015), while it enhances attraction in romantic contexts (Unika Vaev, n.d.). Blue's effectiveness depends on appropriateness (trust for a bank, less so for fast food) (Rocky Mountain College of Art + Design, 2025). Perceived *appropriateness* of color to brand/product context can be more influential than inherent associations (Design Studio UI/UX, 2024). Designers need deep analysis of the use case (user expectations, culture, brand personality, function) rather than applying simple rules.

● **4.2.2. Cultural Variations and Universals:** There's interplay between potential universals (blue preference (Rider, 2009), warm/arousing vs. cool/calming distinction (Arora & Warsi, 2024) , bright=positive/dark=negative link (Rider, 2009) and profound cultural differences in symbolic meaning (Arora & Warsi, 2024). These learned meanings (Red: luck in China, danger in West; White: purity in West, mourning in East Asia (Insights Psychology, 2025) demand cultural sensitivity in global design (Rocky Mountain College of Art + Design, 2025). Designers should acknowledge basic affective responses but prioritize learned, culturally specific meanings relevant to the audience.

**(Table 3: Cross-Cultural Color Symbolism Examples Relevant to Design)**

| Color | Western Associations (Examples) | East Asian Associations (Examples) | Latin American Associations (Examples) | Middle Eastern/Islamic Associations (Examples) | Design Implications/Cautions |
|---|---|---|---|---|---|
| **Red** | Passion, love, excitement, energy, danger, | Luck, prosperity, happiness | Passion, religion (with white), death, | Danger, caution (Eriksen Translations, | Meaning varies widely; potent but requires careful cultural research. Avoid |

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|---|---|---|---|---|---|
| | urgency (Rocky Mountain College of Art + Design, 2025) | (China); Anger, danger (Insights Psychology, 2025) | vibrancy (region varies) (Alnasuan, 2016) | 2020) | assuming universal meaning of urgency/passion. |
| **White** | Purity, weddings, cleanliness, simplicity, peace (Rocky Mountain College of Art + Design, 2025) | Mourning, death, funerals (China, Japan, Korea); Humility (Insights Psychology, 2025) | Purity, peace; Authority (e.g., police uniforms) (Alnasuan, 2016) | Purity, mourning (Sharma & Kapil, 2023) | High potential for misinterpretation in East Asian markets if used for celebratory contexts. Strong association with minimalism. |
| **Yellow** | Happiness, optimism, warmth, caution (Rocky Mountain College of Art + Design, 2025) | Sacred, imperial (China); Mourning (Egypt); Courage (Japan) (Insights Psychology, 2025) | Death, mourning (Mexico, Egypt); Sun, warmth (Insights Psychology, 2025) | Happiness, prosperity | Highly variable negative associations (mourning, envy); requires specific local knowledge. Often disliked hue by adults (Rider, 2009). |
| **Green** | Nature, luck, environment, finance, envy, inexperience (Alnasuan, 2016) | Health, prosperity, harmony; Infidelity (China); Eternal life (Japan) (Design Dash, 2024) | Nature, vegetation, wealth (Alnasuan, 2016) | Holy color (Islam), paradise, fertility, strength | Generally positive (nature, health), but specific negative connotations exist (e.g., Indonesia (Eriksen Translations, 2020). Strong Islamic link. |
| **Blue** | Trust, calm, stability, authority, sadness (Rocky | Immortality, spirituality, heaven; Femininity | Mourning (Mexico); Trust, tranquility | Protection, spirituality, heaven | Relatively safe globally, often signifying trust/calm, but mourning association exists in some |

| | | | | | |
|---|---|---|---|---|---|
| | Mountain College of Art + Design, 2025) | (sometimes) (Eriksen Translations, 2020) | (Alnasuan, 2016) | | specific cultures. |
| **Black** | Sophistication, power, elegance, mourning, evil (Cherry, 2024) | Masculinity, knowledge, evil, mourning (Eriksen Translations, 2020) | Masculinity, mourning, religion, respect (Alnasuan, 2016) | Mystery, evil, mourning | Often linked to luxury/power, but strong association with mourning/negativity requires careful context consideration. |

*Note: Associations can vary within regions and are influenced by context.*

- **4.2.3. Individual Differences:** Significant variation exists beyond culture.

○ *Age:* Preferences shift from warm (childhood) to cool (adulthood) (Rider, 2009). Emotional associations also vary (Beins, 2022).

○ *Gender:* Subtle differences exist (Men: stronger blue preference; Women: may favor purple more, be more sensitive to variations) (Rocky Mountain College of Art + Design, 2025) .Gender stereotypes influence perception (Liang & Hangeldiyeva, 2024).

○ *Personality:* Potential links exist (e.g., agreeableness/conscientiousness with blue/white preference (Xia et al., 2021), but more research needed.

○ *Personal Experience and Preference:* Unique history strongly shapes individual responses (Rocky Mountain College of Art + Design, 2025). Limits predictability based on general principles.

○ *Physiological Variation:* Differences in color vision (color blindness, cone sensitivities (Haller, 2013) mean individuals perceive color differently, necessitating accessible design (sufficient contrast, not relying solely on color (Editverse, 2024).

These factors limit prescriptive application of broad principles, emphasizing user research, personalization, and accessibility.

**4.2.4. The Impact of Color Combinations, Contrast, and Harmony:** Design involves color interplay (Design Studio UI/UX, 2024).

- *Color Harmony:* Subjective pleasantness/balance from combinations (analogous, complementary (Sanvicente, 2024). Analogous schemes create cohesion; complementary schemes create contrast/energy (Design Studio UI/UX, 2024), potentially enhancing emotion (Zhandyrbay, 2024). Harmony lacks universal definition (Arora & Warsi, 2024). Affective responses seem structured (cool-warm dimension (Park University, 2024).

- *Contrast:* Difference in lightness/hue crucial for hierarchy, readability, accessibility (Iyer,

2023) . Essential for legibility (visual impairments (New Perspective Design, 2023). Draws attention (CTAs) (Iyer, 2023).

- *Saturation and Brightness:* Often stronger influence on emotion (arousal, pleasure) than hue (Rider, 2009). Higher saturation increases arousal; higher brightness increases pleasure (Rider, 2009). Affective impact depends on interaction of these dimensions (Lin, Mottaghi, & Shams, 2024).

Understanding individual hues is insufficient. Designers need holistic consideration of the palette (relationships, contrast, saturation, brightness). Testing specific palettes is crucial.

**4.3. Practical Applications and Implications for Design Professionals**

Findings imply several practical points:

- **General Principles:** Use color *intentionally* to communicate messages, evoke congruent emotions, guide attention, and enhance user experience (Sanvicente, 2024). Consider audience (age, culture), context, and brand personality (Design Studio UI/UX, 2024). Test choices (A/B testing, user feedback) due to response variability (Rocky Mountain College of Art + Design, 2025).
- **Graphic Design & Branding:** Color is key to brand identity (recognition, personality, loyalty) (Rider, 2009). Consistency across touchpoints is vital (Bytyçi, 2020). *Appropriateness* to brand personality/positioning is often critical (Design Studio UI/UX, 2024). Consider medium differences (print vs. digital (Hecks, 2025).
- **Web & User Interface (UI) Design:** Color impacts UX (engagement, mood, trust, usability, conversions (Sanvicente, 2024) .Use strategically for hierarchy, navigation, CTAs (Design Studio UI/UX, 2024). Blue fosters trust (World Design Council, 2024); red/orange for action (Koch, 2024). Ensure contrast for readability/accessibility (Iyer, 2023). Dark mode interfaces explored (Fialkowski & Schofield, 2024).
- **Interior Design:** Color affects atmosphere, mood, function (Rocky Mountain College of Art + Design, 2024). Warm colors energize; cool colors calm (bedrooms, healthcare (Arora & Warsi, 2024) . Green reduces stress, enhances well-being/creativity (work/learning spaces) . Strategies like 60-30-10 rule create balance. Consider space function, client preference, light, materials (Rocky Mountain College of Art + Design, 2024).

**Product Design:** Color influences perception of attributes, quality, value. Black/white/silver convey luxury/tech. Color differentiates products, influences purchase decisions (Cherry, 2024) .

**4.4. Ethical Considerations**

Color's subconscious influence (Bytyçi, 2020) raises ethical issues.

- **Manipulation vs. Persuasion:** Fine line between ethical persuasion (guiding attention, enhancing usability) and unethical manipulation (exploiting vulnerabilities, misleading impressions)

. Transparency is key (Rauten, 2024).

• **Cultural Sensitivity:** Using colors without understanding cultural connotations can cause offense or reinforce stereotypes. Responsibility to research and respect differences (Appear Online, 2025).

• **Accessibility:** Relying solely on color or using insufficient contrast excludes users with visual impairments . Ethical design requires adherence to guidelines (e.g., WCAG) (Iyer, 2023).

• **Informed Application:** Given nascent field/methodological weaknesses, making definitive claims or applying principles without context/limitations is irresponsible. Use findings prudently, acknowledge uncertainty, prioritize user well-being (Elliot, 2015).

**4.5. Limitations, Inconsistencies, and Research Gaps**

The field faces limitations:

• **Methodological Weaknesses:** Inadequate color specification/control, disregard for viewing conditions, underpowered samples, ecologically limited stimuli (Rider, 2009). Undermines reliability/generalizability.

• **Theoretical Gaps:** Need for *mid-level* theories with predictive precision for specific design domains (Elliot, 2015). Gap between theory and practice remains (Mirzaei, 2025).

**Limited Scope:** Heavy focus on few hues (red, blue), neglect of saturation/brightness interactions (Rider, 2009). Effects of combinations, textures, interactions with other elements underexplored (Rocky Mountain College of Art + Design, 2024).

• **Inconsistent Findings:** Contradictory results (e.g., red's effect on performance; color impact on affective judgments (Aguayo, n.d.) highlight need for research on moderators.

• **Lack of Longitudinal Studies:** Long-term effects of color exposure less understood.

**Generalizability:** Findings from lab settings/student populations need validation in diverse real-world scenarios (Elliot, 2015c).

**4.6. Future Research Directions**

Addressing limitations suggests future directions:

• **Methodological Rigor:** Prioritize precise color specification (standardized spaces, spectral data), control of viewing conditions, powered samples, validated measures. Promote pre-registration/data archiving (Elliot, 2015).

• **Ecologically Valid Stimuli and Contexts:** Use realistic design stimuli (prototypes, VR (Bonnardel, Piolat, & Bigot, 2010), product designs, renderings) and investigate effects within specific contexts (Park University, 2024).

• **Focus on Moderation and Interaction:** Systematically investigate moderators (culture,

age, personality, task, context (Elliot, 2015) . Examine interactions between hue, saturation, brightness, and other design elements (Rider, 2009).

- **Broader Range of Colors and Outcomes:** Expand investigation beyond primary hues to include neutrals, metallics, etc.. (Elliot, 2015) Explore broader outcomes (creativity, decision strategies, social perceptions, long-term well-being).
- **Cross-Cultural Research:** More rigorous studies using matched stimuli/methods to disentangle universal vs. learned responses (Arora & Warsi, 2024).

**Bridging Theory and Practice:** Develop/test mid-level theories for specific domains (UI/UX, therapeutic environments) (Elliot, 2015). Foster psychologist-designer collaboration.

- **Longitudinal Studies:** Investigate cumulative/long-term effects in real-world settings (Rockfon, 2022).
- **Neuroscience Approaches:** Continue using neuroimaging/psychophysiology to elucidate underlying mechanisms (Sanvicente, 2024).

## 5. CONCLUSION

Color is a psychologically significant design element influencing affect, cognition, and behavior. Research links specific colors (red, blue, green) to distinct responses (arousal, calmness, trust/nature associations). However, color psychology in design is complex and developing. Simple, universal meanings are largely unsupported; impact emerges from dynamic interplay between color properties, context, culture, personal history, and combinations.

The Color-in-Context theory provides a valuable lens, emphasizing situational analysis over prescriptive rules. Methodological rigor remains a challenge, requiring future research to prioritize precise control, ecological validity, powered samples, and investigation of moderators/interactions.

For designers, this review highlights using color thoughtfully and ethically—leveraging its potential while being sensitive to culture, individual differences, accessibility, and manipulation risks. Continued research, especially psychologist-designer collaboration, is needed to refine theory and translate findings into reliable, evidence-based guidelines. Patience and prudence regarding definitive conclusions are warranted until the field matures.

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# ATTENTION FEATURES IN PRESCHOOL AND YOUNGER SCHOOL AGE†

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***Abstract***

*In modern times, in the conditions of the rapid development of society, the multifaceted development of children, deep knowledge, development of cognitive processes, increase of receptivity, and the formation of a harmonious mental and emotional personality are even more critical. The article discusses the problem of cognitive processes, particularly attention, among preschool and primary school children. This attention feature plays an important role in the development of cognitive processes; for example, if a child has well-developed attention, he can remember the memorized material and analyze what he hears and thinks. Therefore, emphasizing the role of attention, in this article, we have discussed the approaches of several well-known psychologists regarding the development of the features of cognitive processes of children of preschool and primary school age, and then we have presented a study aimed at the stability and efficiency of attention of children of the specified age, which was carried out in the city of Glendale, United States of America in the educational center named "Russian School of Mathematics".120 children of preschool and primary school age participated in the research. We used the methods "Find and Delete", "Place Signs", and "Landolt's Circles", which are intended for children of preschool and primary school age. During the implementation of attention methods and in the process of calculating the results, we noticed that there are differences between the efficiency and stability of attention, although this data is lost in the formula for calculating the final results of the test. Since one of our tasks is also to study the dynamics of the development of cognitive processes, we found it appropriate to present the results separately. As we can see from the results, attention efficiency is more developed than stability at an early age. For example, if a child is instructed to draw balls, then the child almost does not make mistakes, does not paint the bucket in the place of the ball, but quickly gets tired and leaves the work half-finished. This refers to an early age. Later, we notice that the effectiveness gradually decreases, and the stability of the*

*results increases. We explain this phenomenon in the following way: after attending school, the child is forced to follow the instructions of the teacher for a long time, as a result of which, due to age characteristics, the arbitrariness of attention develops, which is the logical reason for the development of stability, but at the same time the child loses his ability to work, often makes mistakes, because arbitrary behaviorism forced, the child wants to get rid of it as quickly as possible. These forced situations include sitting in class, listening to the teacher for a long time, and doing homework, so he is distracted and cannot work effectively—another reason why new approaches are needed in organizing children's activities.*

***Keywords**: cognitive processes, memory, development, age specificity, attention, game, relationship system.*

## INTRODUCTION

Today, we live in a time when children have unprecedented access to vast amounts of information about the world. However, they also face significant pressure from adults, especially in the context of educational processes. This reality necessitates reforms in education to meet modern demands. Yet, current educational practices often fail to foster a healthy, well-rounded development for children. In fact, they may contribute to issues such as childhood neurosis and a lack of interest in learning. These challenges will be discussed in this paper, alongside our research, which highlights the negative effects children of young school age may experience. Before addressing these issues, we will explore theoretical approaches to understanding this developmental stage.

## LITERATURE REVIEW

Let us present the psychological characteristics of preschool and primary school children, as presented by various authors, and relate this to the child's cognitive processes, particularly the development of attention. Preschool age includes the period from 3 to 6 years. In the preschool period, it is customary to distinguish between younger preschool age (3–4 years old), middle (4–5 years old) and senior (5–6 years old). At the same time, 3–4 years old is the age when the child masters fine motor skills and individual movements of the arms and legs, middle preschool age is the period of mastering joint activities, and 5–6 years old is the preschool period itself, the stage of preparation for school. In each of these substages, the development of attention has a corresponding direction (Shipaniva, 2017).

D. B. Elkonin explains the existence of the problem at this stage of development by the fact that the child is a member of society, he cannot live outside of society, and his main need is to lead a common life with adults. But in modern historical conditions it is impossible to achieve this, and the child's life passes in indirect, rather than direct, contact with the world. The child strives for independence. From this contradiction, role-playing is born as an independent activity of children, where they imitate the life of adults (Elkonin, 2007).

The essence of the game, according to L. S. Vygotsky, is the realization of the child's generalized desires, the main content of which is the system of relationships with adults. The characteristic feature of the game is that it allows the child to perform an action in the absence of conditions for actually achieving its results, since its motivation is not in obtaining a result, but in the very process of performing the action (Shipaniva, 2017).

Analyzing these approaches, it can be assumed that the child focuses his attention on social roles, the content arising from them. That is, in order for him to play "family", he follows the behavior of mom, dad, the characteristics of their interaction. That is, the game, which is the leading activity of this age, contributes to the development of attention. Gradually, the child's games become more complicated and more and more children are involved in them. Children discover roles and rules (Kruchinin V.A., Komarova N. F., 2016). Games with rules and organized games are more complex and require more attention. Children need to be more attentive in order to monitor compliance with the rules of the game and try to follow them themselves.

L. S. Vygotsky and D. B. Elkonin considered play to be the most important form of a child's socialization, allowing him to connect with the world, including interpersonal and social relationships (Vigotsky, 2004).

D. B. Elkonin, analyzing the origins of play, shows that it appears in the history of mankind at a time when the involvement of children in labor activities was pushed back over time (Elkonin, 1997).

Thus, the development of attention in preschool age is largely determined by its leading activity - the game, development and application in the life of the child.

The main problem here is that in the current period, various role-playing and games with rules have been replaced by computer games or video clips, the content of which is often incomprehensible and contains aggressive elements. I think this is also the reason why, according to statistical data, the number of children with hyperactivity or attention deficit has increased in the world. Dependence on various gadgets, looking at them for a long time leads to the fact that the child quickly gets tired of the toy, the child does not study real life and other accessories, his attention is focused only on the gadget, as a result of which he misses real life.

With all this, the child moves to the next stage of life - junior school age. Let's also consider the features of this stage and their connection with the development of attention.

The younger school age covers the period from 6 to 10 years. At this age, a number of significant changes occur, both physiologically and socio-psychologically. It is at this stage that such personal qualities as independence and diligence (E. Erikson) are formed in the child, which is largely due to the change in leading activity, the transition from play to learning. And it is here that

a number of authors emphasize the complexity and simultaneous crisis of the 7-year-old age. Some authors also determine the course of the crisis of the 7-year-old age by the factors of the child's readiness or not for school (S. Khudoyan, 2004).

One of the features of the younger school age is the restructuring of the child's system of relationships with the surrounding reality, associated with entering school. The younger school age is characterized by the fact that the child acquires a new status - he becomes a student, and the leading activity changes from play to learning. Educational activity has a social significance and puts the child in a new position in relation to adults and peers, changes his self-esteem and rebuilds relationships in the family (Gonina, 2020).

Junior school age is one of the most important stages of personality development, during which there is a transition from carefree childhood to a period when there is a need to take on new roles, to be responsible in fulfilling various requirements. In this period, two main motives come into conflict: necessity and desire. On the one hand, guided by the need for necessity, the child discovers adult life, and on the other hand, motivated by the need for desire, the child demonstrates behavior that returns him to the world of childhood, where everything is safe, familiar, feasible, there are no certain obligations and requirements. On the one hand, the child is impulsive, restless, has unstable attention, and on the other hand, since a new level of needs is already forming in him, he begins to act, guided by certain goals, values, and feelings. Qualitative changes in development are clearly visible during the development of a junior schoolchild. The formation of volition / planning, a program for the development of actions, and the implementation of control appear at the center of the child's mental development (G. J. Craig, 2002).

Let us also present the characteristics of attention as a separate phenomenon. Attention also has various properties, including concentration, stability, distribution, transferability, and volume. For example, concentration refers to focusing mental activity on a particular object or task. This is essential for achieving success in intellectual or creative work. Distribution is the performance of two or more types of activity at the same time; it is the perception of their objects and the control of their own actions. There are complex types of activities that require a person to perform various actions and distribute attention appropriately. Distribution involves performing multiple tasks simultaneously, while transferability refers to the ability to shift focus from one activity to another. Such a need for rapid shifts of attention often arises during the realization of intentions that have been consciously put forward in different circumstances of life. Stability of attention is, first of all, the preservation of the given activity for a long period of time and then only the preservation of reflected objects, their images in consciousness. The stability of attention is ensured by the interest of the activity and its objects, by the voluntary efforts with the help of which a person strives not to

deviate from other issues and phenomena, to remain within the limits of the given activity. The volume of attention is the number of objects, activities, inner mental contents which a person can consciously perceive and keep in his circle of attention (A. Nalchadyan, 1997, pp. 113-116).

Memory and attention also acquire a voluntary quality, and their volume increases. The emotional development of a primary school-aged child depends more than before on experiences outside the home. Children are able to establish relatively stable interpersonal relationships, such as making friends (usually with peers of the same sex) (G. J. Craig, 2002). The main feature of primary school age children's attention is involuntary. The child cannot focus his attention on the necessary educational material for a certain period of time (attention deviates), any new, bright, interesting thing draws the students' attention, if it is interesting, attractive and unusual. The scope of focus for preschool age children is short. Preschoolers focus on attractive pictures, usually for 12-20 seconds. Stability of attention depends on the individual characteristics of preschoolers. The attention of children with certain neurological conditions is diverted faster than healthy children. Moreover, as noted by R. S. S.: Nemov, the difference in stability of attention can reach 1.5-2 times (Nemov, 2005).

The attention of a 6-7-year-old child can be stable for 25-30 minutes or even longer if he is busy with something that requires his active action: drawing, decorating, choosing collections, counting, etc. Without practical work, it is more difficult to maintain the stability of attention during mental action. However, when listening to the story or watching a movie, children can also focus on perceived content for a long time. It is especially important if the activity includes some solving problems. Looking at a picture can cause a deviation after 5-7 minutes of the start of the lesson, if the teacher is satisfied, 386 that the children simply named the depicted subjects.

But if the teacher sets more complex problems that require children to search, study, compare different parts of the picture, establish contact between elements, generalize, draw conclusions, then such work contributes to children's attention. it acquires stability and strength of concentration (G. J. Craig, 2002).

The excessive number of materials given has a negative impact on children's attention. If the teacher used 3-4 pictures in one lesson, or learned 2 new poems or demanded to remember and draw 2-3 scenes from the film they watched, the children's attention is dispersed. The resulting impressions merge into some general vague image. One of the most common reasons for distracting and ignoring children's attention is their fatigue. Keeping one position for a long time, the monotony of the actions taking place, the boring and unnecessary repetitions of what is already known, the forced inactivity, makes the child tired, and the weaker he is, the less he gets used to such work (G. J. Craig, 2002).

The attention and memory of a primary or a younger elementary age child is mechanical and developed at a certain level. The primary school age child is characterized by subject-pictorial memory, but there are also all prerequisites for the development of lexical memory. Children of this age usually have the ability to memorize the material mechanically. They often literally learn and reproduce educational material without delving into the content and try to reproduce it in their own words. With proper pedagogical work, they gradually acquire memorization skills. According to L. S. Vygotsky, if memory is dominant in the mental processes of preschool children, then thinking is dominant in primary school age. Due to this circumstance, the types of thinking of the student develop rapidly. And since the development of other mental processes is determined by the degree of mental development, imagination, will, feelings, etc. also develop as a result. There is a transition from outstanding-pictorial thinking characteristic of preschool age to lexical thinking. The child can analyze, judge logically, formulate thoughts (L. S. Vygotsky, 2004 ).

Junior school age is characterized by the fact that the child acquires a new status. he becomes a student, and the leading activity changes from game to study. Educational activity has a social significance and puts the child in a new position relative to adults and peers, changes his self-esteem and reconstructs relationships in the family (Gonina, 2020). Junior school age is one of the most important stages of personality formation, during which there is a transition from a carefree childhood to such a period when it is necessary to play new roles, to fulfill various requirements of being responsible. In this period, two main motivations are in conflict: necessity and desire. On the one hand, guided by the need for necessity, the child reveals adult life, and on the other hand, motivated by the need for desire, the child shows such behavior that returns him to the world of childhood, where everything is safe, familiar, feasible, there are no certain responsibilities and demands. On the one hand, the child is impulsive, restless, has unstable attention, and on the other hand, there is unstable attention. Since a new level of demands is already being formed for him, he begins to act, guided by certain goals, values, feelings. Qualitative changes in development are clearly visible during the development of the younger schoolchild. The development of volition, planning, action development program, implementation of control appears in the center of the child's mental development (L. S. Vygotsky, 2004).

## MATERIALS AND RESEARCH METHODS

In our study, we included 690 children of preschool and primary school age: 330 boys and 360 girls. The children were students of the Russian School of Mathematics, the River East School, and the Zangak Summer School (USA).We conducted research on the stability and effectiveness of attention in preschool and junior school children, using methods such as "Find and Delete," "Put

Signs," and "Landolt Rings." The purpose of these methods is to assess different aspects of attention: efficiency, stability, volume and transferability. Each of these properties of attention can be assessed both separately and as a whole. The child is given a sheet of paper on which there are randomly selected pictures: a mushroom, a house, a bucket, a ball, a flower, and a flag. The child must, after the instruction, color the picture that the researcher will say until the word "pause" is said. The work lasts 2.5 minutes. Each instruction is repeated 5 times for 30 seconds.

The results are calculated according to the number of highlighted pictures both in each 30 seconds and in the entire 2.5 minutes.

## RESEARCH RESULTS AND DISCUSSION

While implementing the attention techniques and calculating the results, we noticed that there are differences between the efficiency and stability of attention, although this data is lost in the formula for calculating the final test results. Since one of our tasks is also to study the dynamics of the development of cognitive processes, we found it appropriate to present the results separately.

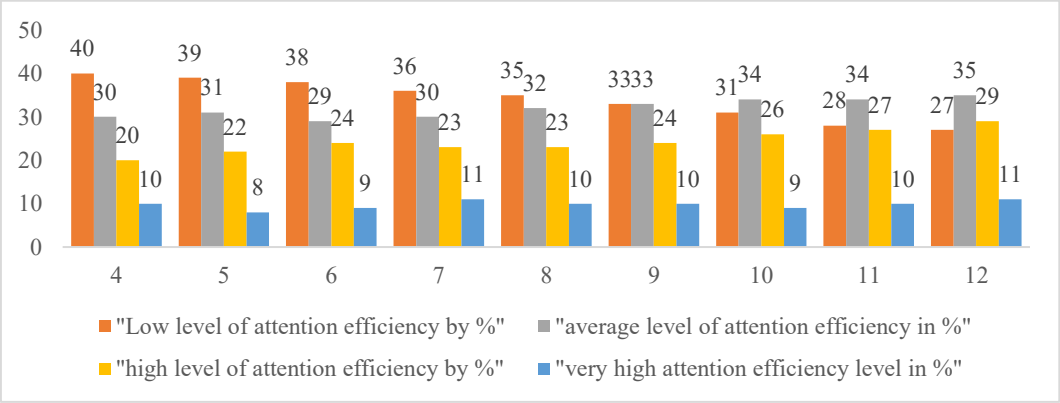


***FIGURE 1. Changes in Attention Efficiency at Different Ages***

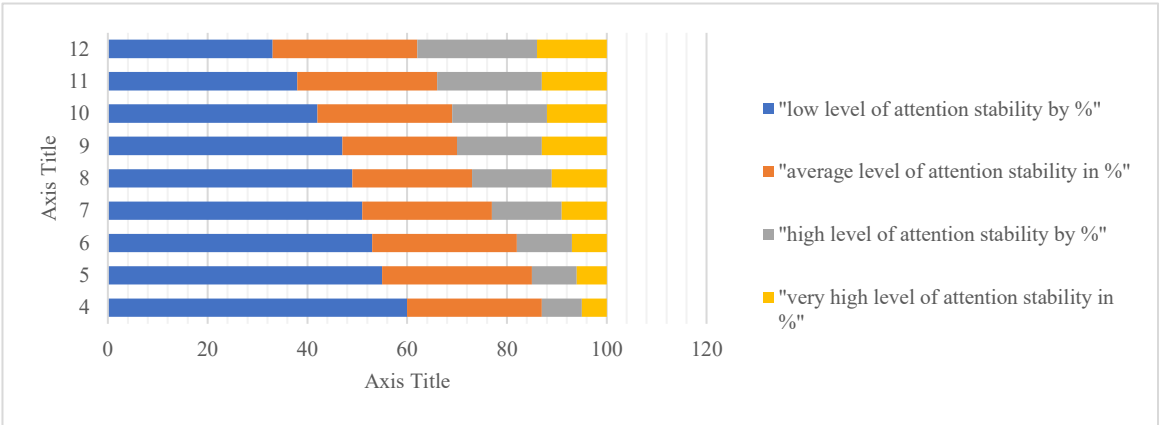


***FIGURE 2. Gradual Increase in Attention Stability During School Age***

As we can see from the results obtained, the efficiency of attention is more developed at an

early age than stability. For example, if a child is given an instruction to draw balls, the child almost does not make mistakes, does not paint the bucket in the place of the ball, but quickly gets tired and leaves the work, mostly performs the task incompletely. This applies to early age. Later, we notice that the efficiency gradually decreases - from 40% to 27%, instead of it, the results of stability increase. It should also be noted that there is also positive dynamics, but it is very small - from 20% to 29%.

However, it is very, very small compared to the decrease. We explain this phenomenon as follows: the child, in particular, after going to school, is forced to follow the instructions of the teacher, the educator for a long time, due to which, also based on age characteristics, the voluntariness of attention develops, which is the logical reason for the development of stability, but at the same time the child seems to lose efficiency, often makes mistakes, since voluntary behavior is imposed The child wants to quickly get rid of those stressful situations, such as sitting in class, listening to the teacher for a long time, doing homework, etc., which makes him/her distracted and unable to work effectively. Another reason why new approaches are needed in organizing children's classes.

## CONCLUSIONS

At an early age, children tend to show high attention efficiency but struggle with sustained focus, often abandoning tasks quickly due to fatigue. As children grow older, attention stability increases, especially after starting the elementary school, where they are required to follow instructions for extended periods. However, this increased stability can come at the cost of efficiency, as children sometimes make more mistakes when forced to focus for longer periods.

This phenomenon underscores the need for new approaches in classroom organization to better support children’s attention development and overall cognitive growth.

These results of attention allow us to come to the following conclusion: it is possible to contribute to the maintenance of attention efficiency through various psychologically developmental games and exercises, for example, in primary school age, and to develop attention stability in preschool age, which today, in a rapidly developing society, can be a very important prerequisite for the child's further development.

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# THE CONNECTION BETWEEN EMPATHY AND SOCIAL STEREOTYPES AMONG EDUCATION PROFESSIONALS‡

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***Abstract***

*The present study explored the emotional intelligence (EI) of 104 teachers from Armenian schools in Lebanon, providing a detailed analysis of key emotional competencies such as self-awareness, emotional regulation, motivation, empathy, and the ability to recognize emotions in others. A particular emphasis was placed on empathy, examining it as a powerful tool for reducing social stereotypes, especially within the context of teaching. The research found a significant negative correlation between empathy and social stereotypes, particularly concerning the teaching profession and age. This suggests that teachers with higher levels of empathy tend to exhibit fewer biases and stereotypes in their approach to education. Additionally, the study presented a set of recommendations aimed at teachers, school leaders, and policymakers. These suggestions are intended to guide the development of strategies for fostering more inclusive and empathetic school environments, ultimately contributing to the creation of communities that are more understanding and accepting within educational settings.*

***Keywords:*** *emotional intelligence, social skills, empathy, stereotypes, teacher development, self-awareness, equity, education.*

## INTRODUCTION

Life in the 21st century is evolving quickly and scientific research and pedagogical literature that used to grow on yearly and decade basis, is now currently at a quicker pace and our pedagogical tools curricula and teaching strategies need to target the needs of the learners in this century. The classrooms of today are preparing the leaders of the third millennium and education

needs to help learners survive and thrive today and transform the future to be more inclusive, tolerant and kind, so all communities grow forward.

Education and the effective tools and methods to prepare the citizens of tomorrow and instill in them skills for life have been an important question to be answered throughout the past decades and especially in the post pandemic world. All researches in the field aim to understand how one can help prepare the successful and happy citizens of tomorrow? What are the skills of the future leaders? How can schools prepare students for life? More than a decade ago, Goleman highlighted the importance of emotional intelligence in leadership, telling the Harvard Business Review "The most effective leaders are all alike in one crucial way: They all have a high degree of what has come to be known as emotional intelligence. (Goleman, 1995)

The process of preparing leaders offers a growing body of social science research is focusing on mental health and emotional wellbeing and is offering evidence that emotional intelligence plays a crucial role in life success and personal happiness. Phrases such as know your emotions, manage your emotions, recognize and read emotions in others are heard during job interviews and individuals are to know and master these skills yet they are not taught at school or during university years.

Life pre and post pandemic offered an opportunity to the world, to try and test the social skills theory in the social and education context as well. Understanding one's self, relating to others, facing challenges with a positive outlook and showing resilience were all set to a test when learners and educators were physically apart. Educational systems underwent this same test to see the learning, development, effective relationship and survival skills that teachers offered to learners, to face a challenging period.

Forbes magazine considered social skills a vital requirement for the leaders of the future and empathy to be the new superpower of changemakers. Successful leaders have emotional intelligence and these "soft" skills give them an edge over other peers and offer them a chance for a happier life. They are kinder, more tolerant and show empathy towards others, thus little predispositions and stereotypes.

Harvard review in its 2021 research states that social emotional learning (SEL) is an essential skill for individuals to succeed in the 21st century workforce. SEL according to CASEL (Collaborative for Academic, Social, and Emotional Learning) is an educational approach that helps people develop social skills and awareness of themselves and others. School-based SEL can help students improve their academic and interpersonal performance. It focuses on the positive behaviors of students instead of the negative behaviors to promote healthy youth development. It helps set school-wide policies that nurture individual differences and allow learners to reach their maximum

potential. SEL targets learners, parents, teachers, administrators and the community at the large, as all stakeholders, in the education system. Implementation of SEL curricula in schools, promises hope on the larger scale of preparing lifelong learners, competent learners, who know themselves well, are aware of their strengths and weaknesses and are empathetic citizens in their society. (CASEL, 2021)

SEL also helps create a safe haven for all learners, despite their capabilities and background, allowing collaboration and effective communication. These programs improve academic performance, raise self-esteem of learners and increase their chance of building and maintaining effective lifelong relationships. Such skills and competencies allow all learners, with different social levels, gender, capabilities… to live experiences inside school walls that prepare them for life outside, in the community, being transformed to solution oriented active citizens.

Social Emotional learning is introduced to schools through school wide policies, and teacher trainings, along with preparation of resources. It is done through specific sessions pre-planned for SEL activities along with instructional strategies that target the emotional wellbeing of learners and allows them to practice these skills and master them.

Emotional competencies can be divided into personal competencies such as self-awareness where accurate self-assessment is crucial and offering learners opportunities to identify their strengths weaknesses dreams and goals along with answering questions of who they are, can yield self-confidence. Self-management on the other hand focuses mainly on how individuals can practice self-control, become trustworthy, predictable, transparent citizens that are able to change and adapt where needed, as well as inspire trust in relationships. They are individuals who are aware of their triggers and motives and know how to regulate their thoughts, words and actions. These emotionally intelligent learners are motivated and know how to elevate their own level of energy along with that of those in their surrounding communities.

Social competencies on the other hand, focus on individuals serving others and their society, through empathetic approach, offering support and growth mindset. It is in social skills that emotional intelligence is evident through the actions of individuals in the community, such as building teamwork and collaboration spirit, communicating growth, developing each other and leading change, through becoming catalysts that embrace change and lead others towards new horizons (Chernis, Goleman, 2001).

Can personal and social competencies manifested through self-awareness and regulation on one hand and empathy, motivation and emotional coaching on the other hand be learned and acquired? If the answer to that question is yes by Mathew and Deary (2009), and Goleman (1995,1998) then the next question would be, where these skills need to be ideally taught? Mayer

and Salovey (1997) declare that a valid response to this question may be schools, the best sites to introduce social skills at early ages. They explain that ideally, human beings need to be introduced to emotional intelligence as early as they start school and learn skills like any other skill through educational institutions and curricula.

First, emotional intelligence was discussed as a thought and an added skill and luxury to one's life until the 21st century where it is considered a vital and essential component for life success and career performance. United Nations stated that "mental health is no more a luxury" it is rather a basic need according to the 2030 sustainable development goals.

According to research, emotional intelligence/Social Emotional learning creates positivity and tolerance at schools and minimizes social stereotype manifestations such as bullying. Thorough research on the website of the ministry of education in Lebanon until December 2022, showed that the Lebanese Ministry of Education, in all its curricula in languages, sciences, math and various arts, has not allocated a specific subject to be taught at schools. The education system followed in all public schools does not allocate sessions to target these skills nor does it give teachers guidelines, scope or sequence of objectives to follow and teach.

Research revealed that for these skills to be taught effectively at schools and yield highest results, teachers need to know about them, learn about them at the teacher preparatory courses, practice tools to introduce them in lesson planning and preparation and implement them in parallel to the academic work.

Schools as organizations, also evolved from the classic teacher centered traditional ones, to more contemporary modern digital phase. Taylor's theory explains that stereotypes are cognitive structures that represent general beliefs and expectations about a particular group of people. These beliefs are often based on limited information and used as mental "shortcuts" to help individuals process information quickly and make sense of the world around them. (Fiske, Taylor, 2020)

Empathy is 'the ability to experience affective and cognitive states of another person, whilst maintaining a distinct self, in order to understand the other'. This is consistent with the understanding that empathy includes at least two key dimensions: cognition and affect (Decety, 2011). If cognitive empathy can be conceptualized as 'I understand how you feel', affective empathy is conceptualized as 'I feel what you feel' (Hein and Singer, 2008).

Intersubjectivity refers to the shared understanding or mutual awareness that people develop when they engage with one another. It's the process through which individuals connect, align, and make sense of each other's thoughts, emotions, and perspectives. In a social context, it involves recognizing that others have their own subjective experiences and viewpoints, and being able to relate to or understand them. Intersubjectivity helps facilitate empathy, communication, and

cooperation by creating common ground between people.

In research like that of Sheng and Han (2012), intersubjectivity is often used to describe situations where group members, despite differences in race, gender, or background, begin to see each other as part of a shared experience or goal. This mutual understanding can reduce biases and enhance empathic responses to others.

Guthridge, M., Penovic, T., Kirkman, M. et al. 2023 acknowledge that empathy is not a cure for all stereotypes in the social content, yet it allows individuals to put themselves in others' shoes, feel with them and understand their feelings, thus leading to a less prejudice and discrimination.

Empathy is a promised hope to creating more sustainable communities based on equality, tolerance and acceptance, thus minimizing the manifestation of stereotypes in these societies.

The study aimed to present a background knowledge and literature review about the importance of emotional intelligence and social emotional learning in lives of teachers as they prepare the leaders of tomorrow. Next it shed light on the emotional intelligence of teachers, specifically their empathy levels and sought a correlation with social age-related social stereotypes in schools in Lebanon. It aimed to highlight the presence of a negative relationship between these attributes and propose recommendation on effective ways of introducing SEL programs into pedagogical institutions.

The study

1. Carried out an analysis of the literature devoted to the preparation of the leaders of the future.

2. Carried out an analysis of the literature devoted to the issue of emotional intelligence. Explain the syndrome of emotional intelligence, identify the components of emotional intelligence, present the characteristics.

3. Presented an overview about emotional intelligence of teachers in these schools.

4. Studied and investigated the correlation of age-related social stereotypes and emotional intelligence among educators.

5. Revealed the influence of the dominant expression of empathy among educators on the weak manifestation of social stereotypes.

6. Experimentally revealed the correlation between empathy and age-related social stereotypes of educators.

Education in post conflict and post war era in Lebanon needed to support civilians and their mental health as they move beyond the war time to an age where they feel safe, self-aware of their strengths and areas of development and move forward with motivation and a focus on building and maintaining healthy relationships with their surroundings and communities.

In the modern era, obtaining quality education, shaping future citizens, and preparing skilled educators is a key development challenge for nearly all societies. For the Armenian diaspora, particularly in Beirut, Lebanon, it has always been a top priority, influenced by the social stereotypes of the surrounding environment. While the issues of social stereotypes and emotional intelligence have been studied in fields like philosophy, psychology, sociology, cultural studies, and linguistics, their exploration within the field of psychology remains underdeveloped and requires a fresh perspective. Various authors (Durlak J., Oberle E., Taylor R., Weissberg R.) have addressed the issue of social stereotypes, presenting different approaches based on their theoretical and methodological stances regarding the origins and characteristics of stereotypes. However, it is important to note that there is no universal definition of the term "social stereotype" in the field of socio-psychological sciences. Despite numerous studies and theories on emotional intelligence (D. Goleman, P. Salovey, J. Meyer, R. Boyatzis, B. Chernis, J. Durlak), the relationship between social stereotypes and emotional intelligence remains underexplored.

Thus, the comprehensive study of social stereotypes and emotional intelligence, particularly in relation to their connection and the impact of social stereotypes on emotional intelligence, becomes a primary issue in uncovering their interrelationship. This underscores the relevance of the topic.

In this research, for the first time in the context of the Lebanese Armenian community, the interrelationship between emotional intelligence and social stereotypes within the pedagogical collective has been examined. The study reveals the connection and interdependence between social stereotypes and emotional intelligence. It also uncovers those higher expressions of empathy led to a reduction in the manifestation of social stereotypes.

The ministry of education in Lebanon was set to work to create a framework for social emotional learning in Lebanon creating curricula for learners to target these skills inside classrooms. However, this search supports the need of understanding teachers and doing a pre-training to understand their emotional intelligence and specifically empathy levels, through an investigation to the current situation and seeking to find a correlation with the stereotypes manifested.

Empathy is the promised solution to the social problem of stereotypes. It aims to minimize intergroup and intragroup differences and allow the focus to be on similarities and common grounds, looking towards shared goals as communities rather than focusing on differences. Empathetic individuals understanding the different perceptive, understand the feelings of others and allow them to be accepted for who they are, thus minimizing the discrimination.

## METHODS

The current research used various tools to investigate and shed light on the presence of the social skills and the manifestation of social stereotypes in Armenian schools in the diaspora, Lebanon.

## PARTICIPANTS

The participants in the current study were 104 educators (87 females and 17 males) from Armenian schools in Lebanon. The research began by contacting the principals of these schools and asking them to distribute the Google Form link to their teachers. Participants taught a variety of subjects and age groups, and they represented a wide range of teaching experience, both in terms of years of service and areas of expertise. The sample was obtained through a convenience sampling method, as participants were recruited based on their availability and willingness to participate in the study. The diversity of teaching experience and subject areas among the participants ensured a broad representation of the educational landscape within the Armenian schools in Lebanon.

## INSTRUMENTS

The N. Hall's tool was used for assessing "emotional intelligence" (EQ questionnaire) 09.02.2017 Irina Andreeva 9 N. Hall's method for assessing "emotional intelligence" (EQ questionnaire) // E.I. Ilyin. Emotions and feelings. - St. Petersburg: Peter, 2001. - S. 633-634. N. Hall's technique is proposed to identify the ability to understand the relationship of the individual, represented in emotions and manage the emotional sphere on the basis of decision-making. It consists of 30 statements and contains 5 scales: 1) emotional awareness, 2) management of emotions (rather it is emotional outgoing, emotional non-rigidity), 3) self-motivation (rather, it is just arbitrary control of one's emotions, excluding paragraph 14), 4) empathy, 5) recognition of emotions of other people (rather - the ability to influence the emotional state of others).

The Boyko test-questionnaire (Boyko's empathy test: Methodology for diagnosing the level of empathic abilities allowed participants to identify the type or empathy presence whether low, medium or high in various domains. The diagnostic methodology of "Empathic ability level" proposed by V. Boyko aims to assess an individual's empathic abilities. Empathy refers to the ability to understand and share the feelings of others, and it plays a crucial role in human social interactions and relationships. Boyko's diagnostic methodology involves a comprehensive assessment process that combines self-report measures, behavioral observations, and physiological measurements. The goal is to provide a holistic understanding of an individual's empathic abilities across different dimensions.

It broke down the empathy into more measurable terms such as rational empath, emotional, intuitive. It elaborated on the source such as availability of settings that promote empathy, penetrating power or identification in empathy.

The instruments used in this research were specifically created to investigate the presence of social stereotypes within the target population. Two primary questionnaires were developed for this purpose:

1. Questionnaire for Assessment of Expression of Age Stereotypes: This questionnaire aimed to assess the participants' perceptions of age-related stereotypes within the teaching profession. It asked participants to evaluate the presence or absence of certain characteristics associated with young, experienced, and older teachers.
2. Questionnaire for Assessment of Expression of Teaching Profession Stereotypes: This questionnaire focused on identifying stereotypes related to the teaching profession itself. Participants were asked to rate their level of agreement with statements that reflected various social stereotypes associated with teaching.

Before the final administration of the instruments, both questionnaires underwent a pilot test with a random sample of 500 educators. This pilot study was conducted to ensure the clarity, reliability, and validity of the questionnaires. Feedback from the pilot participants led to minor revisions in the wording and structure of certain items to improve their comprehensibility and effectiveness in measuring the intended constructs.

## PROCEDURES and RESULTS

This study adhered to ethical guidelines throughout its design and implementation. Prior to data collection, all participants were fully informed about the purpose of the research, the voluntary nature of their participation, and their right to withdraw at any time without consequence. Informed consent was obtained from each participant before they completed the questionnaires, ensuring that they understood the potential risks, benefits, and confidentiality measures associated with their involvement in the study. Participants' responses were anonymized and stored securely to protect their privacy and maintain confidentiality.

The first section of the Google form that was shared with all participants was the demographics of the participants. Eighty-seven females and 17 males representing different age groups.

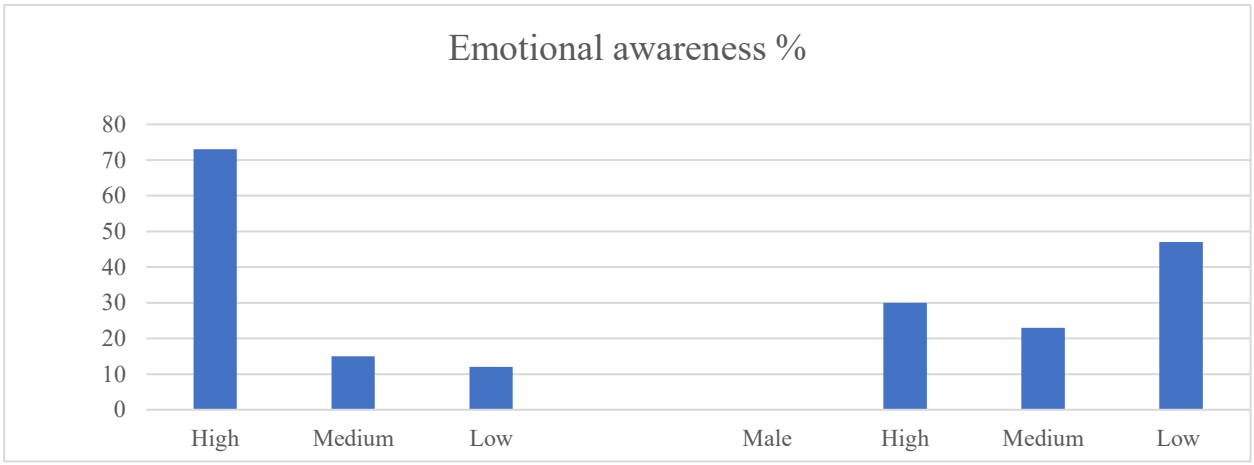


***FIGURE 1: Self awareness of teachers on Hall's questionaire***

The participants were also representative of the years of teaching experience ranging from less than years in teaching to more than 30 years of experience.

The Hall's tool was used to measure the emotional awareness of the participants. When comparing males to females, females had higher self-awareness compared to males who scored less. When checked the overall self-awareness, the results were as follows:

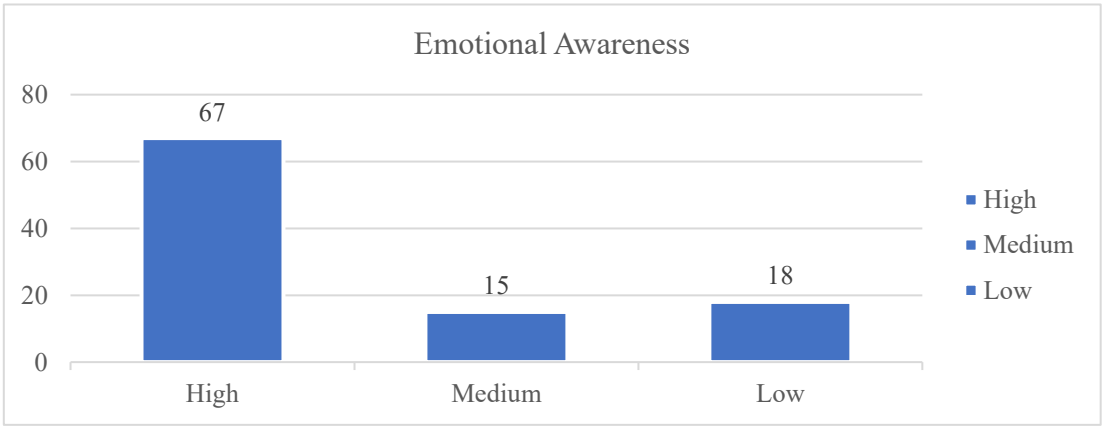


***FIGURE 2. Emotional awareness of teachers using Hall's questionnaire***

The teachers in these schools whether male or female, had high level (67%) and medium (15%) of self-awareness and self-knowledge.

The second aspect that was measured by Hall's tool was management of emotions. Similar results were found in terms of women having higher emotion control and regulation compared to men.

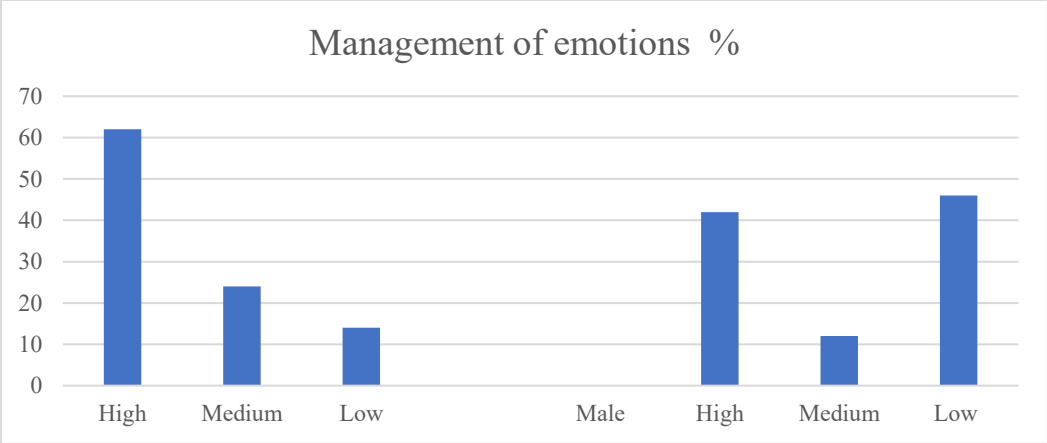


***FIGURE 3: Management of emotions of teachers using Hall's questionnaire***

Nevertheless, the general analysis of emotion management yielded overall, high level of emotion regulation ranging high 59% of participants, 22 medium emotion regulation skills and the remaining low emotion regulation skills of 19%.

The third aspect that was measured by Hall's tool was self-motivation. The results did not vary from the previous two components. Fifty six percent of the participants were highly motivated, while medium motivation and low motivation were shown 16 and 28 percent respectively.

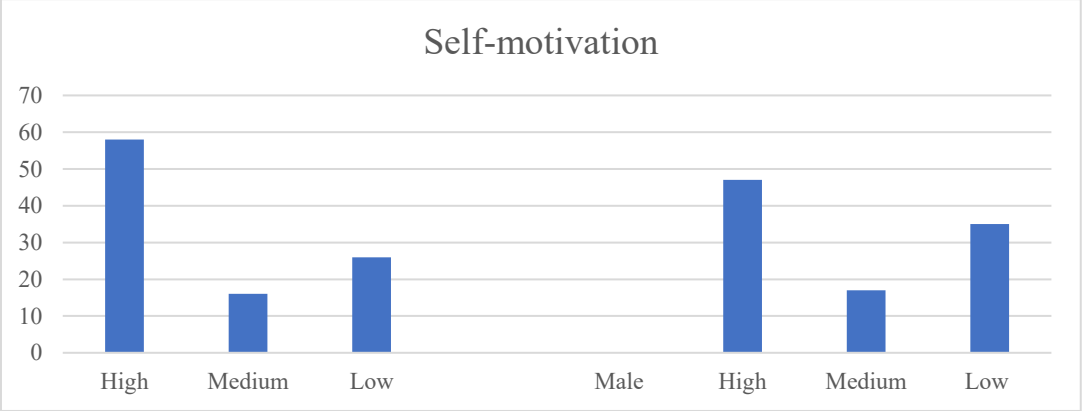


***FIGURE 4. Motivation of teachers using Hall's questionnaire***

The next section of the Hall's tool measured the social skills and the interpersonal capabilities.

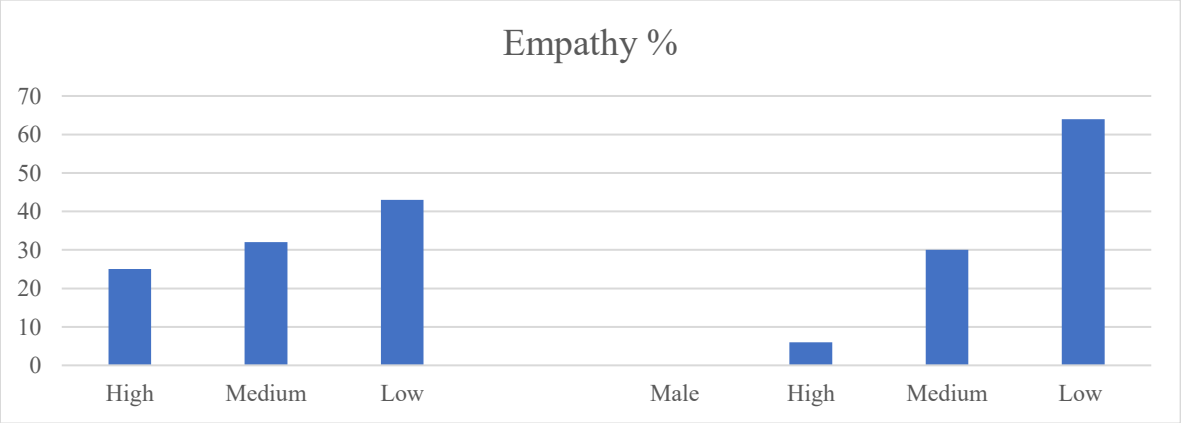


***FIGURE 5: Empathy of teachers using Hall's questionnaire***

Results there were different than the first section of intrapersonal skills and personal attributes. Forty three percent of females and 64% of males scored low empathy while scored overall was similar to the detailed description. An average of 53% of the general population scored low on empathy. Overall, 46% of the participants scored low on empathy, 32% medium and only 22% high.

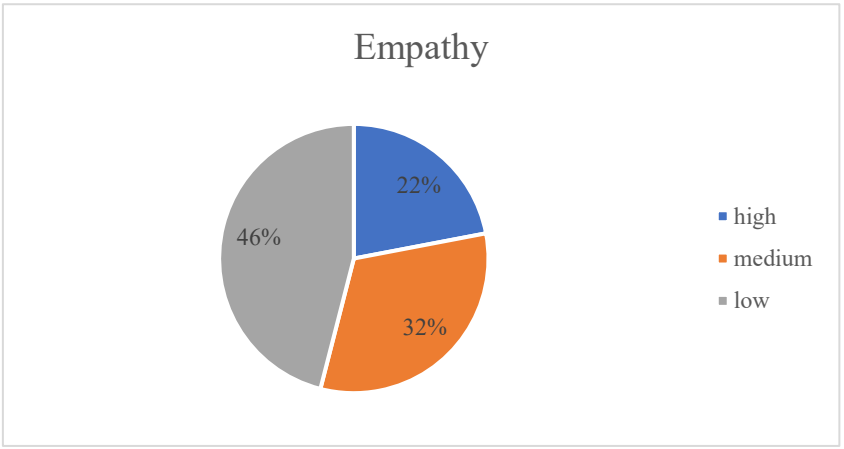


***FIGURE 6. Empathy of teachers using Hall's questionnaire***

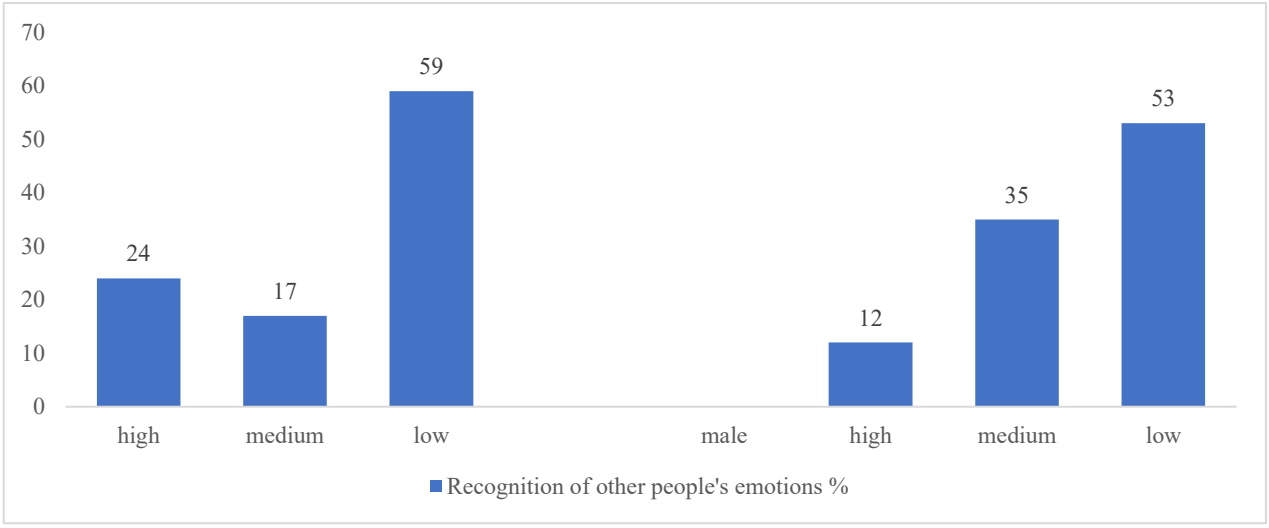


***FIGURE 7. Recognition of teachers of others emotions using Hall's questionnaire***

The final component was to evaluate the individual's capacity to recognize emotions in others. The results were as follows: Fifty nine percent of females and 53% of males scored low ability to recognize and read emotions in others. Fifty six percent of overall participants showed the low score in these skills and their need for improving the overall social skills.

Boyko's Empathy test was used next with social stereotypes (authored tools for this research).

## DATA ANALYSIS[§]

Age-Related Stereotype

| Reliability Statistics | | |
|---|---|---|
| Cronbach's Alpha | Cronbach's Alpha Based on Standardized Items | N of Items |
| .722 | .711 | 26 |

***Table 1: Reliability Statistics of the Author's Questionnaire for Assessing Stereotypes related to age of Educators.***

Profession-Related Stereotype

| Reliability Statistics | | |
|---|---|---|
| Cronbach's Alpha | Cronbach's Alpha Based on Standardized Items | N of Items |
| .796 | .797 | 20 |

***Table 2: Reliability Statistics of the Author's Questionnaire for Assessing Stereotypes in the***

### Professional Orientation of Educators

Pearson's correlation test revealed that there were significant, negative, and small to medium correlation between Boyko's empathy and social stereotypes related to teacher's age; r = -.20, p = .042 (one-tailed). As such, hypothesis that states that there is a negative association between Boyko's empathy and social stereotypes related to teacher's age, was supported.

Pearson's correlation test also revealed that there were significant, negative, and medium to large correlation between Boyko's empathy and social stereotypes related to teacher's profession; r = -.46, p < .001 (one-tailed). As such, hypothesis which states that there is a negative association between Boyko's empathy and social stereotypes related to teacher's profession, was supported.

[§] *Artificial intelligence (AI) tools were utilized as supplementary instruments during the data analysis phase to assist in the interpretation of results, identification of patterns, and to promote objectivity and enhance the efficiency of the analytical process. The authors retained full responsibility for all analytical interpretations*

| | | Social stereotype age related | Social stereotype teacher related |
|---|---|---|---|
| Empathy Boyko's | Pearson Correlation | -.195 | -.456 |
| | Sig. (1-tailed) | .042 | .000 |
| | N | 104 | 104 |

***Table 3: Pearson Correlation between Empathy Boyko's questionnaire and social stereotypes***

Hall's tool showed evidence that the participants had high level (67%) and medium (15%) of self-awareness and self-knowledge, high level of emotion regulation ranging high 59% of participants, 22 medium emotion regulation skills and the remaining low emotion regulation skills of 19%. Fifty six percent of the participants were highly motivated, while medium motivation and low motivation were shown 16 and 28 percent respectively. Forty three percent of females and 64% of males scored low empathy while scored overall was similar to the detailed description. An average of 53% of the general population scored low on empathy. Overall, 46% of the participants scored low on empathy, 32% medium and only 22% high. The final component was to evaluate the individual's capacity to recognize emotions in others. The results were as follows: Fifty nine percent of females and 53% of males scored low ability to recognize and read emotions in others. Fifty six percent of overall participants showed the low score in these skills and their need for improving the overall social skills.

Pearson's correlation test revealed that there were significant, negative, and small to medium correlation between Boyko's empathy and social stereotypes related to teacher's age; $r = -.20$, $p = .042$ (one-tailed). Pearson's correlation test also revealed that there were significant, negative, and medium to large correlation between Boyko's empathy and social stereotypes related to teacher's profession; $r = -.46$, $p < .001$ (one-tailed).

## DISCUSSION

Results offered evidence that the teachers who scored high on social skills and empathy manifested lower levels of stereotypes. Evidence shows that teachers are self-aware and have effective skills to manage and regulate their emotions. This is in terms of personal competencies of knowing the self and regulating themselves where they can lead and motivate themselves. Self-aware and emotion regulating individuals are able to lead themselves and stay motivated to build and maintain healthy relationships with others.

Their empathy level and their ability to understand and read emotions of others is a very significant and indispensable skill. This is a huge area of concerns because teaching and learning processes have empathy and understanding the other at their core. If schools aim to improve the academic performance and offer learners the boost and head start of social skills, then teachers are the agents to make that come true. If teachers are to lead by example, then they have to possess the ability to put themselves in others' shoes and read them emotions to show empathy and kindness.

Decety, J. (2011) has offered biological evidence on what empathy does to the brain and how it minimizes the manifestations of anger when brain "connections" are made through empathy. Moreover, cognitive empathy (understanding another's perspective) and affective empathy (sharing another's emotions) each have distinct relationships with stereotypes. Cognitive empathy can either reduce stereotypes by promoting nuanced understanding or reinforce them by intellectualizing differences without emotional connection. Affective empathy can decrease stereotypes by fostering emotional bonds and individual recognition, but it can also lead to in-group favoritism, reinforcing biases against out-group members. Overall, cognitive empathy may mitigate or perpetuate stereotypes depending on the context, while affective empathy has a more direct effect, either reducing or amplifying biases based on emotional connections (Decety, 2011).

Research has consistently indicated that women generally exhibit higher levels of empathy than men, with studies suggesting that females often outperform males in tasks requiring emotional recognition and perspective-taking. (Toussaint, L., & Webb, J. R. , 2005).

The stereotypes present in classroom can increase the gap between learners and eventually marginalize minorities and disrupt the teaching learning processes. It is vital that educators and school policy makers are aware of these stereotypes and do take actions to minimize their presence, through creating equity inside classrooms and ensuring that schools are safe places for all learners.

The 104 teachers come from Armenian schools in Lebanon, which is contextually specific. However, self-reflection questionnaires can sometimes offer bias findings and we need to be careful when we come to generalize these findings to larger population. Moreover, feedback from teachers, learners and parents can also add triangulated evaluation and assessment and thus a deeper understanding.

Teachers who are already inside classrooms, will need training to implement these skills in forms of trainings, workshops, courses. As for student-teachers, these courses need to be in their teaching diploma courses, where they learn about philosophy and psychology of education and then they are equipped with lesson planning and classroom management skills to implement effective teaching that is fit for the 21st century learner.

Targeting pre service and in service teachers is an effective way to train teachers on emotional

intelligence and empathy so that they can cater to the de-motivated learners, the emotionally unbalanced youth and help the whole society heal, recover and move forward.

After the covid pandemic, teacher burnout is the major pandemic and if we are not able to cater to the mental health of educators, and offer them tools for self-care, motivation and empathy, they will not be able to survive in the challenging profession.

Kindness and empathy are the requirements for the future leaders and if we do not train our children on empathy and social skills, they will suffer making their way. As educators it is our role, to propose tools for teachers and pioneer as change catalysts and agents for growth. This project needs various components to be present:

✓ Teacher Personal Mental Health: Teachers who are not feeling well emotionally, physically, psychologically and socially, are not able to relate to learners and be able to show empathy and compassion to target lessons to the relevance of learners and for their benefit.

✓ Teaching resources and strategies: Helping teachers identify tools to effectively introduce social Emotional learning inside classrooms. Teachers need besides training, resources and materials to be able to use them effectively inside classrooms, integrated with their academic work. Ideally, teachers can do both: have unique explicit social emotional learning sessions to introduce these skills and create emotional literacy and yet they can also integrate them hand in hand with academic teaching strategies to ensure best results. The classroom climate can create the larger umbrella where thoughts, words and actions are inspired by the social emotional learning standards.

✓ Overall school wide policies: Teachers are the main agents to start the change and create compassionate classrooms, yet they cannot do it alone. They need school leaders who believe in social emotional learning and support this work and together create a roadmap that caters to their wellbeing as individuals and also supports and nurtures the growth of empathetic learners. These road map would differ from school to another based on their mission and vision, yet the goal and shared vision remains the same: education for hope and resilience, an education that creates self-aware empathetic learners who build and maintain relationship with their communities creating sustainable change and equity.

It is through such professional development opportunities that the effective framework would be complimented and implemented so that emotional intelligence and empathy through education can create equity in the society where self-aware and confident individuals aim to be motivated to build and maintain healthy relationships, tolerating those who are different, accepting those with special needs and creating a more inclusive and sustainable societies with lifelong learners.

Introducing SEL inside schools is a journey that only courageous educators and leaders can

start because it can transform lives and create sustainable growth within communities. It starts with preparing teachers in terms of knowledge and awareness of competencies such as self-awareness, emotion regulation, motivation, empathy and social skills so that they can cater to their own emotional intelligence and wellbeing and then move to preparing them to teach these skills inside classrooms. Daniel Goleman urges educators to plan strategically lessons and experiences that target these skills because they count 80% of life success. (Goleman, 1995).

Introducing SEL inside classroom can be done next by offering teachers resources such as activity ideas, posters, games, flashcards so that they have the right tools to work with. However, this needs to be paired with creating the safe classroom atmosphere that nurtures the choice and the voice of learners. Teachers then get equipped with teaching strategies that target learner centeredness and allow learner to manage their emotions, resolve conflicts, solve problems and work collaboratively, building all these life skills through the integrated mode of SEL with academics.

Finally, parents need to be active stakeholders and partners to work hand in hand at home, and improve the effectiveness of such programs. The monitoring and evaluation processed throughout all the phases can allow hope to be born and ensure that SEL becomes part of the national teacher certifications, essential part of teaching diploma of preparing teachers and also a highly recommended topics for in service teacher programs.

Readiness on the level of policy makers is the key when discussing the concept of Emotional intelligence and social skills. It is vital to ensure that leaders of the education systems, organizations and schools understand the long-term benefits of developing SEL programs and experience their own competencies of Emotional Intelligence in order to communicate the purpose and the importance of such programs. The leaders of the schools and national educators on the ministry level need to monitor, evaluate and offer ongoing feedback on the development of the competencies in their personal development plans as well as the impact of these programs inside schools.

In order to proceed into such programs, educational leaders need to have a clear assessment of their own strengths and limitations, so that they can improve their status, before becoming themselves change catalysts in the organizations. These leaders would emphasize self-development and development of teachers on these vital skills, offering them evidence in science, psychology and education, so teachers buy in and join the action. When organizations plan such changes inside the spirit and the culture of schools, it is crucial that communication is clear, objective, honest and scientific. (Chernis, Goleman, 2001)

Goleman insists that these skills are teachable and learnable and research shows that emotional intelligence is first in someone's genetics and then it is established at the child stage

already and in grows and increases later stages, through healthy and meaningful experiences and interaction between parent-child, child to child, child to school and child to society. Qualter and Gardner, aligned with Goleman, insist that through social and emotional learning and curricula at schools, such programs can help children boost their emotional intelligence and thus improve their self-worth and self-regard at early stages of life (Qualter and Gardner 2007).

Can personal and social competencies manifested through self-awareness and regulation on one hand and empathy, motivation and emotional coaching on the other hand be learned and acquired? If the answer to that question is yes by Mathew and Deary (2009), and Goleman (1995,1998) then the next question would be, where these skills need to be ideally taught? Mayer and Salovey (1997) declare that a valid response to this question may be schools, the best sites to introduce social skills at early ages. They explain that ideally, human beings need to be introduced to emotional intelligence as early as they start school and learn skills like any other skill through educational institutions and curricula.

More specifically, Petrides, Frederickson and Furnham (2004) studied 650 pupils in British secondary education to evaluate the potential role of emotional intelligence in academic performance and in deviant behavior at school. Their findings suggested that trait Emotional Intelligence was significantly related to scholastic achievement especially in the languages. Trait emotional intelligence was negatively associated with unauthorized absences and expulsion from school. Emotional intelligence, according to Petrides et al, is an aspect to investigate especially for vulnerable learners. (Petrides, Frederickson and Furnham 2004)

Bracket & Katulak (2006) explain that introducing any new change to school curricula ideally starts with teacher's education and then administration support and then only results may be seen on the level of learners. Teachers are advised to be trained with knowledge basis and practical tools to be able to integrate any new concept and skill to education. They both argue that before teachers enter the classroom, they need to attend proper workshops and training in order to be able to create a "safe, caring, satisfying and productive school environment". According to them, proper preparatory courses should give teachers a theoretical background as well as practical tools to implement and bring innovation to their daily classrooms.

Finally, if one is to realistically start the advocacy through preservice and Inservice teacher trainings, then comes the national framework and curricula for universities and also for schools.

## CONCLUSION

This study compellingly illustrates the deep interconnection between empathy—a core component of emotional intelligence—and the reduction of social stereotypes among education

professionals. Conducted among 104 Armenian educators in Lebanon, the research clearly highlights that higher levels of empathy correlate with a lower expression of both age-related and profession-related stereotypes. The findings support the hypothesis that emotional intelligence, and specifically empathy, functions as a psychological buffer against biased cognitive structures that contribute to stereotyping.

The results revealed a concerning imbalance: while many teachers demonstrated high self-awareness and emotion regulation, the majority exhibited low levels of empathy and poor skills in recognizing others' emotions. Notably, 53% of participants scored low on empathy, and over half struggled to interpret the emotions of others—skills essential to fostering inclusive classrooms. This disparity raises critical questions about teacher preparedness and training in emotional and social competencies.

Through the use of Boyko's empathy test and original stereotype assessment tools, the study confirmed statistically significant negative correlations:

- **Empathy vs. Age-Related Stereotypes** ($r = -0.195$, $p = 0.042$)
- **Empathy vs. Profession-Related Stereotypes** ($r = -0.456$, $p < 0.001$)

These correlations affirm that educators with greater empathic capacity are less prone to stereotype their peers or students. This relationship is particularly crucial in post-conflict contexts like Lebanon, where emotional resilience and mutual understanding are foundational to healing and rebuilding trust within educational settings.

The discussion further explores the duality of cognitive and affective empathy. Cognitive empathy enables perspective-taking, whereas affective empathy fosters genuine emotional attunement. Both play pivotal yet distinct roles in disrupting stereotype formation. However, when empathy is lacking—especially affective empathy—teachers may unintentionally reinforce in-group biases, further marginalizing vulnerable students.

Crucially, this study calls for system-wide changes:

1. **Policy Integration**: Emotional intelligence and SEL (Social Emotional Learning) should be mandated within teacher preparation and certification programs.
2. **Training and Resources**: Teachers need structured, research-backed training, teaching strategies, and ready-to-use materials for embedding SEL in everyday pedagogy.
3. **Institutional Culture**: Whole-school policies must align with SEL goals, led by administrators who model emotional intelligence themselves.
4. **Community Partnership**: Parents and community stakeholders must be included in the SEL journey to reinforce empathy and inclusion both inside and outside school walls.

In sum, empathy emerges not only as a personal strength but as a transformative educational force. Its cultivation in teachers can mitigate biases, foster inclusive classrooms, and lay the groundwork for equitable education. As Goleman (1995) emphasized, emotional intelligence accounts for more than 80% of success in life—schools must rise to the challenge of nurturing it. Only then can we truly prepare students for a future grounded in tolerance, equity, and shared humanity.

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# THE CORRELATIOAN OF DEFENSE MECHANISMS AND SELF-ESTEEM AT DIFFERENT AGE GROUPS**

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***Abstract***

*The article presents the applicability of psychological defense mechanisms in different age groups of personality development, the levels of self-esteem development and correlations between individual psychological defense mechanisms and self-esteem. The data obtained show the frequency of use of psychological defense mechanisms, as well as the interaction of self-esteem of people of both age groups (14-15 and 22-25 years old) with psychological defense mechanisms.*

*The aim of our research was to study the features of the correlation between defense mechanisms and self-esteem at different stages of personality development.*

*From the results obtained, it becomes clear that the psychological defense of a teenager is realized primarily through elementary mechanisms. However, mature defense mechanisms are already used by the adolescent, although not as often as elementary defense mechanisms. And young people aged 22-25 more often use more mature defense mechanisms, such as intellectualization, compensation. The frequency of application of defense mechanisms of denial, regression, displacement is decreasing.*

*The study of correlations between self-esteem and defense mechanisms did not reveal correlations in adolescents, and among 22-25 year olds, correlations of medium strength were revealed with compensation, projection, displacement and intellectualization.*

***Keywords:*** *Self-esteem, psychological defense mechanisms, compensation, projection, displacement, intellectualization.*

## INTRODUCTION

Current socio-economic, socio-psychological changes create new challenges for the formation

and stability of a person's self-esteem, psychological defense mechanisms and adaptation process. Although the issue of self-esteem and defense mechanisms is not new, studies and theoretical approaches don't cover all aspects of the issues. Modern approaches mainly refer to the age dynamics, stability, changes of self-esteem in different situations. The issue of psychological defense mechanisms has also been studied sufficiently, however, the sensitive phases of ego development for their formation, the patterns of manifestation of psychological defense mechanisms, the interaction of psychological defense mechanisms and self-esteem at different age groups of personality development are still not sufficiently studied.

The problem of self-esteem has been studied by a number of scientists who interpreted in their own way the problems related to the structure of self-esteem, its nature and functions, development patterns. Self-esteem is one of the components of a person's self-awareness. Self-awareness is formed during the ontogenetic development of the person. For the formation of self-awareness, the evaluations of people around are very important, but as the personality matures, its own self-evaluations begin to gain primary importance for it. Understanding the correlation between psychological defense mechanisms and self-esteem helps in understanding how individuals manage psychological stress and maintain emotional balance.

## LITERATURE REVIEW

Bozhovich considers the evaluations given by parents and teachers are the main source of a child's self-awareness formation. According to him, if until adolescence, the child simply internalizes the assessments given to him, at the age of adolescence he already thinks about them. The reflection develops, which helps him to eliminate the shortcomings that can prevent communication especially with peers, by analyzing the evaluations of people around him and his own behavior. Already at the end of the adolescence, a person is able to direct his own behavior with his own evaluations (Bozhovich, 1995).

Bass distinguished 2 components in the structure of self-awareness, which express separate levels of development. The first component was the sensory self, which is specific to both humans and animals. At the level of the sensory self, Bass distinguished double stimulation: the stimulus and the response to it, the recognition of body boundaries and mirror reflection. The other component is specific to humans only and is more advanced. According to Bass, this component is the cognitive component, which in turn consists of several parts. The Cognitive Self includes the self-esteem of a person, which allows us to evaluate ourselves. Self-esteem is formed by valuing others and being evaluated by them (Bass, 1980).

Carl Rogers (1959) proposed that self-esteem results from congruence between one's self-

concept and ideal self. Low self-esteem is often linked to feelings of inadequacy, shame, and vulnerability, which can trigger defensive responses aimed at preserving the individual's sense of self-worth.

Vaillant's work on defense mechanisms demonstrated that individuals with higher self-esteem tended to use more mature defense mechanisms, while those with low self-esteem used more immature defenses. His research showed that mature defenses such as anticipation and humor were positively correlated with emotional resilience and higher self-esteem, while defenses such as denial and projection were associated with lower self-esteem and psychological distress (Vaillant, 1977).

Kohut's work on self psychology emphasizes the relationship between self-esteem and defense mechanisms in individuals with narcissistic tendencies. Kohut argued that individuals with fragile self-esteem often rely on defensive grandiosity (exaggerated self-importance) to protect themselves from feelings of worthlessness, leading to maladaptive behavior patterns. His work highlights how defensive strategies such as idealization or devaluation may stem from low self-esteem but can prevent individuals from achieving healthy self-acceptance (Kohut, 1977).

Cramer presented his research on defense mechanisms carried out over the past 40 years with children, adolescents, adults, and psychiatric patients. He believed that the protection of self-esteem and self-integration are additional functions of defense mechanisms. (Cramer, 2014).

Perry J. explores the role of defense mechanisms in coping with threats to self-esteem studying defenses in both process and outcome in psychotherapy (Perry , 1990).

In adolescence the formation of self-awareness and self-esteem is greatly influenced by contact with peers.

The period of youth age is a relatively stable period of formation and development of personality structures and traits. New formations acquired during previous age stages develop and stabilize. In youth a person's self-awareness is more developed than self-awareness of 14-15-year-olds, as a result of which the mechanisms of self-control and self-evaluation work better.

The main function of psychological defense mechanisms is to protect a person's psyche from anxiety and mental disorders. They are aimed to change the perception of reality, protecting against excessive anxiety, which is caused either by the perception of a disturbing external situation, or as a result of existing internal mental states. A number of psychologists have studied the protection of self-esteem by defense mechanisms.

Dotsenko presents psychological defense as the use of psychological measures by a person to eliminate or weaken the harm threatened by another person. He distinguishes 4 components for analyzing of psychological defense (Dotsenko, 1997).

The first component is the object of psychological defense, which specifies what is being

protected. Psychologists don't agree about the object of psychological defense. Z. Freud considered the main function of the psychological defense is the defense of the I-image or the Self (Z. Freud, 1896). T. Shibutani considered the object of psychological defense are the person's ideas about himself, and E. Hilgard believed that psychological defense protects a person's self-esteem and self-respect (Hilgard, 1962; Shibutani, 1961).

The second component is the threat or what the psychological defense protects against. Psychologists have different opinions about harmful factors also. Z. Freud and A. Freud, E. Heine (1971) found that psychological defense protects against distress that may arise from internal conflicts. According to Nalchajyan and Hilgard, psychological defense mechanisms are ways of protection against frustrations of needs (Freud, 1966; Nalchajyan, 2010).

The third component is the nature of the harm, or what the person is defending to avoid. This component is directly related to the object of protection and the nature of the threat. As a result of exposure to risk factors, a person's self-esteem and ideas about himself, sense of uniqueness, intentions and plans can be damaged.

The fourth component is the means of protection, the manifestations of which are very different (psychological defense mechanisms, coping mechanisms, etc.) (Dotsenko, 1997).

Several studies have explored the relationship between defense mechanisms and self-esteem.

Thus, self-esteem as a component of self-awareness has 3 important functions: regulatory, protective and developmental. In turn, psychological defense mechanisms protect a person's self-esteem and contribute to his development.

## RESEARCH METHODS AND METHODOLOGY

The aim of our research was to study the features of the correlation of defense mechanisms and self-esteem at different stages of personality development.

94 respondents participated in the research. The research was conducted in two groups of personality development: 14-15 years old and 22-25 years old. The study involved 47 pupils from school No. 129 and 47 part-time 2nd year students at the Faculty of Educational Psychology and Sociology of ASPU.

For the aim of the study, we used the Lifestyle Index (LSI) questionnaire by R. Plutchik, G. Kellerman and H. R. Conte (Vasserman, Eryshev, Klubova, 2005).

The questionnaire determines the frequency of the respondent's use of a particular psychological defense mechanism, and also determines the general applicability of psychological defense.

For the study of self-esteem, we used the «Self-esteem» test (Trofimova N.M., Polenjakina,

Trofimova N.B., 2005).

The degree of freedom of data and the assessment of reliability of connections was carried out by using the K. Pearson table (Plohinskij, 2005).

## RESULTS AND DISCUSSION

Accordingly, self-esteem is low in 32% of adolescent respondents, average in 49% and above average in 19%.

15% of respondents aged 22-25 years had low self-esteem, 68% had an average level, and 17% had an above average level of self-esteem.

In our study, we examined the use of defense mechanisms and the frequency of their use among 14-15 and 22-25 year old respondents.

Thus, Denial is hardly used or very little used by 53% of 14-15 year olds, moderately used by 32%, and used much by 15%. The data for 22-25 year olds is little different from the data for 14-15 year olds. The results show that 62% of 22-25 year olds don't use Denial or use it very little, 23% use it moderately and 15% use it a lot. The main reason for not using Denial is due to the level of development of the person, the age-specific features of the development of personality structures, which contribute to the work of more mature defense mechanisms. 22-25 year olds already have enough experience, problem solving knowledge and ways to analyze alarming information and find solutions.

A study on the use of Repression among respondents aged 14-15 years showed that 90% of respondents don't use Repression or use it very little, only 4% use it moderately, and only 6% use it quite often. 89% of respondents aged 22-25 use Repression not often. And the remaining 11% were found to have a high level of use of Repression. As Repression is very difficult to identify, we tend to assume that the obtained data are due to the specificity of the Repression, which is unconsciously keeping unpleasant information from person's conscious mind.

The results of the study showed that 60% of respondents aged 14-15 don't use Regression or rarely use it, and 40% use it moderately. The data obtained are due to the age characteristics of adolescents. Adolescents very often have behavioral patterns that are typical of earlier age stages, due to which they avoid solving a problem or choose a form of behavior that has previously contributed to solving a certain problem and has become an appropriate form of behavior. And among the 22-25-year-olds, 70% of the respondents don't apply Regression or use it very little, and 30% apply it. Regression is a basic defense mechanism, the frequency of which decreases with age, because in early adulthood a person tends to solve problems.

32% of 14-15-year-old respondents use Compensation defense mechanism, and 68% don't use

it or use it little. And among 22-25-year-olds, 70% of respondents don't apply for Compensation or do it very little, and 30% apply. According to A.E. Andreeva, Compensation is the newest developed, most compound mechanism of cognitive defense, and adolescents more often use Hypercompensation (Andreeva, 2005).

Projection is the most commonly used defense mechanism. 47% of 14-15 year olds use Projection moderately, and 53% use it a lot. Among 22-25 year olds, 64% use Projection moderately, and 36% use Projection too much. The use of projection depends on the level of psychological maturity of the person. A mature person uses relatively little Projection and takes responsibility for his actions, strengths and weaknesses.

62% of 14-15-year-old respondents don't use the Displacement defense mechanism or use it very little, and only 38% use it a lot. 81% of respondents aged 22-25 use little or don't use Displacement, and 19% use it a lot. As Displacement is a basic defense mechanism, it is assumed that as a person matures, its use should decrease in favor of more mature defense mechanisms.

47% of 14-15-year-old respondents don’t use Intellectualization defense mechanism or use it very little, 42% use it moderately, and 11% use this defense mechanism quite a lot. Intellectualization is formed already in early adolescence. The formation of this mechanism is related to the frustration that, for example, a teenager can feel when he fails to compete with his peers. Only 27% of respondents aged 22-25 don't use Intellectualization or use it very little, 41% use it moderately, and 32% use it quite a lot. Intellectualization is one of the mature defense mechanisms. Unlike teenagers, in early adulthood a person is more prone to Intellectualization.

47% of 14-15-year-old respondents either don’t use or use Reaction formation very little, 30% use it moderately, and 23% use it very much. And among the 22-25 year olds, 53% don´t use or use Reaction formation very little, 30% use moderately and only 17% use Reaction formation defense mechanism a lot. The results of our research indicate that the use of Reaction formation mechanism decreases along with the development of the personality. Teenagers use Reaction formation more often than 22-25 year olds. In general, the frequency of the use of elementary defense mechanisms decreases with the maturation of a person, which is due to the formation and development of mature and cognitive defense mechanisms.

Thus, a teenager’s psychological defense is realized primarily through elementary mechanisms. However, mature defense mechanisms are used already by the adolescent, although not as often as elementary defense mechanisms.

And young people aged 22-25 more often use more mature defense mechanisms, such as Intellectualization, Compensation.The frequency of application of Denial, Regression and Displacement is decreasing.

In the study of correlations between self-esteem and defense mechanisms, no correlations were recorded in adolescents, and in youth, correlations of medium strength were revealed with Compensation, Projection, Displacement and Intellectualization.

Thus, the positive correlation of $p \leq 0.05$ reliability was revealed between Compensation and self-esteem of 22-25-year-olds ($r=0.304$). Knowing one's shortcomings and trying to get rid of them, the person uses Compensation, as awareness of the shortcoming threatens a person's self-esteem.

The positive correlation between Projection and self-esteem ($p \leq 0.05$, when $r=0.322$) is also associated with the neutralization of information that threatens self-esteem. By attributing one's own shortcomings and negative qualities to others, the person protects self-esteem, because in case of their realization, the self-esteem of the person would be lower than desired.

$P \leq 0.05$ reliability correlation ($r=0.302$) between Displacement and self-esteem is most likely due to the fact that during Displacement, the person is unable to adequately respond to the person or situation that threatens his self-esteem and has to find an object that is weak or accessible to store negative emotions.

A positive correlation was also revealed between Intellectualization and self-esteem ($p \leq 0.05$, when $r=0.317$). During late adolescence, a person's self-esteem is no longer based on external assessments, but on the reflection of the individual, information about himself obtained through self-knowledge.

## CONCLUSIONS

Thus, elementary defense mechanisms contribute to the formation of personality structure and self-esteem. In turn, formed and developed self-esteem begins to protect the personality structure and contributes to its development, as a result of which the basic defense mechanisms are not enough to protect the personality structure of a new level of maturity, and it becomes necessary to use more mature defense mechanisms, in the activities of which the intellect begins to participate. Both mature and elementary psychological defense mechanisms are already used by young people to protect their self-esteem.

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# DESTRUCTIVE CONSEQUENCES OF SOCIAL NEUROTICISM AND PSYCHOLOGICAL MEANS OF PREVENTION††

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***Abstract***

*In psychology, the destructive development of social neuroticism, as an independent process, has been little studied. The question of what impact adverse or unregulated social relations have on the destructive development of social neuroticism has not been fully studied. In addition, special concepts that could serve as a basis for preventing the destructive impact of social neuroticism have not yet been introduced into the psychological discipline. This article presents the main forms and features of the destructive consequences of social neuroticism. Social neuroticism is characterized as a set of individual-personal qualities that are influenced by adverse processes and social relationships occurring in the social environment. Therefore, there is a need to develop methodological guidelines aimed at extinguishing the negative potential of social neuroticism for different social groups, in particular, immigrants with social alienation or marginalization, and people of different age groups in crisis stages of life.*

***Keywords:*** *destructive development, social neuroticism, social relationships, social alienation, subjective and objective factors.*

## INTRODUCTION

The complex system of social neuroticism and the multifactorial nature of its emergence and aggravation indicate that the destructive development of social neuroticism is conditioned by various factors, both subjective and objective. It is no secret that the destructive development of neurotic traits negatively affects the psyche of a person and his activities. That is why we are faced with the task of identifying the destructive consequences of social neuroticism and ways to prevent them. Taking into account the fact that the phenomenon of social neuroticism is interconnected by the nature of the relationship between a person and society, the development of the destructive consequences of social neuroticism inevitably affects the complex and multi-layered spheres of the individual-society relationship, that is, it is systemic in nature and can exhaust all the resources of the person's psyche, in extreme cases it can proceed with cases of self-harm and suicide.

## LITERATURE REVIEW

Understanding the phenomenon of social neuroticism underlies the social organization of society, the mechanisms of social integration and coping behavior. The concept of social integration was developed by E. Durkheim in the context of the dependence of the individual on external, social conditions of the environment. The integration of the individual with society was also noted by T. Parsons as a basic construct of the organization of society (Hanifah and Nugraha, 2022).

The phenomenon of social neuroticism can be studied using various theoretical and methodological models. This area of social psychology is at the stage of forming a theory that will become a link between social and psychological sciences related to the problem of neuroticism. However, it is already possible to find certain parallels between modern attempts to define social neuroticism and some theoretical approaches to studying stress and coping. Let us dwell in more detail on the transactional model of R. Lazarus and S. Folkman (1984), put forward in the last quarter of the 20th century. According to this model, coping is a series of assessments and reactions of a person to stress factors. This process involves both an assessment of the requirements of the situation, as well as psychological resources aimed at overcoming the stressful situation. The authors note that coping behavior is formed in one of two directions. In particular, the orientation of coping behavior to a problematic situation, as a rule, is effective if it is possible to change the stressful situation or control it. Otherwise, emotion-focused coping behavior becomes more effective.

Thus, the founders and followers of the theory of social integration assumed that the key component of social organization is the mechanism of interpenetration/interaction of the social system and the personal construct. In turn, representatives of the transactional model supplemented this process of interaction with the mechanism of coping behavior.

One way or another, the definition of social neuroticism is associated with the ability of the individual to social integration, on the one hand, and the preservation of personal space, on the other.

Violation of the social-personal balance in the process of social integration can be characterized by signs of social neuroticism. At present, in psychological literature, some parallels of the transactional model and definitions of social neuroticism are observed. In particular, the tendency to choose ineffective coping mechanisms leads to the manifestation of the phenomenon of social neuroticism. Such a choice can be an orientation to emotions in the case of a controlled problematic situation, or, conversely, an orientation to the problem in the case where the situation is insoluble.

Recent studies have allowed us to identify the stages through which social neuroticism passes

and turns into destructive consequences. They are as follows:

• Nervous difficulties related to relatively uncomplicated problems of the inner world, and inner life of a person. Nervous difficulties manifest themselves in the form of doubt, uncertainty, hopeless situations, and the absence of ways to solve problems.

• Intrapersonal and interpersonal conflicts, which are the most complex types of social neuroticism. The severity of their manifestation depends on the mental stability of the person and the peculiarity of the person's perception of a difficult or emergency.

• Crises, which are characterized by specific periods of a person's life. These periods lead to significant psychological changes. These are accompanied by changes in the semantic structure of the person's consciousness, and reorientation to new goals and values (Li et al., 2023; Quan et al., 2024; Widinger & Oltmann, 2017).

The typology of the development of the negative potential of social neuroticism according to the degree of its impact on the psyche of a person is necessary so that we can identify early what experiences the person is experiencing at a given moment and what is the reason for it. Other subjects interacting with the person in the social environment will likely be able to notice these negative shifts earlier and warn about the destructive crisis maturing in a person suffering from social neuroticism earlier. In our opinion, it is precisely such a development that is the reason why a person is unable to get out of such a situation alone, which is followed by destructive consequences after a certain time. For this reason, both the person suffering from the negative consequences of social neuroticism and the psychologist supporting the person should be able to distinguish the crisis stages and features of social neuroticism since their recognition will allow them to detect and prevent the destructive development of the phenomenon on time. In the case of the destructive development of social neuroticism, the person is constantly forced to encounter unpleasant and painful experiences. Neurotic symptoms with destructive development generally have the following consequences:

• Deepening of the personality split, the emergence of crises and neurotic reactions
• Inhibition of productive activity
• Inhibition of personal development
• Exhaustion of energy, formation of inferiority complexes, loss of meaning in life
• Violation of interpersonal relationships, aggressiveness, anxiety
• The emergence of negative psychological states
• In extreme cases, suicide (Wiebe et al., 2018).

In addition to the above, we consider it necessary to note that their destructive development can lead to

1. Blocking of personal development, degradation of the personality
2. Psychological and physiological disorganization of the personality
3. Decrease in activity and efficiency of activity
4. Doubt, oppression, and depressive state of mind
5. Exacerbation of aggression, or vice versa, activation of defense
6. Lack of confidence in one's strengths and feelings of inferiority
7. Meaningful devaluation
8. Manifestation of destruction in interpersonal relationships
9. Weakening of the personality's activity in the group
10. Presence of high sensitivity
11. Manifestation of deviant behavior
12. Manifestation of rude formal behavior.

Naturally, these consequences can be expressed more sharply by several objective and subjective factors caused by complex social relations or difficult life situations. A neurotic state of mind developing destructively is capable of undermining the daily life of a person and his environment. The list of negative consequences of social neuroticism is so large and so wide-ranging that our primary task is not so much finding ways to solve them as prevention.

Social neuroticism is often accompanied by deviant behavior. The formation of deviant behavior is accompanied by an internal struggle of a person, the intractability of which often leads to alcoholism, drug addiction, self-deception, and even suicide. In other words, different ages and social groups exhibiting deviant behavior are also at risk: adolescents, marginalized people in conditions of social isolation and alienation, immigrants, and others. After all, addictive behavior, as a variety of deviant behavior, is a serious problem for social groups that have problems adapting and integrating into the environment.

In addition to the above examples of addictive behavior, another destructive way to get rid of social neuroticism is suicide. What is the reason that a person chooses this particular method, why does he consider the struggle for his own life meaningless? The acute emotional state that arises during crises, when a person is faced with vital problems, can also lead to suicidal behavior. This is due to intrapersonal contradictions: interpersonal conflicts, problems in society, inconsistency of moral and value concepts with reality, etc. It should be noted that crises can occur not only in extreme conditions but also simply during the performance of work duties (Jang et al., 2018).

In our opinion, the following reasons are included in the list of suicides committed in the presence of social neuroticism:

1. Fear

2. Mentally unstable states: depression, stress, trauma

3. Unreciprocity love

4. Social and cultural alienation

5. Financial debt and problem situations

In our opinion, these factors can be divided into the following groups:

1. Objective factors:

-social injustice

-patronage

-physical and mental overstrain and overload

-strictly regulated daily life

-being cut off from family and relatives

-loss of relatives

-feeling of helplessness and hopelessness

2. Subjective factors

-character accentuation

-low adaptability

-lack of knowledge and skills

-worldview differences

-value system, distorted or negative ideas about moral norms

3. There is another factor that can be included in each of the above groups, which is subculture.

## METHODS AND METHODOLOGY

For the experimental study conducted within the framework of studying the destructive consequences of social neuroticism, observation, interview, assessment, and comparison methods were selected. The semantic differential was chosen as the assessment method. Respondents were presented with a list of objective and subjective factors of social neuroticism mentioned above. The sample of study participants consisted of the following groups at risk of social neuroticism:

- Group 1 - adolescents aged 13-18 (n=90),
- Group 2 - immigrants aged 30-45 (n=85),
- Group 3 - unemployed people aged 30-45 (n=105).

The total number of the sample was 280 people. The immigrants included those forcibly displaced as a result of war operations (Syrian and Artsakh Armenians). The assessment was carried out on a [-3] – [+3] assessment scale. Low scores received a negative, neutral score - 0, and high

scores are positive quantitative indicators. Low and high scores were then rated according to the recorded quantitative indicators.

Interview was conducted at the Psychological Observatory of the International Scientific-Educational Center of the National Academy of Sciences of the Republic of Armenia. The study was started subject to the verbal consent of respondents.

The key guiding questions for interview were the following: “How often do you discuss personal problems with family members / people close to you?”, “In what situations do you feel helpless and hopeless? What do you do to get out of this situation?”, “What situations of social injustice have you encountered?”, “How do you feel about the phenomenon of protection?”, “What ideas about moral standards exist in society?”, “What ideas do you have about moral standards?”, “What concepts in your worldview differ most from the common ideas in society?”, etc. The degree of consistency between interview questions was calculated using Cronbach's α, which was equal to 0.788.

Taking into account the fact that the empirical study of social neuroticism is a multi-stage research process, we set a methodological task to cover a sample consisting of different age and social groups. The methodological basis for forming the sample was the results of preliminary closed observation in order to identify problem situations in the process of social integration. Observation was carried out according to the main objective and subjective signs of social neuroticism. In the future, we plan to continue the empirical research in each of the presented groups separately for the purpose of a more in-depth analysis of the social and age characteristics of the manifestation of social neuroticism.

The answers obtained as a result of the interviews were subjected to correlation analysis. The purpose of the analysis was to identify interdependent relationships among the variables of the respondents' answers. In the future, the results of the correlation analysis can become a methodological basis for a more in-depth analysis of social neuroticism separately in each of the studied groups of respondents. To determine the correlation method, we conducted a Shapiro-Wilk test to normality assumption check. This test showed $p<0.05$ which means that variables are nonnormally distributed. Statistical data was analysed by Spearman correlation method using JASP 0.17.3.0 software.

## RESULTS

The research results recorded the following indicators (FIGURE 1).

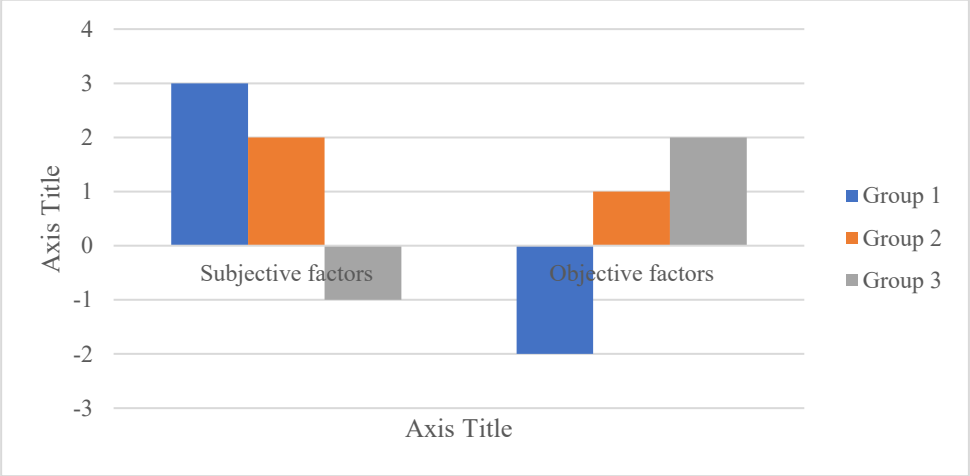


***FIGURE 1. Distribution of social neuroticism factors among 3 groups***

As we can see in FIGURE 1, the most extreme responses in the assessments of the objective and subjective factors of social neuroticism discussed above were recorded in Group 1 of adolescents. In this group, we see that adolescents predominantly associate their dissatisfaction, difficulties in communicating in the social environment, and the loss of meaning in life with the subjective factors of biosocial neuroticism, while the objective factors received the lowest ratings. The responses recorded in Group 2 of immigrants were identical: respondents almost equally highly assessed both subjective and objective factors affecting social neuroticism, with a slight predominance of the first group of factors. Group 3, which was represented by a sample of unemployed individuals, gave preference to objective factors, assessing factors that exist independently of them, i.e., external environmental factors, as determinants of the manifestations of social neuroticism and their destructive consequences.

These indicators were also confirmed by the interview method, when adolescents showed more extreme subjective assessments, while the unemployed, on the contrary, sought to see the causes of existing problems outside their inner world, in objectively existing environmental circumstances, thereby trying to "justify" their unemployment. And, finally, during the conversation with the sample group of immigrants, it also turned out that both subjective and objective factors were important in the assessment of social neuroticism; It was noteworthy that according to the period of immigration, within 1-12 months, the majority of immigrants, 74% of respondents, indicated external, environmental factors as the cause of social neuroticism. The picture changed during the conversation with immigrants within 2-4 years, as assessments of internal, subjective factors began to prevail in the assessments.

The main results of correlation analysis is presented below (Table 1).

Table 1. Correlation interrelations of objective and subjective factors of social neuroticism

| Spearman rho | Objective factors, Group 1 | Subjective factors, Group 1 | Objective factors, Group 2 | Subjective factors, Group 2 | Objective factors, Group 3 | Subjective factors, Group 3 |
|---|---|---|---|---|---|---|
| Objective factors, Group 1 | - | | | | | |
| Subjective factors, Group 1 | -.709*** | - | | | | |
| Objective factors, Group 2 | .258 | .641 | - | | | |
| Subjective factors, Group 2 | .316 | .981 | -.201* | - | | |
| Objective factors, Group 3 | .554 | -.636 | -.333 | .435 | - | |
| Subjective factors, Group 3 | .501 | -200 | -268 | .487 | -.421** | - |

Note: *p<.05, **p<.01, ***p<.001

## DISCUSSION

In our opinion, these factors form a common set that has a psychologically damaging effect on a person and creates fertile ground for the destructive development of social neuroticism. As a result, we have long-term stressful situations, unprovoked aggression in a person's behavior, interpersonal conflicts, self-mutilation, even suicidal attempts, and completed suicide. As a result, instead of finding solutions to the created situation, a person finds himself in a hopeless situation, as a result of which he chooses a destructive way out of a difficult situation, which is very often of a self-destructive nature. Speaking about the destructive consequences of social neuroticism, let us note that it is also extremely important to reveal psychological ways to prevent them since their prevention in a social environment is necessary not only to maintain the mental balance and resources of a person but also to improve the general moral and psychological state of a socially significant group for a person. Prevention of destructive consequences is carried out either independently if A person can manage and direct this process alone, or with the help of a psychologist or psychotherapist if painful experiences and emotions prevent the person from finding

a solution. Different authors offer different methods of solving the problem. As a rule, the essence of the methods known in psychological science depends on what, according to the given author, is the basis of the conflict. Some choose psychotherapeutic intervention, some - self-analysis, some - the choice of defense mechanisms, and another group may prefer simply a means of replacing possible exits or the development of alternatives. It is clear that such alternatives The choice is highly individual, but in any case, it is necessary to guide the person and present an overall picture of overcoming the problem (Khan et al., 2021; Weiss & Deary, 2019; Khodayarifard & Fatemi, 2013; Turiano et al., 2020).

Maffini and Pham (2016) state that after overcoming any conflict, a person should encourage himself, note the fact that he has overcome an obstacle, and is ready for new heights. In our opinion, this methodological tool is a unique motivator for a person in the future and helps him to make the changes required of him more boldly.

As can be seen from Table 1, within each group there are statistically significant inverse relationships between subjective and objective factors. It is noteworthy that the most strongly expressed negative correlations were found in Group 1, which indicates a more disturbing picture of the manifestations of social neuroticism among adolescents. These results will serve as an important basis for further studies.

## CONCLUSIONS

Generalizing the information received from different sources, we can conclude that the destructive development of social neuroticism can be prevented only through long-term psychological work and the help of a psychotherapist. In many cases, the inability to get rid of the negative consequences of social neuroticism causes pathological developments and psychosomatic disorders in a person. It should also be noted that destructive means of solving the consequences of social neuroticism are chosen mainly by mentally immature people. This implies that it is necessary to increase the level of knowledge of the general public about social neuroticism and ways to solve it, which is another step towards preventing the destructive development of this phenomenon.

As solutions, the following methods of self-regulation and prevention of the negative potential of social neuroticism are proposed:

- acceptance of a difficult situation as a vital necessity,
- normalization of one's vital values, flexibility and adaptability,
- weakening of excessive concentration on details,
- management of one's desires,
- adequate self-assessment and self-control,

- development of volitional qualities,
- the ability not to artificially create problems, not to give in to panic.

Of course, the participation of a psychologist in the process of solving the negative consequences of social neuroticism is a necessity, since the concepts of preventing the destructive consequences of social neuroticism have not yet been introduced into society. Therefore, we consider it important to develop a concept for overcoming and preventing the destructive impact of social neuroticism and other negative phenomena accompanying it, which will serve as a methodological guide for specialists in the field.

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# SECTION 2.

# PEDAGOGY

# (EDUCATIONAL SCIENCES)

MAIN ISSUES OF PEDAGOGY AND PSYCHOLOGY (MIOPAP)
https://miopap.aspu.am/

# SCHOOL PRINCIPAL'S MANAGEMENT STYLE AND TEACHERS' WORK MOTIVATION‡‡

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***Abstract***

*The effectiveness of the school system largely depends on the principal's management style and its impact on teachers' work motivation. With the rapid changes in the educational sphere, school leaders must adapt their leadership approaches to maintain teachers' engagement, job satisfaction, and motivation. This study investigates the relationship between school principals' management styles and teachers' motivation, highlighting how various styles—authoritarian, democratic, and liberal—influence the level of motivation among teachers. The research was conducted across four schools in Armenia, utilizing quantitative and qualitative methods, including surveys and interviews. The findings indicate that teachers under democratic leadership exhibit higher creative motivation, while those under authoritarian leadership show lower intrinsic motivation but stronger compliance. The study contributes to the understanding of educational leadership psychology and provides practical recommendations for school management. This study empirically examines the correlation between school principals' leadership styles and teachers' work motivation, providing statistical validation of this relationship. Unlike predominantly theoretical studies, it integrates psychological assessment tools to ensure systematic analysis. The findings highlight leadership-motivation patterns and propose a hybrid leadership model for optimizing teacher engagement and job satisfaction.*

***Keywords:*** *management style, school principal, work motivation, teacher motivation, leadership in education.*

## INTRODUCTION

Leadership style plays a crucial role in shaping work motivation, influencing employees' attitudes, engagement, and overall productivity. The correlation between leadership and motivation has been the subject of extensive research, with scholars exploring various psychological and managerial approaches to understanding their interaction.

While leadership theories and their impact on employee motivation have been widely explored in corporate settings, their application to the educational sector remains under-researched. Existing studies primarily focus on theoretical discussions, lacking empirical validation. This research addresses this gap by providing statistical evidence on the relationship between school leadership styles and teachers' motivation, integrating psychological assessment tools to ensure objective analysis. The study's findings challenge conventional assumptions about leadership efficiency in schools and propose a more flexible, hybrid leadership model that balances structure and participation.

Kurt Lewin (1939) identified three fundamental leadership styles: authoritarian, democratic, and laissez-faire. Each of these styles has a distinct effect on employee motivation and workplace efficiency. Authoritarian leadership, characterized by strict control and centralized decision-making, has been associated with lower intrinsic motivation due to the suppression of autonomy and creativity (Lewin, 1939). However, Herzberg's two-factor theory suggests that such leadership primarily affects hygiene factors—salary, job security, and working conditions—rather than key motivators such as achievement and recognition (Herzberg, 1959).

Democratic leadership, on the other hand, fosters participation and employee involvement in decision-making. Douglas McGregor (1957), in his Theory Y, highlights that employees naturally seek responsibility and personal growth when provided with autonomy, leading to increased motivation and higher engagement (McGregor, 1957). Maslow's hierarchy of needs also supports this view, emphasizing that democratic leadership satisfies employees' higher-order needs, such as self-actualization and belonging (Maslow, 1954).

Laissez-faire leadership, which minimizes managerial intervention, is often effective in teams with highly skilled and self-motivated individuals. However, in settings where employees require guidance, it may lead to a lack of direction and lower engagement (Stogdill, 1974).

The relationship between leadership and motivation has also been explored through various motivational theories. McClelland's Theory of Needs suggests that employees are driven by achievement, affiliation, and power, with different leadership styles fulfilling these needs in different ways (McClelland, 1961). Democratic leadership aligns with achievement and affiliation, while authoritarian leadership tends to cater to the need for power.

In different organizational contexts, leadership styles produce varying motivational effects. Research suggests that democratic leadership is most effective in stable environments, fostering innovation and long-term commitment, whereas authoritarian leadership becomes necessary in crisis situations, ensuring quick decision-making and stability (Fiedler, 1967).

In recent years, leadership studies have expanded beyond traditional models to include transformational and adaptive leadership approaches. Transformational leadership (Bass, 1985) emphasizes inspiring and motivating employees through shared vision and personal development. In the educational context, transformational leaders create innovative environments, support teacher professional growth, and enhance job satisfaction. Recent studies confirm that such leadership styles positively influence both teacher motivation and student outcomes.

Similarly, adaptive leadership (Heifetz, 2009) highlights the importance of flexibility in addressing complex and changing challenges. In schools, adaptive leaders help teachers navigate reforms, implement new pedagogical strategies, and adjust to student needs, leading to increased motivation and professional fulfillment.

These findings are consistent with recent international research highlighting the positive impact of participatory leadership on teacher well-being and professional engagement (e.g., Leithwood & Sun, 2018; Wang et al., 2021). Moreover, the observed dissatisfaction with financial rewards under democratic leadership reflects global trends, where intrinsic motivation increases with autonomy, but extrinsic dissatisfaction persists in underfunded systems (OECD, 2020). This alignment with global patterns strengthens the relevance of the current study and its implications for broader educational reforms.

Moreover, hybrid leadership models have gained recognition for their ability to combine elements of various leadership styles to optimize school management. Research indicates that school principals who integrate authoritarian structure with democratic participation achieve higher engagement and efficiency among teachers (Smith & Bell, 2021). This study builds upon these frameworks, contributing insights into how a hybrid leadership model can foster teacher motivation in Armenian schools.

The novelty of this study lies in its empirical exploration of how different leadership styles are linked to specific types of teacher motivation, including creative, collective, and power-related motives. While previous research has often generalized the impact of leadership on motivation, this study distinguishes between motivational drivers and identifies how each is influenced by authoritarian and democratic management styles in Armenian schools. The focus on nuanced motivational patterns adds depth to the current literature and fills a significant gap in localized empirical studies.

The effectiveness of leadership styles in work motivation highlights the necessity of adaptability in managerial approaches. Future research should focus on hybrid leadership models that integrate elements of different styles to enhance motivation, productivity, and overall workplace well-being.

## METHODOLOGY

As a result of the analysis of scientific literature, it becomes evident that the relationship between school principals' leadership styles and teachers' work motivation is a significant factor in educational management. The article presents a quantitative study conducted in four schools, involving 60 teachers and their principals.

In the Republic of Armenia, psychological and educational research that does not involve medical procedures or risk to participants' health does not require formal approval from an ethics committee. Nevertheless, the study was conducted in full compliance with the ethical standards outlined in the Law of the Republic of Armenia on Scientific and Scientific-Technical Activity (Article 24), ensuring voluntary participation, anonymity, and the use of data solely for academic purposes.

For the study, we selected several diagnostic methods, including S. Solovyov's "Assessment of Personal Motivation", V.B. Zakharova and A.L. Zhuravlev's "Determination of Leadership Style", and N.P. Fetiskin's "Leadership Style Self-Assessment" methodology.

While international tools such as the Multifactor Leadership Questionnaire (MLQ) (Bass & Avolio, 1995) and Self-Determination Theory (SDT) (Deci & Ryan, 2000) are widely used in leadership research, they have certain limitations within the Armenian educational context:

MLQ and SDT were developed in Western settings and require adaptation to the hierarchical structure and leadership perceptions in Armenian schools. MLQ is predominantly used in business and corporate environments, whereas the selected methodologies are tailored to educational institutions. The chosen diagnostic tools are already validated within educational research in post-Soviet countries, ensuring a more accurate reflection of leadership and motivation factors in Armenian schools.

Thus, these methodologies provide a contextually relevant and scientifically valid approach to understanding school leadership styles and teacher motivation in the Armenian educational setting.

The research was conducted in A. Navasardyan High School No. 196, Raffi High School No. 36, D. Hovsepyan High School No. 191, and A. Blok High School No. 122.

To ensure validity, the study was carried out in three stages:

1. Preparation stage – defining the relevance of the research, formulating objectives, conducting a theoretical analysis, and selecting appropriate methods.
2. Main stage – implementing the study, where teachers and principals were surveyed, and observational methods were applied.

3. Final stage – analyzing the collected data and formulating conclusions.

Participants were informed about the research procedure, ensured anonymity, and were notified that the collected data would be used solely for academic purposes.

Additionally, the interview method was used to explore teachers' perceptions of their principal's leadership style and how it influences their work motivation. This helped determine whether different leadership approaches create varying levels of job satisfaction, professional creativity, and motivation.

## DATA ANALYSES AND RESULTS

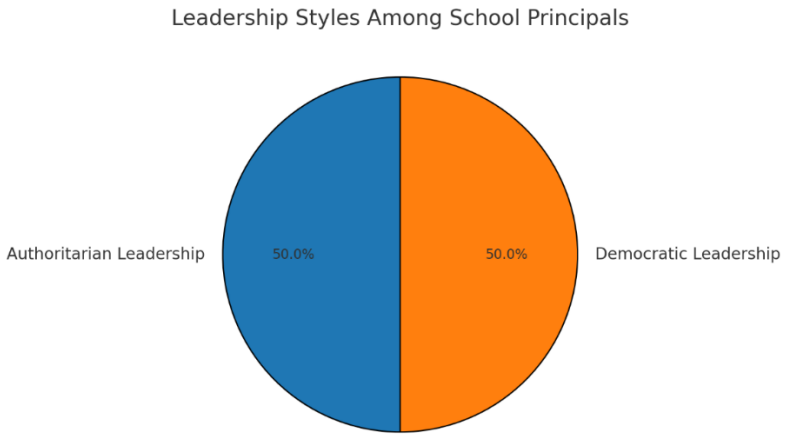
The study utilized V.B. Zakharova and A.L. Zhuravlev's "Leadership Style Determination" methodology, N.P. Fetiskin's "Leadership Style Self-Assessment" methodology, and S. Solovyov's "Personal Work Motivation Assessment" methodology to examine the relationship between school principals' leadership styles and teachers' work motivation. A total of 60 teachers and 4 school principals participated in the study, with two demonstrating an authoritarian leadership style and two employing a democratic leadership style.

Analysis of leadership styles revealed that:

• 50% of the school principals exhibited an authoritarian leadership style, characterized by centralized decision-making, strict hierarchical structures, and limited teacher autonomy.

• 50% of the school principals displayed a democratic leadership style, which emphasized collaboration, participatory decision-making, and open communication.

Figure 1




These classifications were validated through teacher evaluations, confirming that educators largely perceived their principals' leadership styles in alignment with the principals' self-assessments.

Impact of Leadership Style on Teacher Motivation

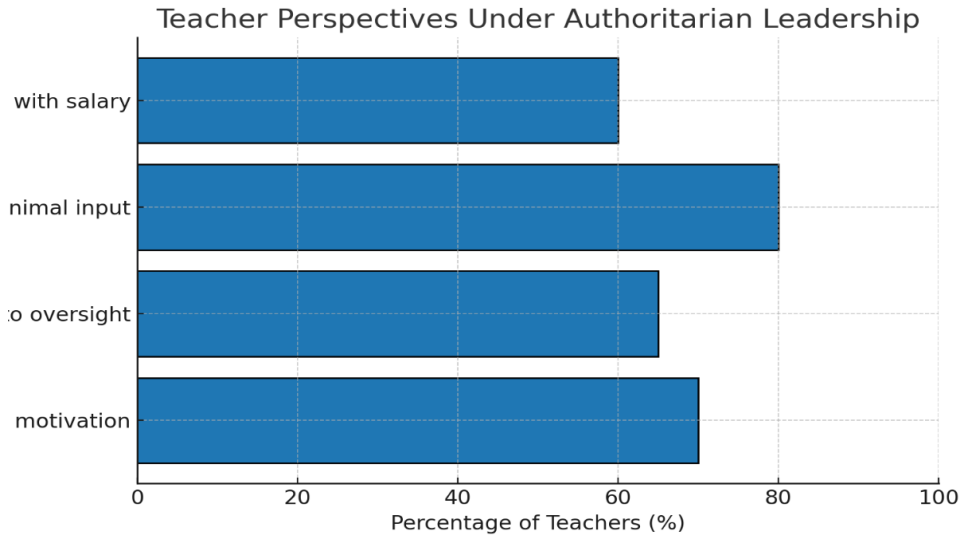
To assess how leadership styles influenced teachers' motivation, the study measured six key motivational factors using S. Solovyov's methodology:

1. Work (intrinsic satisfaction derived from professional responsibilities)
2. Profession (dedication to the teaching field)
3. Salary (financial incentives and compensation)
4. Creativity (opportunities for professional innovation)
5. Team (collegial relationships and workplace environment)
6. Power (aspiration for authority and leadership roles)

The results demonstrated distinct motivational patterns among teachers depending on their principal's leadership style:

- Teachers under authoritarian leadership:
- 70% reported that job security and stability were their primary motivational factors rather than professional fulfillment.
- 65% felt limited in their ability to engage in creative teaching practices, citing strict oversight and hierarchical restrictions.
- 80% indicated that decision-making was centralized, with minimal opportunities for teacher input.
- 60% expressed moderate dissatisfaction with their salaries, yet financial security remained a primary motivating factor.

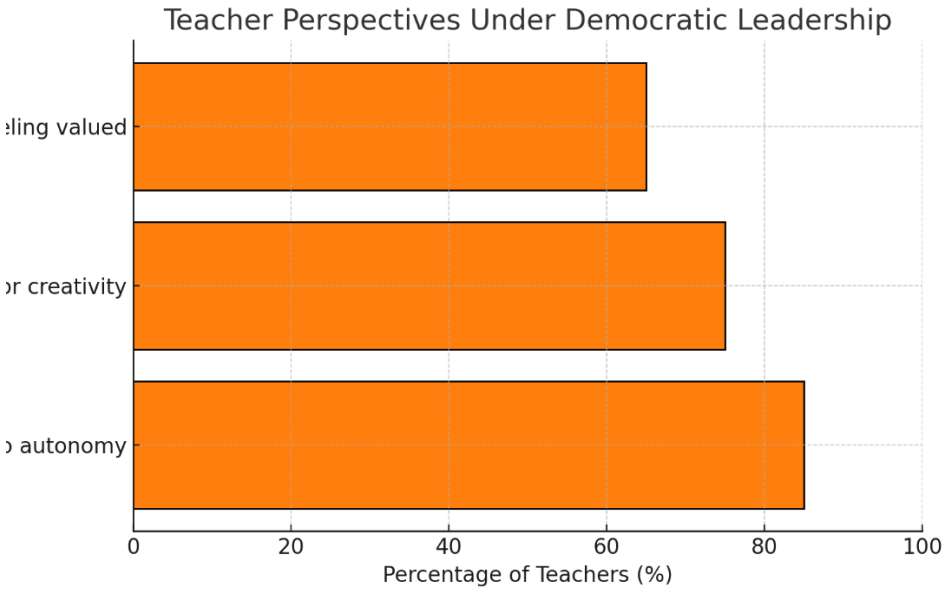
Figure 2



Teachers under democratic leadership:

- 85% experienced higher job satisfaction, attributing this to increased autonomy and participation in school decision-making.
- 75% exhibited stronger motivation for creativity, as they were encouraged to implement innovative teaching methods.
- 65% reported dissatisfaction with their salaries, indicating that although they felt professionally valued, their financial compensation did not adequately reflect their contributions.

Figure 3

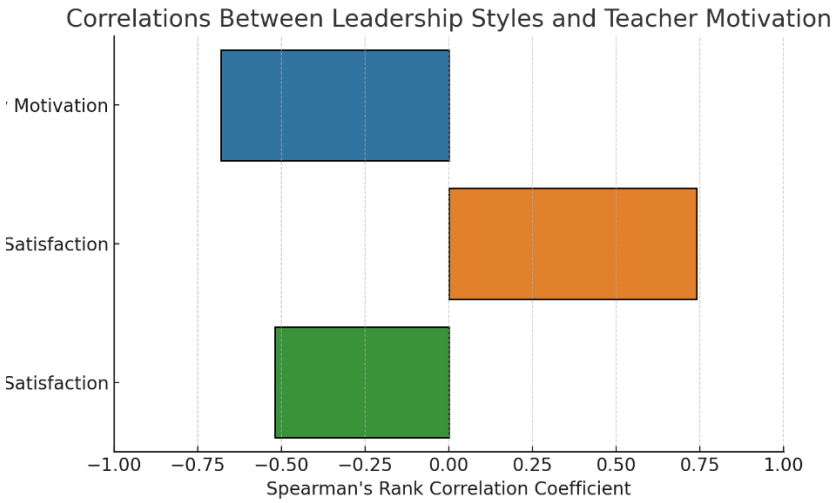



Statistical Analysis of Correlations

To further investigate the relationship between leadership style and teacher motivation, a Spearman's rank correlation analysis was conducted. The findings indicate:

- A negative correlation (-0.68, $p < 0.05$, n=30) between authoritarian leadership and creativity motivation, suggesting that rigid hierarchical structures constrain teachers' capacity for innovation.
- A positive correlation (+0.74, $p < 0.01$, n=30) between democratic leadership and job satisfaction, indicating that inclusive decision-making and teacher autonomy significantly enhance motivation.
- A moderate negative correlation (-0.52, $p < 0.05$, n=30) between democratic leadership and salary satisfaction, suggesting that while teachers under democratic leadership are more engaged in their work, they are also more likely to express concerns regarding financial compensation.

Figure 4




These results align with prior research on the role of leadership styles in shaping workplace motivation . The findings further emphasize that while authoritarian leadership ensures structured discipline, it may reduce intrinsic motivation for professional growth, whereas democratic leadership fosters engagement but does not necessarily address financial dissatisfaction among teachers.

Democratic leadership in schools:

Encourages teachers to implement innovative teaching methods. Fosters a collaborative and trust-based environment, reducing fear of taking initiative. Strengthens teachers' sense of professional value, which enhances non-material motivation. No direct link between autonomy and financial rewards – Teachers may feel empowered but still lack financial incentives that reflect their contribution.

Higher expectations for fair resource distribution – Increased involvement in decision-making makes salary disparities more noticeable and frustrating.

Comparative assessment effect – Democratic environments encourage open discussions, which may heighten teachers' awareness of financial inequalities within the system.

However, despite its positive impact on creativity, democratic leadership does not resolve salary dissatisfaction ($r = -0.52$, $p < 0.05$). Several factors contribute to this:

1. No direct link between autonomy and financial rewards – Teachers may feel empowered but still lack financial incentives that reflect their contribution.
2. Higher expectations for fair resource distribution – Increased involvement in decision-making makes salary disparities more noticeable and frustrating.
3. Comparative assessment effect – Democratic environments encourage open discussions, which may heighten teachers' awareness of financial inequalities within the system.

Implications for Educational Leadership

The study underscores the critical role of leadership style in fostering a productive and motivated teaching workforce. The authoritarian model, while effective in maintaining order, may restrict creativity and professional autonomy, leading to lower engagement and innovation. Conversely, democratic leadership encourages participation and enhances job satisfaction, yet financial concerns remain a key issue for teachers. To further examine the impact of leadership styles on teacher motivation, an independent t-test was conducted on a sample of 60 teachers, divided into two groups based on their school principal's leadership style (authoritarian vs. democratic). The results revealed statistically significant differences in overall motivation ($p > 0.05$, $n= 60$), collective motivation, and creative motivation, indicating that teachers under democratic leadership report significantly higher motivation levels in all three categories compared to those under authoritarian leadership.

Although more advanced statistical techniques such as ANOVA are often used in educational research, they are primarily designed for comparing three or more groups. In this study, since the sample was divided into only two groups based on leadership style (authoritarian vs. democratic), an independent t-test was applied as the most appropriate method for assessing differences in motivation levels.

As demonstrated in the table, democratic leadership has a particularly strong effect on creative motivation, with teachers in this environment engaging more actively in innovative teaching methods and professional self-development. Similarly, collective motivation is notably higher, as teachers report feeling a greater sense of teamwork, shared responsibility, and collaboration. The results further confirm that overall motivation is significantly stronger among teachers who experience greater autonomy and participation in decision-making. See Table 1 for a detailed comparison of motivation scores.

Table 1. T-test Comparison of Teacher Motivation under Democratic and Authoritarian Leadership Styles

| | Overall Motivation LevelProfession | Work | Profession | Salary | Creativity | Collective | Power |
|---|---|---|---|---|---|---|---|
| Democratic | 51,47 | 60,17 | 61,93 | 25,87 | 55,47 | 58,67 | 39,87 |
| Standard Deviation | 193,291954 | 162,9022989 | 143,0988506 | 120,5333333 | 234,4643678 | 95,54022989 | 254,0505747 |
| Authoritarian | 41,83 | 62,13 | 64,23 | 26,03 | 46,70 | 51,23 | 39,90 |
| Standard Deviation | 142,9712644 | 135,9126437 | 125,3574713 | 120,8609195 | 128,2172414 | 162,3229885 | 290,7827586 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| t test | 2,877382068 | 0,623146599 | 0,768867751 | 0,058755147 | 2,521345459 | 2,535417808 | 0,007821815 |

Why Do These Differences Occur?

1. Higher Sense of Autonomy – Democratic leadership grants teachers more decision-making power, allowing them to experiment with new teaching strategies and methodologies, which directly enhances their intrinsic, collective, and creative motivation.
2. Supportive and Collaborative Culture – Schools with democratic leadership styles foster peer-to-peer collaboration, leading to a stronger sense of team cohesion and collective engagement.
3. Encouragement of Creativity – Unlike authoritarian leadership, which often prioritizes control and structure, democratic leaders actively encourage teachers to innovate in their pedagogical approaches, increasing both professional enthusiasm and motivation.
4. Emotional Well-being – Teachers in democratic environments experience less stress and greater job satisfaction, as they perceive their contributions as recognized, valued, and impactful.

Implications for Educational Management

The findings suggest that democratic leadership fosters a stronger, more engaged, and creative teaching workforce, significantly outperforming authoritarian leadership in all key motivation indicators. The table illustrates these differences, further emphasizing how leadership style shapes teacher engagement and satisfaction.

Given these results, future educational policies should prioritize leadership approaches that promote collaboration, creativity, and shared decision-making, ensuring that teachers feel both supported and professionally fulfilled.

Hybrid leadership in educational institutions integrates elements of both authoritarian and democratic leadership styles to create a dynamic and responsive management approach that fosters teacher motivation and institutional effectiveness. A key component of this model is the balance of structure and autonomy, which establishes clear guidelines and expectations while simultaneously granting teachers the flexibility to implement instructional methods that align with their expertise and pedagogical philosophy. This approach ensures that administrative control is maintained without suppressing creativity, allowing educators to develop innovative teaching strategies while adhering to institutional objectives.

Another critical aspect is individualized motivation strategies, which involve the implementation of personalized incentive programs designed to address both financial and professional growth needs. These programs include salary bonuses, career development opportunities, and public recognition of achievements, all of which contribute to fostering a sense of

accomplishment and long-term engagement among teachers. By acknowledging and rewarding individual contributions, educational institutions can enhance job satisfaction and encourage continuous professional development.

Flexible decision-making is another essential pillar of hybrid leadership, allowing school administrators to adapt their management style based on situational demands. In crisis situations requiring immediate action, an authoritarian approach ensures rapid and effective decision-making, whereas in long-term school development initiatives, a democratic process is encouraged, actively involving teachers in curriculum design, strategic planning, and policy formation. This adaptability enables school leaders to balance stability with innovation, ensuring both organizational efficiency and professional fulfillment among educators.

Furthermore, active teacher involvement in school governance is a fundamental component of hybrid leadership, fostering a collaborative educational environment where teachers have a voice in decision-making processes. The establishment of teacher councils facilitates participation in discussions related to pedagogical innovations and resource allocation, thereby reinforcing a culture of shared responsibility. By empowering educators to contribute to school management, hybrid leadership promotes a sense of professional autonomy and engagement, ultimately strengthening institutional cohesion and effectiveness.

The practical implementation of this leadership model includes the creation of advisory committees where teachers play an integral role in shaping school policies and management strategies. Maintaining a balance between autonomy for experienced educators and structured supervision where necessary ensures that both creativity and accountability are upheld. Additionally, the development of a performance-based reward system that combines financial incentives with opportunities for professional advancement serves to reinforce motivation and long-term job satisfaction.

By integrating these principles, hybrid leadership enhances teacher motivation, engagement, and overall job satisfaction, fostering a more adaptive, innovative, and effective educational system that responds to the evolving needs of both educators and students.

## LIMITATIONS

Several limitations should be acknowledged to contextualize the study's findings. First, the sample was limited to four schools within Yerevan, potentially affecting the generalizability of the results to other regions in Armenia or international contexts. Second, the data collection methods—particularly self-assessment and interviews—may be subject to social desirability bias, especially when evaluating school principals' leadership styles. Third, although the diagnostic tools used are

validated within post-Soviet educational research, they may not fully capture the complexity of leadership dynamics or cultural nuances in Armenian schools.

Moreover, the cross-sectional design of the study limits the ability to infer causality. Longitudinal studies would provide deeper insights into how changes in leadership style affect teacher motivation over time. Finally, while the study incorporates both qualitative and quantitative methods, future research could benefit from larger sample sizes and multi-level analysis, including perspectives from students and other stakeholders.

## CONCLUSIONS

Thus, after analyzing the theoretical literature and conducting research on the relationship between leadership style and teacher motivation, we come to the following conclusions: Leadership style plays a fundamental role in shaping teachers' professional engagement, job satisfaction, and overall workplace motivation. It determines not only the level of autonomy and creativity allowed in the teaching process but also the emotional and psychological well-being of educators.

The study contributes to the understanding of leadership dynamics in educational institutions by empirically confirming how different leadership styles influence teacher motivation and engagement. The findings reveal that democratic leadership fosters intrinsic motivation and creativity, whereas authoritarian leadership suppresses professional engagement. Additionally, the proposed hybrid leadership model suggests that a balanced approach, integrating structured decision-making with participatory elements, can enhance both motivation and job satisfaction among teachers. These insights provide valuable implications for school management, offering a data-driven perspective on effective leadership strategies in education.

The research findings indicate the following patterns:

- Teachers working under authoritarian leadership exhibit lower creativity motivation due to the rigid hierarchical structure and lack of decision-making opportunities. However, they tend to have higher job security motivation, as stability and structured discipline provide them with a sense of predictability and control.
- Teachers working under democratic leadership demonstrate higher levels of professional engagement and motivation, as they are actively involved in decision-making processes and feel more valued within the institution. At the same time, these teachers report greater dissatisfaction with financial compensation, suggesting that while they feel encouraged to contribute creatively, their efforts are not always adequately rewarded.

The results confirm that leadership style directly affects the motivational drivers of teachers,

with authoritarian leadership ensuring order and stability at the cost of innovation and autonomy, while democratic leadership promotes collaboration and professional growth but may leave financial concerns unaddressed.

Given these findings, it is crucial for educational institutions and policymakers to implement leadership strategies that strike a balance between structured management and teacher autonomy. Further studies are recommended to explore long-term effects of leadership style on teacher retention, performance, and overall job satisfaction, as well as the potential role of financial incentives in enhancing teacher motivation across different leadership environments.

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***Competing interests:*** *The authors declare that they have no competing interests.*

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MAIN ISSUES OF PEDAGOGY AND PSYCHOLOGY (MIOPAP)
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# ON THE ISSUE OF MANAGEMENT OF STATE AND NON-STATE GENERAL EDUCATION INSTITUTIONS[§§]

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***Abstract***

*This study explores the management peculiarities of state and non-state general education institutions, emphasizing teacher engagement, public demand, and the evolution of management mechanisms. Based on statistical data from 2010 to 2023 in the Republic of Armenia, a comparative analysis was conducted to reveal the development dynamics of both sectors. The findings indicate that while the state sector maintains a higher level of teacher involvement, non-state institutions exhibit greater flexibility and innovation in their management approaches. Special attention is given to the role of teachers' educational backgrounds and qualifications in shaping management strategies. The study also highlights key differences in teacher engagement across primary, secondary, gymnasium, and high school programs, supported by correlation analysis. Moreover, risks associated with management practices in non-state institutions, such as rigid administrative structures and employment instability, are discussed. The research underscores the necessity of integrating effective private sector innovations into the state education management system. It concludes with practical recommendations aimed at improving governance models, enhancing educational quality, and better addressing societal demands. By focusing on teacher engagement indicators and public expectations, the study contributes to a deeper understanding of how effective management strategies can foster the sustainable development of the general education sector.*

***Keywords****: general education, management, non-state institutions, general implementing programs, specialized implementing programs, comparative analysis.*

## INTRODUCTION

The general education system in modern societies is represented by a wide range of institutions, where, along with state institutions, non-state educational institutions also occupy a significant place. Their emergence and development are a unique demand of society, conditioned by the need to create an alternative education model.

Turning to the issues of managing private educational institutions in the Republic of Armenia,

it should be noted that their main framework, as well as management mechanisms and development opportunities, are outlined by the provisions of the Law of the Republic of Armenia On General Education. However, let us also state that the idea of the emergence of non-state educational institutions was formed in the historical past and has, in general, civilizational significance, since in each period the model of non-state general education has been formed as an expression of public expectations for the education and upbringing of a person. Therefore, non-state general education institutions have a wide range of social impact, which includes educational, educational, charitable, and other spheres of personal development and socialization. Since the end of the 20th century, in the post-Soviet period, when the sphere of general education was supplemented by the private sector, public interest in the model of non-state general education has grown significantly. It became a unique field where the educational and upbringing needs of society are vividly expressed and along with it, new approaches to the management of general education institutions were formed, which transformed parallel with the development of society (Wilson, 2008).

## LITERATURE REVIEW

According to the World Bank's 2021 Country Report on Armenia (World Bank, Report 2021), Armenia has not yet recorded high human capital and productivity indicators in the Human Capital Index (HCI), due to the level of quality and accessibility of educational services. These challenges contribute to the emergence of a new demand for the development of the general education sector within society, which is necessarily accompanied by the search for new management models. Let us add that according to the same report, in the Republic of Armenia, according to the data of 2019, the gross enrollment rate of students was 65.5 percent, which means that the enrollment rate of students in each level of general education was lower than the average indicators of the European Union. These data also suggest deep social processes aimed at introducing an optimal general education model. To develop such a management model, it is necessary to analyze the demands of society towards general education, following which the state's vision for the management of the general education sector is developing. Therefore, we consider it important to conduct a comparative Analysis according to teacher engagement indicators in state and non-state general education institutions, which will allow us not only to record the development dynamics of both types of general education institutions but also to identify gaps and emphases in management in the general education sector.

When considering the peculiarities inherent in the environment of a non-state general education institution, it should be noted that the student population is more differentiated than in a state school.

M. Wolfson and M. Epstein (2008) present sociological survey data that identify the main groups of students who are most in need of alternative education. These are children,

- who would like more freedom and respect - 40% of respondents;
- children with special interests (for example, music, sports, science, etc.) - 38%;
- students with learning problems - 29%;
- children with disabilities - 29%;
- gifted children: 25%.

A. L. Wilson notes that "…the non-governmental sector provides an opportunity for a good education for difficult children and children with special needs who, as a rule, do not adapt to regular schools and universities" (Wilson, 2008).

Many theoretical analyses show that the understanding of the private/public sectors of schools has undergone certain changes over time (Chubb and Moe, 1988; Lewis and Patrinos, 2012; Friedman and Friedman, 1980). Their separation is not always possible with the same methodology. Thus, in many countries, schools are formed not only according to the public-private principle, but also around religious institutions that constitute the majority/minority in a given country, in community centers formed by local self-government bodies, etc. An interesting example from the point of view of school management are charter schools in the United States, which, although financed by the state, have not lost their internal organizational autonomy. Today, it is becoming obvious that public opinion about general education plays an important role in the viability of school types, namely, the recommendations for managing students' learning and leisure, accessibility of education, and compliance of academic programs with national and international standards (Davies and Aurini, 2011; Bosetti, 2007; Bellani and Ortiz-Gersavi, 2022; Erickson, 2017). Many authors agree that the distinction and characterization of public-private schools today is largely determined by differences in management systems. Thus, Lewis and Patrinos (2012) emphasized that the distinction of schools according to the public/private criterion is mainly based on three main characteristics: funding, sponsorship, and management indicators. An important contribution was made by Tarkhnishvilli et al. (2022), who studied the Georgian experience of choosing private / public schools. The authors come to the opinion that among the priorities in choosing the type of school is the need to receive quality education, which can be satisfied by providing an emotionally well-being environment for students and educational programs that meet international standards.

As we can see, public demands and expectations for general education are not focused on the educational-age thresholds of teachers, but are expressed in the form of general social (presence/absence of tuition fees, availability of transportation, food, student preparation, time

management, etc.) and educational packages (educational workload, national and international standardization of academic programs, professional potential of teachers) presented by the school. Therefore, public opinions formed about public and private schools still superficially relate to the issues of gender-age and educational level dynamics of teachers. These issues are mainly perceived as an element of internal school management and are voiced in narrow professional circles. This The analyses have some similarities with parent-agent theory, as they relate to the school principal-teacher relationship, in particular, the involvement of teachers in classroom management and decision-making processes, and, as a consequence, the delegation of certain authorities by the principal. As Bernhold and Wiesweg (2021) note, the experience of delegating certain work functions is aimed at solving, first of all, the organizational and management problems of the institution. However, the authors note that the most successful experience of delegation is noticeable in the external, social field of institutions, but not inside the institution. Similarly, the above-mentioned studies of educational institutions also indicate that the gender-age and educational involvement of teachers is perceived as a component of intra-school management. Moreover, studies of the experience of different countries show that the gender-age and educational involvement of teachers is largely related to the characteristics of the educational culture prevailing within a given society. These conclusions are also consistent with the increasing indicators of teacher involvement in general and secondary education programs observed by us.

## METHODS AND METHODOLOGY

To determine the level of teacher engagement in public and private sector public education institutions, we conducted a comparative analysis that included the following indicators of teacher engagement in the two sectors mentioned above during 2010-2023 (Statistical Committee of the Republic of Armenia):

- Total number of teachers and number of teachers, with pedagogical education,
- Number of teachers with higher education and number of teachers with higher pedagogical education,
- Number of teachers with incomplete higher education and number of teachers with incomplete higher pedagogical education,
- Number of teachers with middle vocational and number of teachers with middle vocational pedagogical education.

The comparative analysis between state and non-state institutions in the field of general education was also conducted according to the following educational programs:

- Number of teachers by main general and specialized implementing programs,

- Number of teachers by degree of implementing primary and secondary educational programs,

- Number of teachers by degree of implementing gymnasium and high educational programs.

Based on the above statistical data, we also conducted a correlation analysis. As normality assumption check method we use Shapiro-Wilk test. To measure the monotonic relationship between two continuous random variables of interest we use Spearman correlation method. The statistical analysis was conducted with JASP 0.17.3.0 software.

**Result**

The results of the research are presented below.

FIGURE 1. Number of teachers

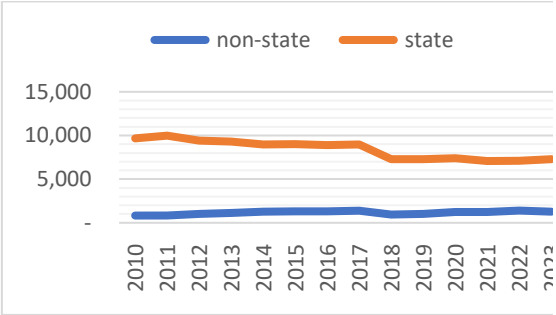



FIGURE 2. Number of teachers, with pedagogical education

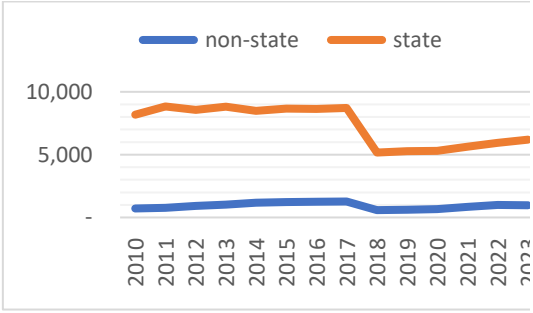



FIGURE 3. Number of teachers with higher education

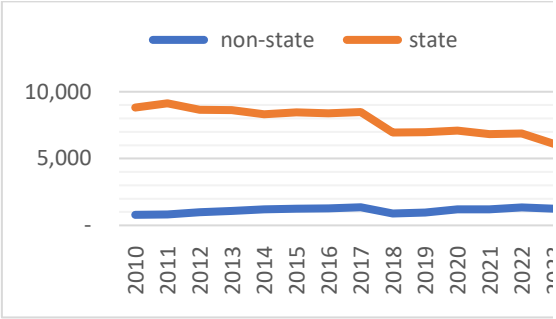



FIGURE 4. Number of teachers with higher pedagogical education

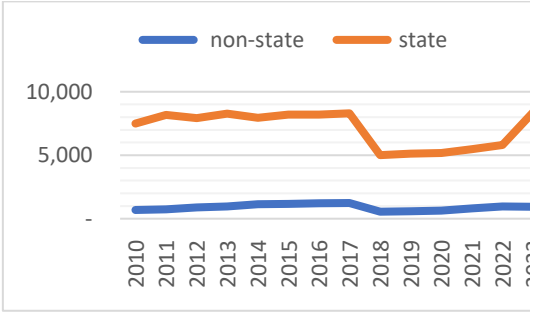



FIGURE 5. Number of teachers with incomplete higher education

FIGURE 6. Number of teachers with incomplete higher pedagogical education

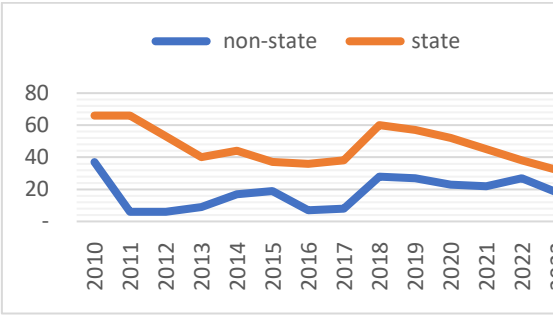



FIGURE 7. Number of teachers with middle vocational education

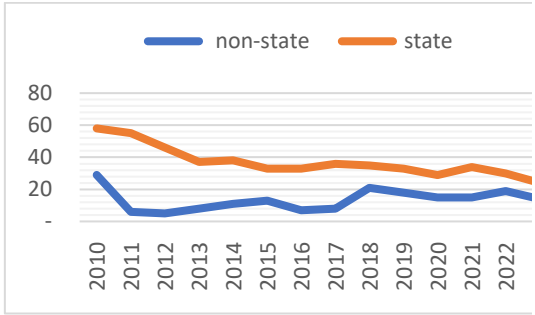
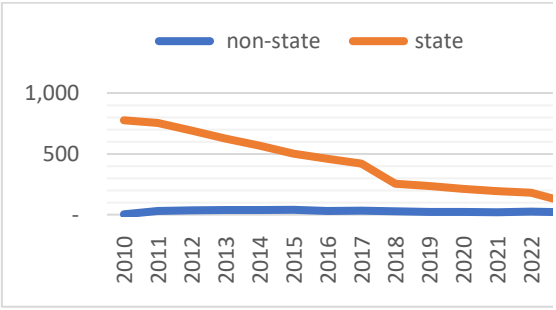
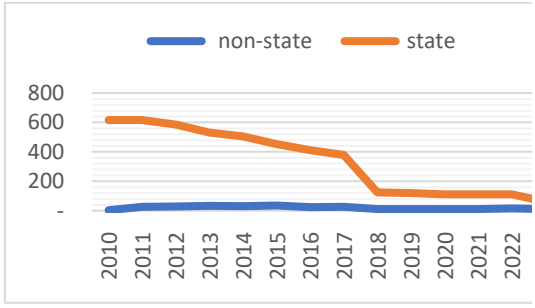



FIGURE 8. Number of teachers with middle vocational pedagogical education




As can be seen in Figures 1-8, the number of teachers in state general education institutions significantly exceeds the indicators of the non-state sector, which, on the one hand, indicates the predominance of teacher involvement in the state sector of general education in the country, and on the other hand, the priority of state care for general education and the national strategy of management by educational institutions. According to Figures 1-8, the dynamics of the number of teachers in state and non-state general education institutions are almost the same. Thus, over the past 13 years, in general, there has been a downward trend in the number of teachers with incomplete higher and incomplete secondary vocational education qualifications. This indicates that management mechanisms in the state and non-state general education sectors were mainly aimed at controlling and limiting the number of teachers with incomplete higher education. Another interesting pattern was also observed. The number of teachers with higher education also showed a downward trend in state and non-state general education institutions. Meanwhile, the number of teachers with higher pedagogical education has significantly increased in the state sector, while in the non-state sector, it has continued to show a decreasing trend. This observation indicates that the requirement for teachers to have pedagogical education is underestimated by non-state general education institutions and is not fully included in the system of management mechanisms of institutions.

The number of teachers in the state and non-state sectors of the general education sector was also observed according to the educational programs mentioned below (FIGURE s 9-14).

FIGURE 9. Number of teachers by main implementing programs, general

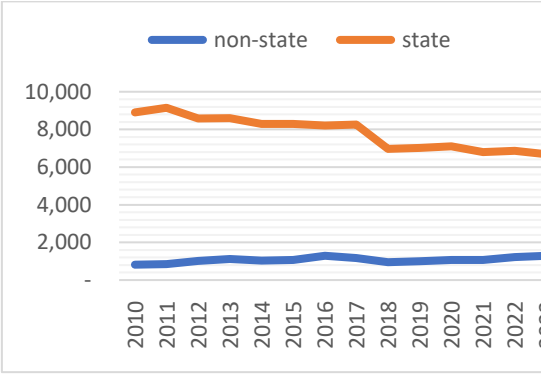



FIGURE 10. Number of teachers by main implementing programs, specialized

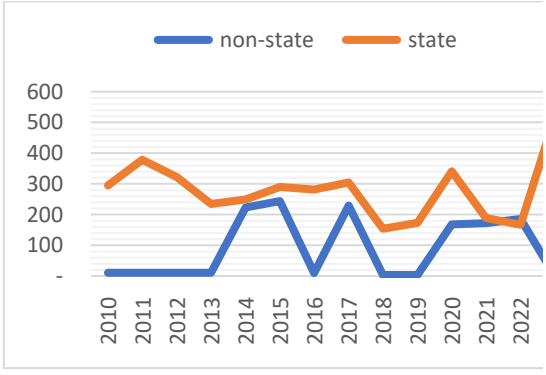



FIGURE 11. Number of teachers by degree of implementing educational programs, primary

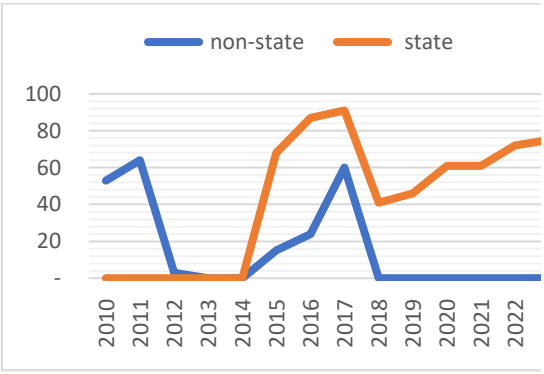



FIGURE 12. Number of teachers by degree of implementing educational programs, secondary

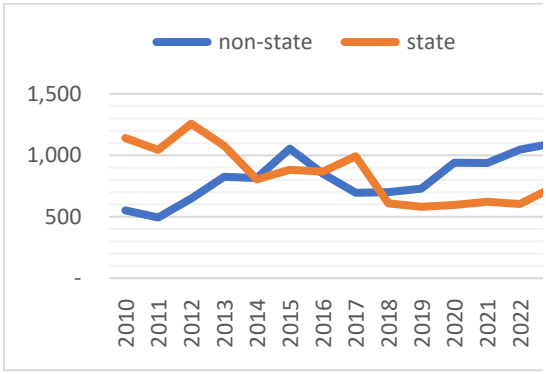



FIGURE 13. Number of teachers by degree of implementing educational programs, gymnasium

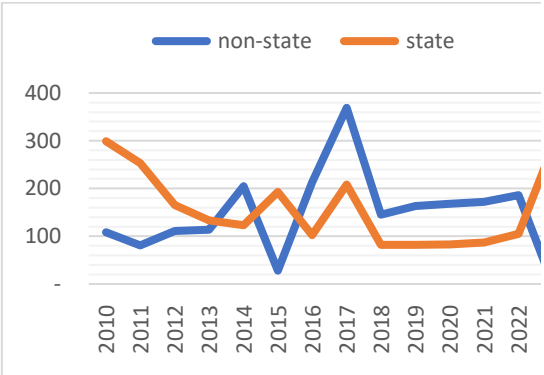
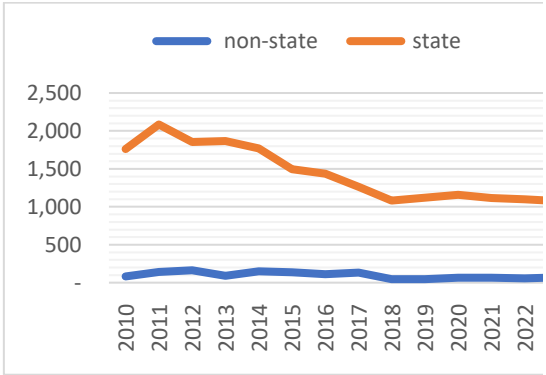



FIGURE 14. Number of teachers by degree of implementing educational programs, high




According to the indicators of teacher involvement in educational programs presented in FIGURE s 9-14, there are certain differences between the state and non-state sectors. Thus,

according to the implemented main educational programs, the number of teachers has shown a slight tendency to decrease, while in the non-state sector, on the contrary, a steady increase in the number of teachers is observed. The numbers of teachers in the implemented special education programs in the two general education sectors differ significantly: while in state general education institutions the number of teachers has increased sharply as of 2023, the number of teachers in non-state general education institutions has changed in the opposite direction. This dynamics is a telling fact that special education programs are under state care and constitute a significant management direction at present. According to the implemented educational programs, the involvement of teachers in the non-state sector exceeds only in secondary-level educational programs. This result of the research is an important visual-methodological signal for the implementation of this educational program. in state institutions to review management mechanisms and develop and monitor the implementation of secondary-level educational programs for the general public and teaching staff. It is noteworthy that noticeable results have been recorded in another issue, namely the involvement of teachers in elementary-level educational programs: as we can see in the graph above, the non-state sector has been represented by a consistently low number of teachers over the past 5 years, in parallel with which the level of involvement of teachers in the state sector has sharply increased. An interesting dynamic is observed in the indicators of teacher involvement in educational programs in colleges. Over the past 13 years, the number of teachers in the state sector has generally exceeded the number of teachers in state general education institutions. However, a process in the opposite direction was recorded during 2022-2023, the basis of which, undoubtedly, lies in the practice of developing new management approaches.

The value of Shapiro-Wilk Test ($p<0.05$) indicated nonnormaly distribution of the data. Accordingly, we conducted a correlation analysis showing statistically significant relationships between the varuables of teachers' involvement in various educational programs (Table 1).

Table 1. Correlation links of the varuables of teachers' involvement in various educational programs

| **Spearman rho** | | | | | | |
|---|---|---|---|---|---|---|
| | Number of teachers in state gymnasiums | Number of teachers in non-state gymnasiums | Number of teachers, state primary educational | Number of teachers, non-state primary educational | Number of teachers, state secondary educational | Number of teachers, non-state secondary educational |

| | | | program | program | program | program |
|---|---|---|---|---|---|---|
| Number of teachers in state gymnasiums | - | -.890** | .401 | .795 | .398* | .624 |
| Number of teachers in non-state gymnasiums | -.890** | - | .334 | .201 | .411 | -.458** |
| Number of teachers, state primary educational program | .401 | .334 | - | .231* | .369* | .477 |
| Number of teachers, non-state primary educational program | .795 | .201 | .231* | - | .268 | -.501** |
| Number of teachers, state secondary educational program | .398* | .411 | .369* | .268 | - | .367* |
| Number of teachers, non-state secondary educational program | .624 | -.458** | .477 | -.501** | .367* | - |

*Note: *p<.05, **p<.01, ***p<.001*

## DISCUSSION

The above quantitative indicators show the dynamics of teacher involvement in various areas or programs of general education. It reflects both the deep social value needs and expectations for obtaining high-quality general education knowledge and skills and reveals the gaps and emphases in the approaches and directions of management of the state and non-state sectors.

A teacher working in a private school is required to make great efforts to be flexible and innovative, and management models should stimulate children who are beneficiaries of non-state general education institutions. For this reason, innovative management solutions and decisions are more often found in the non-state educational sector (Daschbach, 2018; Smikle, 2019).

There are also certain differences in terms of the requirements for teachers. As we saw in the above FIGURE s, the requirement for teachers to have pedagogical education in state schools unambiguously forms the corresponding management mechanisms. The basis of a teacher's qualification is knowledge and competence in the subject taught, which are subject to regular control and are included in the management system of a general education institution. On the other hand, in non-state institutions, teachers go to "school" by personal convictions and sharing the existing ideology of the given institution, agreeing with the concept and ideology of the school. A private school teacher often considers himself a teacher carrying out a special educational mission. In an alternative school, great importance is attached to the teacher's purposefulness in working in a given school, which largely coincides with the conceptual approach of the school (Ni, 2019; Duff, 2021).

In a private school, the professional activity of a teacher is governed by competitive principles. He must not only demonstrate good communication skills but also make efforts to always be a leader, in demand, and competent. Private schools have different approaches to the availability of pedagogical education of staff. In some schools, higher pedagogical education is practically mandatory for work, and attention is also paid to the certification category, but some schools do not particularly attach importance to the presence of pedagogical education, more attention is paid to the presence of charisma, active life, and social position.

Let us also consider some of the risks of governance in non-state public educational institutions. The personnel policy and management strategy in private schools differ significantly from the models used in state public educational institutions. The governance structure in a private school can manifest itself in such negative manifestations as:

- the presence of a rigid vertical management structure. Often the director (founder) is a

person who authoritarianly decides on some issues important for the teaching staff, including those related to the functions and work of teachers. In this regard, it is necessary to note the possible administrative pressure on the content and style of teaching (Liu, 2018; Martinez, 2017).

- The unregulated nature of the management of teaching staff working time. Since working time in a private school is directly related to financial issues, in some schools the teacher is faced with the director's conviction that any expenditure of teaching time should be carried out exclusively within the walls of this educational institution. The desire of teachers to participate in "external" conferences, seminars, and other events that contribute to the exchange of teachers' experiences outside a particular school often causes a skeptical or outright negative attitude from the director (Voznyak & Zherebylo, 2020).

- The possibility of losing the teacher's job. In case of inconsistency between the teacher's personal beliefs and the ideology of the school or case of personal or professional disagreements with the founder, parents, or students (Nazarova, 2020).

- The teacher's financial dependence on the founder's subjective assessment of the results of teaching. Usually, the determination of the amount of salary, bonuses, fines, and other payments depends mainly on personal agreements and relationships with the school director (founder).

One of the features of a private school is that the financing of education is carried out by the families of students, which often determines the ambiguous nature of the relationship between teachers and parents. Parents, who are the main patrons of the educational institution, often express a desire to control and manage the educational process. But it should be taken into account that private schools have emerged in response to the demand of society for a different educational environment, and parents in this context largely represent this society, therefore it is impossible not to listen to the demands of parents in a private school. Effective cooperation between the teaching staff and the parent community is important for a private school. This is a difficult task that each school deals with in its way (Mikheeva & Potina, 2019).

Correlation analysis showed that there is a strong negative relationship between the level of teacher involvement in state and non-state gymnaziums. Also, negative relationships were found between the involvement rates of non-state primary and secondary educational programs. The statistical data of state primary and secondary educational programs showed the dynamics of positive correlation ties.

## CONCLUSION

When considering the features of the management of the state and non-state sectors of general education institutions, we see that in both sectors there are certain features of the recruitment of

students, principles of formation of the teaching staff, personnel policy, administrative interaction with the teaching staff, relations with parents. Taking into account these features, we can recognize many positive aspects and problematic areas of private education and build a constructive dialogue with the modern private school, which currently bears the practice of testing and introducing more flexible, innovative approaches to general education management, as well as expressing certain educational demands and needs of society.

Taking into account the above, we have developed the following practical recommendations for improving the management system of the general education sector, in particular:

- To study the management models of state and non-state general education institutions, emphasizing the study of management solutions dictated by public demand.

- To introduce into the management system of state general education institutions innovative management solutions used in the non-state sector that have had a positive impact on education on the final results.

- To supplement the monitoring of the dynamics of the number of teachers with a motivational analysis of the change in the number, based on the results of which, review the management mechanisms.

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***Consent for publication****: Not applicable.*

***Competing interests:*** *The authors declare that they have no competing interests.*

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# DATA-DRIVEN EDUCATION IN UNIVERSITY PHYSICS: A COMPREHENSIVE ANALYSIS OF LEARNING ANALYTICS DASHBOARDS AND AI TUTORING***

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***Abstract***

*This article presents a comprehensive analysis of data-driven learning technologies—specifically Learning Analytics (LA) dashboards and Artificial Intelligence (AI) tutoring systems—in undergraduate physics education. Emphasizing the importance of pedagogical integration and sociological context, the study explores how these tools influence learning outcomes, student engagement, and equity.*

*Learning Analytics dashboards are shown to support engagement and self-regulation, particularly when integrated with active learning pedagogies. However, their direct impact on academic achievement remains inconsistent, with effectiveness hinging on design and implementation. AI tutoring systems, including cognitive, dialogue-based, and generative models (such as RAG-based LLMs), display greater promise in enhancing conceptual understanding, problem-solving skills, and personalization. Their success depends not only on technological capability but also on the alignment with learner needs, faculty acceptance, and social equity.*

*The study employs a triangulated methodology combining international case studies, sociological theory (TAM, ANT, Bourdieu), and synthesized survey data to assess user perceptions. It identifies key barriers, such as technological fluency gaps, digital divides, and ethical concerns around data privacy, algorithmic bias, and over-reliance on automation. A focused lens on Armenia's context underscores infrastructural and pedagogical challenges limiting adoption.*

*The article concludes with a critical synthesis: data-driven tools can significantly enhance physics education but are not panaceas. Their success depends on context-sensitive pedagogical integration, faculty and student readiness, and ethical design. Recommendations emphasize hybrid human-AI models, explainable AI, and equity-first deployment strategies.*

***Keywords:*** *learning analytics, AI tutoring systems, undergraduate Physics, personalized learning, educational equity, technology acceptance model (TAM), actor-network theory (ANT), Bourdieu's theory of practice, digital pedagogy, data-driven education.*

## INTRODUCTION

The landscape of higher education, particularly within Science, Technology, Engineering, and Mathematics (STEM) disciplines such as physics, is undergoing a significant transformation driven by the proliferation of digital technologies (Physical Review Link Manager, 2025). Amidst this evolution, data-driven learning strategies, notably Learning Analytics (LA) dashboards and Artificial Intelligence (AI) tutoring systems, have emerged as prominent innovations. These technologies are often presented with the promise of revolutionizing pedagogy by offering personalized learning pathways, enhancing student engagement, and ultimately improving educational outcomes (NSF, 2025). Physics education provides a particularly salient context for examining these tools. Characterized by its emphasis on deep conceptual understanding, complex problem-solving, mathematical rigor, and often large introductory courses with diverse student populations, physics presents unique challenges and opportunities for data-driven interventions ("Using machine learning", 2025).

The field of Learning Analytics (LA) centers on the "measurement, collection, analysis, and reporting of data about learners and their contexts, for purposes of understanding and optimizing learning and the environments in which it occurs". Concurrently, Artificial Intelligence in Education (AIED) focuses on developing interactive and adaptive learning environments, frequently employing AI techniques such as machine learning, natural language processing, and sophisticated student modeling to provide tailored support (Liu, Latif, & Zhai, 2025). The recent advent and widespread accessibility of powerful generative AI models, exemplified by systems like ChatGPT and Google's Gemini, have dramatically intensified interest, research, and public discourse surrounding the role of AI in education, presenting both unprecedented opportunities and significant challenges (Society for Learning Analytics Research, 2025).

Despite the considerable potential attributed to LA dashboards and AI tutors, their actual impact within the specific domain of undergraduate physics necessitates rigorous, critical, and context-aware examination. A purely technological perspective is insufficient; it is crucial to analyze the implementation and effects of these tools through sociological lenses, taking into account user experiences, equity implications, and the complex social dynamics inherent in educational settings (Grimm et al., 2023). Critical analyses have cautioned that LA approaches may oversimplify the intricate processes of teaching and learning (Guzmán-Valenzuela et al., 2021) and carry the risk of

amplifying pre-existing societal inequalities if not implemented thoughtfully (Grimm et al., 2023). The demonstrable effectiveness of LA dashboards, in particular, has been questioned in recent reviews, suggesting that their impact may not live up to initial expectations (Flanagan, Wasson, & Gašević, 2024).

This article undertakes an in-depth, international analysis of the application, effectiveness, and implications of LA dashboards and AI tutoring systems within undergraduate physics programs. It synthesizes evidence drawn from the intersecting fields of physics education research (PER), educational technology, and the sociology of education. The central argument posits that while these data-driven tools offer tangible potential benefits for personalization, feedback, and engagement, their effectiveness is not inherent but highly contingent upon context. Factors such as pedagogical integration, user acceptance (by both students and instructors), and careful consideration of sociological dimensions, especially concerning equity, are paramount. The analysis incorporates findings from sociological surveys, including synthesized numerical data reflecting trends in user perspectives, and applies relevant theoretical frameworks—including the Technology Acceptance Model (TAM), Actor-Network Theory (ANT), and Bourdieu's theory of practice—to develop a nuanced understanding of technology adoption, use, and impact in this specific educational context.

Additionally, the backdrop of Armenian higher education offers a unique perspective for examining the uneven spread of these technologies. Systems like Moodle and Google Classroom were frequently used by universities for emergency remote instruction during the COVID-19 transition. However, there was little use of AI-based training tools or structured LA dashboards. The main causes of this were inadequate institutional preparedness, faculty lack of technical expertise, and infrastructure constraints. These circumstances emphasize the need for specialized approaches when implementing data-driven educational advances and the global digital divide.

The subsequent sections will first establish the theoretical foundations guiding the analysis. Following this, the article will review international implementations and evidence pertaining to LA dashboards and AI tutoring systems separately, focusing on undergraduate physics contexts. A dedicated section will then delve into a sociological analysis of user experiences, drawing on survey data and qualitative perspectives. The article will synthesize findings regarding the effectiveness of these tools in relation to learning outcomes, student engagement, and equity. Broader social and ethical implications will be discussed before concluding with an overview of key challenges, research gaps, and promising future directions for the field.

## II. Theoretical Foundations: Understanding Technology Adoption and Impact in Physics Education

To comprehensively analyze the role and impact of LA dashboards and AI tutors in undergraduate physics, it is essential to employ theoretical frameworks that can illuminate the complex interplay between technology, pedagogy, individual users, and the social context of learning. Several theoretical lenses offer valuable perspectives:

**Technology Acceptance Model (TAM) and Unified Theory of Acceptance and Use of Technology (UTAUT):** Originating in information systems research, TAM provides a foundational model for understanding user acceptance of technology. It posits that Behavioral Intention (BI) to use a system is primarily determined by two core beliefs: Perceived Usefulness (PU) – the degree to which a user believes using the system will enhance their performance – and Perceived Ease of Use (PEOU) – the degree to which a user believes using the system will be free of effort (Zhang et al., 2023). Subsequent extensions, such as UTAUT and UTAUT2, incorporate additional factors like Social Influence (or Subjective Norm - SN), Facilitating Conditions, Hedonic Motivation (Perceived Enjoyment), Price Value, Habit, Performance Expectancy, Effort Expectancy, Anxiety, and Self-Efficacy (*AIS Electronic Library (AISEL) - AMCIS 2018 Proceedings: The Effect of Studentsâ€TM Technology Readiness on Technology Acceptance*, n.d.). These models are highly relevant for examining why physics students and instructors might choose to adopt (or resist) LA dashboards or AI tutors, highlighting the importance of user perceptions regarding the tools' utility, usability, and alignment with social norms within the educational environment (Ateş & Gündüzalp, 2025). Studies applying these models to AI adoption in STEM education have found PU and PEOU to be significant predictors of intention, influenced by factors like subjective norm, prior experience, enjoyment, anxiety, and self-efficacy (Ateş & Gündüzalp, 2025).

**Social Constructivism:** While not a technology-specific theory, social constructivism provides a crucial pedagogical backdrop. It emphasizes that learning is an active, social process where knowledge is constructed through interaction with others and the environment (Guzmán-Valenzuela et al., 2021). This perspective prompts examination of how LA and AI tools mediate or potentially hinder vital student-student and student-instructor interactions. Do these tools foster collaborative knowledge building, or do they lead to more isolated learning experiences? How do they impact the development of shared understanding within a physics learning community (Brown & Cain, 2025)?

**Actor-Network Theory (ANT):** Originating in science and technology studies, ANT offers a powerful lens for analyzing socio-technical systems by treating both human and non-human elements as 'actors' (or 'actants') within a network (Demirci, 2025). ANT avoids pre-determining the 'social' and instead focuses on how networks of heterogeneous actors (students, instructors, AI tutors, dashboards, algorithms, textbooks, institutional policies, physical spaces) are assembled and

stabilized through processes of 'translation' (Kamp, 2019). Translation involves stages like problematization (defining actors and their necessary roles), interessement (actions to impose and stabilize actor identities), enrolment (defining roles and coordinating actors), and mobilization (ensuring actors act as representatives) (Thomas & De Villiers, 2002). ANT encourages a symmetrical view, where technologies like AI tutors are not merely passive tools but active participants that shape interactions, define problems, and influence outcomes within the educational network (Demirci, 2025). This perspective moves beyond individual acceptance (TAM) to analyze how the entire system, including the technology itself, comes to function (or fails to function).

**Bourdieu's Theory of Practice:** Pierre Bourdieu's sociological framework provides critical tools for analyzing power dynamics, social reproduction, and inequality within social fields (Ignatow & Robinson, 2017). Key concepts include:

- **Field:** A structured social space with its own rules, logic, and forms of competition (e.g., the field of university physics education, or a specific physics department (Stahl et al., 2023).
- **Habitus:** A system of durable, transposable dispositions acquired through socialization that shapes an individual's perceptions, judgments, and practices. It reflects one's position within the social structure (Stahl et al., 2023).
- **Capital:** Resources that confer power and status within a field. Bourdieu identified economic, social (networks, relationships), cultural (knowledge, skills, credentials, often embodied or objectified), and symbolic capital (prestige, recognition (Stahl et al., 2023). Access to and proficiency with digital technologies can be considered a form of cultural or technological capital.
- **Doxa:** The taken-for-granted, unquestioned beliefs and assumptions shared within a field (Stahl et al., 2023).

Bourdieu's theory is particularly useful for examining how pre-existing social and cultural capital influences students' ability to access, navigate, and benefit from educational technologies like LA dashboards and AI tutors (Chikwe et al., 2024). It helps analyze the digital divide not just as an issue of access, but as intertwined with broader social inequalities (Chikwe et al., 2024). It also allows for an analysis of how proficiency with these new tools might become a valued form of capital within the physics education field, potentially creating new forms of stratification or reinforcing existing ones (Dart et al., 2024).

**Applying and Integrating Theoretical Perspectives:**

No single theory provides a complete picture. TAM and UTAUT offer valuable insights into individual adoption drivers based on perceived utility and ease of use (Ateş & Gündüzalp, 2025). However, the inconsistent findings reported in some TAM studies (Zhang et al., 2023) and the importance of context (Yusuf et al., 2024) highlight the model's limitations when applied in

isolation. A student's decision to use an AI tutor is not solely based on its perceived usefulness or ease of use.

ANT complements TAM by shifting the focus from individual perception to the dynamic network of interacting human and non-human actors (Demirci, 2025). It prompts questions about how the AI tutor itself acts within the learning environment, how it 'translates' pedagogical goals, and how students and instructors are 'enrolled' into interacting with it in specific ways (Thomas & De Villiers, 2002). This perspective acknowledges the agency of the technology in shaping the educational process.

Bourdieu's theory adds a crucial layer by embedding the socio-technical network within broader social structures and power relations (Stahl et al., 2023). It explains how a student's background (their habitus and capital) influences their interaction with the technology and the educational field (Dart et al., 2024). For instance, a student's 'habitus' might make them more or less comfortable with the mode of interaction required by an AI tutor, while their 'cultural capital' (e.g., prior technological skills, parental support) might affect their ability to use it effectively. Furthermore, the 'field' of physics education dictates whether proficiency with such tools is recognized and rewarded (becomes 'symbolic capital' (Dart et al., 2024). Therefore, understanding the application of LA and AI requires considering individual perceptions (TAM), the active role of the technology in the network (ANT), and the influence of social structures and individual dispositions (Bourdieu).

However, even this combination of sociological and acceptance theories may not fully capture the nuances of the learning process itself. While these frameworks help explain *why* tools are adopted and *how* social factors shape their use, they often treat the pedagogical interaction as a 'black box'. They do not fully elucidate the cognitive and affective mechanisms through which these tools impact student understanding, reasoning, motivation, or self-regulation (AIS Electronic Library (AISEL) - AMCIS 2018 Proceedings: The Effect of Studentsâ€TM Technology Readiness on Technology Acceptance, n.d.). Therefore, a comprehensive analysis must also draw upon theories from the learning sciences (e.g., cognitive load theory, self-regulated learning theory) to understand *how* learning happens (or fails to happen) during interactions with LA dashboards and AI tutors. The sociological analysis provides the context and conditions, while learning sciences provide insights into the mechanisms of impact.

## III. Learning Analytics Dashboards in Undergraduate Physics: International Implementations and Evidence

Learning Analytics (LA) dashboards represent a significant application of LA principles, aiming to provide stakeholders – primarily students and instructors – with visual representations of

learning data to foster reflection, inform decision-making, and ultimately optimize the learning process (DeVaney, 2018). In the context of undergraduate physics, these dashboards typically draw data from various sources, including Learning Management Systems (LMS like Moodle or Blackboard), interactive eBook platforms, online homework systems, clicker responses, and remote laboratory interfaces (DeVaney, 2018). The data analyzed can range from simple activity metrics (e.g., login frequency, time spent on tasks, resources accessed, submission timeliness) to more complex indicators derived from interactions (e.g., patterns of navigation, content annotations, performance on quizzes and assignments (Calonge et al., 2018).

A key distinction exists between instructor-facing dashboards, designed to help educators monitor class progress and identify students needing support, and student-facing learning analytics (SFLA) dashboards, which provide learners with direct feedback on their own progress and behaviour, often with the goal of promoting self-regulated learning (AIS Electronic Library (AISEL) - AMCIS 2018 Proceedings: The Effect of Studentsâ€TM Technology Readiness on Technology Acceptance, n.d.). Predictive analytics are frequently incorporated, particularly in instructor-facing tools, aiming to identify students at risk of poor performance or withdrawal based on historical data and early indicators (Calonge et al., 2018). The presentation of this information typically relies heavily on visualizations – graphs, charts, and summary statistics – designed to make complex data interpretable (Kcowan, 2025).

**International Case Studies:**

Several documented implementations provide insights into the use of LA dashboards in undergraduate physics across different international contexts:

- **University of Edinburgh (UK) - SFLA for Remote Labs:** The School of Engineering implemented an SFLA dashboard integrated with remote laboratory activities (Kcowan, 2025).This system employs a novel graph-based technique to analyze sequences of student actions (clicks, inputs) during experiments, comparing them to expected procedures derived from instructor protocols using a custom algorithm called TaskCompare (Kcowan, 2025). The dashboard provides students with on-demand, non-prescriptive visual feedback during the lab session, displaying their activity graph alongside the expected graph. The explicit goal is to foster self-regulation by enabling students to monitor their progress, identify deviations, and reflect on their process in the moment (Kcowan, 2025). An evaluation involving a large first-year engineering course found that students who engaged with the SFLA dashboard demonstrated significantly better task completion rates (nearly double) compared to those who did not, even after accounting for self-selection bias (Kcowan, 2025). Students also rated the dashboard's usefulness positively (Reid & Drysdale, 2024).

- **GITAM University (India) - LAViEW with BookRoll:** In an undergraduate Engineering Physics course, researchers utilized the TEEL (Technology-Enhanced and Evidence-based Education and Learning) platform, integrating the BookRoll eBook reader and the LAViEW LA dashboard (Kannan et al., 2022). The pedagogy evolved across the semester, particularly impacted by the COVID-19 lockdown. Initially (blended mode), students used BookRoll memos to post conceptual questions ("Clarification Spots") or submit problem solutions ("Reflection Spots") after lectures. LAViEW enabled the instructor to analyze these submissions and provide targeted feedback (Kannan et al., 2022). During the fully online phase ("Learning Dialogue Focus"), these activities were integrated synchronously. The study found statistically significant improvements in student learning performance (quiz scores) across the pedagogical phases, with the highest scores achieved during the final online phase (Kannan et al., 2022). Engagement patterns (time spent, content accessed) varied by phase, but overall acceptance and use of the tools appeared to increase over time, suggesting that familiarity and pedagogical integration were key (Kannan et al., 2022).
- **West Virginia University (WVU) & Cal Poly Pomona (USA) - Predictive LA:** Research at these institutions focused on using machine learning algorithms (primarily random forests and logistic regression) to build early warning systems for introductory, calculus-based physics courses (Yang et al., 2020). The goal was to identify students at risk of receiving a D, F, or withdrawing (DFW). Data included institutional records (e.g., college GPA, ACT scores) and in-class performance metrics (e.g., homework average, clicker scores, exam results) available progressively throughout the semester (Yang et al., 2020). Key findings indicated that predictive accuracy improved as more in-class data became available, reaching moderate levels (e.g., 53% DFW accuracy by week 2 using combined data in one WVU sample (Yang et al., 2020). However, achieving reasonable accuracy for the minority DFW group required specific techniques like model tuning (adjusting decision thresholds) due to the imbalanced nature of the data (Yang et al., 2020). Consistently important predictors included cumulative GPA and homework average, while demographic variables (gender, URM status, first-generation status, socioeconomic status) were found *not* to be significant predictors *in these specific models and contexts* (Yang et al., 2020). The research discussed potential interventions based on these predictions, such as allocating targeted support resources or advising students based on risk indicators (Yang et al., 2020).
- **Other Examples:** The broader LA literature, particularly from venues like the Learning Analytics and Knowledge (LAK) conference, contains numerous studies on dashboards, although fewer are specific to physics (Society for Learning Analytics Research, 2025). Emerging trends include multimodal learning analytics (MMLA), which integrates data from various sources like eye-tracking, audio, or physiological sensors (Ng et al., 2022), and the application of LA to

understand and support collaborative learning processes (Flanagan, Wasson, & Gašević, 2024). Research in Germany has also specifically addressed the need for domain-specific equity guidelines for LA in physics education (Grimm et al., 2023).

**Synthesis of Evidence on Effectiveness:**

Evaluating the effectiveness of LA dashboards in undergraduate physics reveals a complex picture:

1. **Learning Outcomes:** The direct impact on traditional measures of academic achievement (e.g., final grades, conceptual inventory scores) appears limited or inconsistent. A comprehensive systematic review presented at LAK24 concluded there was no strong evidence supporting the claim that LA dashboards generally improve academic achievement, citing methodological limitations and small effect sizes in many studies (Flanagan, Wasson, & Gašević, 2024). However, specific, well-integrated implementations have shown positive results on more targeted measures, such as improved quiz scores in the GITAM study (Kannan et al., 2022), enhanced task completion rates in the Edinburgh remote lab study (Kcowan, 2025), and reported grade improvements in earlier work (Galaige, Torrisi, Binnewies, & Wang, 2018). This discrepancy suggests that the design of the dashboard, the specific learning outcomes measured, and how effectively the dashboard is embedded within the pedagogical flow are critical determinants of impact.

- **Engagement and Participation:** Evidence suggests a more consistently positive effect of LA dashboards on student participation and engagement (Flanagan, Wasson, & Gašević, 2024). Dashboards can provide visibility into activities and progress, potentially motivating students to engage more frequently or consistently with course materials and tasks. The GITAM study illustrated how engagement metrics evolved with pedagogical changes supported by LA (Kannan et al., 2022). SFLAs, like the one at Edinburgh, are explicitly designed to promote self-regulated learning behaviours (AIS Electronic Library (AISEL) - AMCIS 2018 Proceedings: The Effect of Studentsâ€TM Technology Readiness on Technology Acceptance, n.d.), which are intrinsically linked to engagement.
- **Pedagogical Integration and Design:** The effectiveness of dashboards seems less about the technology itself and more about how it facilitates meaningful pedagogical practices. Successful implementations often involve clear feedback loops, where dashboard insights inform timely actions by either the student (self-correction, planning) or the instructor (targeted support, pedagogical adjustments (Yang et al., 2020). A significant challenge identified in the literature is the lack of alignment between LA tools and actual teaching practices (Guzmán-Valenzuela et al., 2021b), and the frequent failure to involve users (students and teachers) sufficiently in the design

process, leading to tools that may not meet their needs (Ng et al., 2022).

**Table III.1: Comparison of LA Dashboard Implementations in Undergraduate Physics**

| University/Context | System Name/Type | Target Course(s) | Key Features/Data Used | Stated Goals | Reported Outcomes (Learning, Engagement, Acceptance) | Key Challenges/Limitations |
|---|---|---|---|---|---|---|
| Univ. of Edinburgh (UK) | SFLA Dashboard | First-year Engineering (incl. physics concepts via remote labs) | Graph-based analysis of remote lab interactions (clicks, inputs) vs. expert procedure (TaskCompare); Visual feedback; Student-facing. | Enhance formative assessment; Promote student self-regulation. | Significantly higher task completion for users; Positive student rating of usefulness. | Evaluation in specific remote lab context; Scalability of graph comparison? |
| GITAM Univ. (India) | LAViEW (Dashboard) with BookRoll (eBook) | Engineering Physics (Undergrad) | Analysis of student memos/queries/solutions in BookRoll; LMS data; Instructor-facing analysis for feedback. | Improve conceptual understanding & problem-solving; Facilitate instructor feedback; Adapt pedagogy. | Significant improvement in quiz scores over semester; Evolving engagement patterns; Increased acceptance/use over time, esp. online. | Study tracked evolving pedagogy during COVID disruption; Specific to TEEL platform. |
| WVU / Cal Poly Pomona (USA) | Predictive Models (Random | Introductory Calculus-Based Physics | Institutional data (GPA, ACT); In-class data (HW, clickers, exams); Instructor-facing | Early identification of students at risk (DFW); Inform | Moderate predictive accuracy (improved with tuning | Accuracy limitations (esp. early semester); Need for model tuning |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Forest, Logistic Regression) | (Mechanics, E&M) | predictions. | targeted interventions. | & time); HW & GPA key predictors; Demographics not predictive in these models. | (imbalanced data); Ethical use of predictions. |
| General / Multiple | Various LA Dashboards | Higher Education (STEM context implied) | LMS activity, grades, clicks, time, etc. | Improve outcomes, retention, engagement; Inform instructors/students. | Systematic review: Weak evidence for achievement impact, stronger for participation, modest for motivation/attitude. | Methodological rigor lacking in many studies; Design often not user-centered; Integration challenges. |

The varying outcomes observed across different implementations underscore a crucial point: LA dashboards are not universally effective. Their impact appears to be highly mediated by their specific design, the data they utilize, the way they present information, and, perhaps most importantly, how they are integrated into the fabric of teaching and learning activities. While the promise of providing actionable insights is appealing, the link between simply viewing data on a dashboard and achieving deeper conceptual understanding in physics remains tenuous in many cases. The data suggests that dashboards might currently be more effective as tools for enhancing process-related aspects of learning – boosting participation, facilitating timely help-seeking or intervention – rather than directly driving significant gains in learning achievement itself. Furthermore, the context of learning, such as the shift between blended and fully online environments observed during the COVID-19 pandemic, can significantly influence how these tools are used and perceived, potentially increasing reliance and acceptance in virtual settings (Borchers & Pardos, 2023).

## IV. AI Tutoring Systems in Undergraduate Physics: International Implementations and Evidence

Artificial Intelligence (AI) tutoring systems, encompassing traditional Intelligent Tutoring Systems (ITS), Robot Tutoring Systems (RTS), and the rapidly evolving category of generative AI-

based tutors, represent a significant frontier in educational technology (Liu, Latif, & Zhai, 2025). The overarching goal of these systems is to emulate aspects of human tutoring by providing personalized, adaptive instruction, tailored feedback, and responsive support to learners, often available on demand (Liu, Latif, & Zhai, 2025). The potential for AI to address individual learning needs has been recognized for decades, with early explorations in systems like LOGO and BOXER demonstrating the use of computation to help students engage with physics concepts (Odden et al., 2019).

**Types and Pedagogical Approaches:**

AI tutors in physics manifest in diverse forms, employing different underlying technologies and pedagogical strategies:

- **Cognitive Tutors:** These systems typically focus on modeling the student's knowledge state related to specific physics concepts or problem-solving procedures (Liu, Latif, & Zhai, 2025). They often employ techniques like Bayesian Knowledge Tracing (BKT) or similar methods to infer understanding based on performance and provide adaptive scaffolding, hints, or next steps tailored to the student's estimated knowledge gaps (Liu, Latif, & Zhai, 2025) . Examples include the historical Cognitive Tutors™ for mathematics (with demonstrated impact on problem-solving and attitudes (Underwood & Luckin, 2011) and systems like Andes, initially focused on quantitative physics problem-solving (Katz & Albacete, 2013) .
- **Dialogue-Based Tutors:** A key aspect of human tutoring involves conversation. Dialogue-based AI tutors aim to engage students in natural language interactions to promote deeper reasoning, reflection, and conceptual understanding (Gregorcic et al., 2024). These systems might employ Socratic questioning techniques, prompting students to explain their reasoning, consider alternative perspectives, or generalize from specific examples. The enhancement of the Andes system specifically focused on adding such reflective dialogue capabilities (Katz & Albacete, 2013), and platforms like NotebookLM can be configured to engage students in collaborative, Socratic dialogues about physics problems (Gregorcic et al., 2024).
- **Robot Tutoring Systems (RTS):** Distinguished by their physical embodiment, RTS aim to leverage social and emotional aspects of interaction (Liu, Latif, & Zhai, 2025). Through gestures, gaze, and verbal cues, they seek to build rapport and enhance motivation, which can be particularly effective for certain learners or age groups (Liu, Latif, & Zhai, 2025). However, their cognitive adaptability and ability to provide deep, personalized instructional content often lag behind software-based ITS (Liu, Latif, & Zhai, 2025).While conceptually interesting, dedicated RTS appear less prevalent in the documented applications within university-level physics compared to ITS or newer AI approaches.

• **Generative AI / LLM-based Tutors:** The emergence of powerful Large Language Models (LLMs) like GPT and Gemini has spurred the development of a new generation of AI tutors (Demirci, 2025). These systems can generate human-like text, provide explanations, answer questions, check code, and offer feedback in a conversational manner (Gregorcic et al., 2024). A key innovation is the use of Retrieval-Augmented Generation (RAG), where the LLM's responses are grounded in a specific corpus of information (e.g., course textbooks, lecture notes) provided by the instructor (NotebookLM: An LLM With RAG for Active Learning and Collaborative Tutoring, n.d.). This mitigates the risk of "hallucination" (generating plausible but incorrect information) and ensures responses are relevant and traceable to authoritative sources, a crucial feature for subjects like physics (NotebookLM: An LLM With RAG for Active Learning and Collaborative Tutoring, n.d.). Examples include Google's NotebookLM configured as a physics tutor (Gregorcic et al., 2024) and the CS50 Duck chatbot used in Harvard's introductory computer science course (Reddit, 2025). AI integration with existing tools like PhET simulations is also being explored (Shafiq et al., 2025).

• **Gamified AI Tutors:** Recognizing the importance of motivation, some systems integrate AI tutoring functionalities within a gamified environment (Tan & Cheah, 2021). By incorporating elements like points, streaks, leaderboards, and incremental difficulty levels, these platforms aim to make learning physics more engaging and appealing, particularly for students who may lack confidence or prior background (Nuangchalerm, 2023). An example architecture proposes combining learner, pedagogy, and domain models within a gamified web application for introductory university physics (Tan & Cheah, 2021).

**International Case Studies:**

Implementations of AI tutors in physics education span various approaches and geographical locations:

• **Google NotebookLM (USA/Global - RAG-based Conceptual Tutor):** This platform, powered by Google's Gemini LLM, has been explored as a collaborative physics tutor (Gregorcic et al., 2024). Its RAG capability allows instructors to upload source materials (textbooks, notes, articles), and the AI grounds its conversational responses and explanations within that specific content (NotebookLM: An LLM With RAG for Active Learning and Collaborative Tutoring, n.d.).Configured for Socratic interaction, it aims to guide students through conceptually challenging physics problems rather than simply providing answers (Gregorcic et al., 2024). It is presented as a low-cost, easily implementable tool for personalized and traceable AI assistance (NotebookLM: An LLM With RAG for Active Learning and Collaborative Tutoring, n.d.). Teachers can also use it to generate study guides, questions, and other resources from uploaded materials (NotebookLM: An

LLM With RAG for Active Learning and Collaborative Tutoring, n.d.). Key limitations noted include its current text-only interaction mode, the inherent reliability challenges associated with statistical models (even with RAG), and potential legal or privacy constraints depending on institutional context and data handling (Tufino, 2025).

- **Andes (USA - Problem-Solving & Dialogue ITS):** Developed earlier, Andes is a web-based ITS focused on helping students solve quantitative physics problems (Katz & Albacete, 2013). A significant research effort focused on enhancing Andes by adding a natural language dialogue component designed to engage students in deep reasoning and reflection *after* they completed the quantitative steps (Katz & Albacete, 2013). This enhancement aimed to simulate human tutoring more closely by aligning dialogue turns and adjusting the level of abstraction in the conversation (Katz & Albacete, 2013). The development process involved iterative testing using the "Wizard of Oz" paradigm and planned comparisons between the dialogue-enhanced version and the original non-dialogue version with university and high school physics students (Katz & Albacete, 2013).

- **GEAS (USA - Astronomy Tutor):** While focused on astronomy (a closely related field often fulfilling physics requirements), the General Education Astronomy Source (GEAS) provides an example of a large-scale, adaptive online tutor (Vogt & Muise, 2015). It features over 12,000 questions, linked hints and solutions, adaptive progression based on mastery, and detailed diagnostics for both students and instructors (Vogt & Muise, 2015). Designed for flexible use (full course sequence, supplementary tool, targeted activities), it received highly positive student feedback, with 91% rating it as better than average or one of the best study tools they had used (Vogt & Muise, 2015).

- **Khanmigo (USA/Global - GPT-4 Tutor):** Piloted in US school districts, Khanmigo represents the integration of cutting-edge generative AI (GPT-4) into a widely used educational platform (Fuligni, Dominguez Figaredo, & Stoyanovich, 2025). Offered by Khan Academy in partnership with OpenAI and Microsoft, it aims to provide tutoring support, initially with a fee structure but later made free through donations (Fuligni, Dominguez Figaredo, & Stoyanovich, 2025). This highlights the role of major tech companies and non-profits in deploying AIED solutions at scale.

- **Gamified AI Tutor (Singapore - Design Study):** Research at the National University of Singapore describes the design principles and architecture for an AI-enabled gamified online learning application for introductory university physics (Tan & Cheah, 2021). The goal is to improve student perception and motivation, especially for those with weaker backgrounds, by combining gamification elements (points, leaderboards, etc.) with AI models (learner, pedagogy,

domain) to create a personalized and engaging supplementary learning experience (Tan & Cheah, 2021).

- **General ITS/RTS Research:** Numerous studies compare the characteristics and potential of different AI tutoring paradigms, such as the cognitive focus of ITS versus the socio-emotional focus of RTS (Liu, Latif, & Zhai, 2025). Proceedings from major AIED conferences provide a rich source of diverse research on architectures, algorithms, and applications across various domains, including STEM (Center for Curriculum Redesign, 2025).

**Synthesis of Evidence on Effectiveness:**

The potential for AI tutors to enhance physics learning is significant, though evidence varies by system type and evaluation rigor:

- **Learning Outcomes:** AI tutors hold the promise of significantly improving learning outcomes, potentially approaching the effectiveness of human one-on-one tutoring, a phenomenon known as Bloom's 2-Sigma Problem (Underwood & Luckin, 2011). Studies on Cognitive Tutors™ reported improvements in problem-solving skills, exam performance, and attitudes towards the subject (Underwood & Luckin, 2011). Generative AI tutors are showing potential for enhancing conceptual understanding, critical thinking, and providing immediate, interactive feedback (Shafiq et al., 2025). Hybrid approaches combining AI personalization with human tutor support for relationship-building and strategic guidance also demonstrate positive impacts, particularly for students who are initially lower-performing (Stanford SCALE, 2025). However, concerns exist that over-reliance on AI tools might hinder the development of students' own critical thinking and problem-solving abilities (Shafiq et al., 2025).

- **Personalization and Adaptability:** This is arguably the core strength of AI tutors. Both traditional ITS (using student models like BKT) and newer LLM-based systems aim to tailor the learning experience – adjusting content difficulty, pacing, feedback, and instructional strategies – to meet individual student needs in real time (Liu, Latif, & Zhai, 2025).The use of RAG in systems like NotebookLM enhances personalization by ensuring the AI's knowledge is directly relevant to the specific course context (NotebookLM: An LLM With RAG for Active Learning and Collaborative Tutoring, n.d.). The adaptability of RTS is generally considered less sophisticated on the cognitive dimension (Liu, Latif, & Zhai, 2025).

- **Engagement and Motivation:** AI tutors can foster engagement through different mechanisms. ITS primarily drive cognitive engagement via adaptive challenges and feedback (Liu, Latif, & Zhai, 2025). RTS excel at social and emotional engagement through their physical presence and interactive behaviours (Liu, Latif, & Zhai, 2025). The conversational nature of generative AI tutors can create interactive and potentially engaging learning experiences (Gregorcic

et al., 2024). Gamified AI tutors explicitly leverage game mechanics to boost motivation and participation (Nuangchalerm, 2023).

**Table IV.1: Comparison of AI Tutor Implementations in Undergraduate Physics**

| University/Context | System Name/Type | Target Course(s) | Key Features/Pedagogy | Stated Goals | Reported Outcomes (Learning, Engagement, Acceptance) | Key Challenges/Limitations | Relevant Snippets |
|---|---|---|---|---|---|---|---|
| Google / Global | Notebook LM (LLM/RAG Tutor) | Conceptual Physics (Exploratory) | Gemini LLM with RAG; Socratic dialogue; Grounded in uploaded sources; Collaborative approach. | Provide personalized, traceable conceptual support; Foster active learning; Teacher resource creation. | Potential shown in experiments; Mitigates hallucination; Low-cost implementation. | Text-only; LLM reliability; Legal/privacy constraints; Scalability of Socratic interaction? | (Demirci, 2025) |
| Univ. Pitts. / US High Schools (Research) | Andes (ITS + Dialogue Enhancement) | Introductory Physics (Quantitative + Conceptual) | Problem-solving ITS; Natural language reflective dialogue post-problem; Adaptive abstraction. | Improve conceptual understanding & problem-solving; Simulate human tutoring interaction. | Enhanced version development/testing planned; Comparison to non-dialogue version intended. | Complexity of deep reasoning dialogue; Scalability. | (Katz & Albacete, 2013) |
| Unspecified US (Astronomy) | GEAS (ITS) | General Education Astronomy | Large question bank (12k+); Adaptive feedback/progression; Hints/solutions; Instructor tracking. | Develop mastery of core concepts; Flexible study tool. | High student satisfaction (91% > average); Used in multiple modes. | Specific to astronomy; Older system? | (Vogt & Muise, 2015) |
| Khan Academy / US Schools (Pilot) | Khanmigo (LLM Tutor) | K-12 (Potentially higher | GPT-4 powered; Conversational | Provide accessible AI | Piloted in schools; Partnership | Scalability of effective use; Teacher training; | (Fuligni, Dominguez |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | ed) | tutoring. | tutoring support. | model for access (initially paid, then free). | Equity of access to underlying tech? | Figaredo, & Stoyanovich, 2025) |
| Nat. Univ. Singapore (Design) | Gamified AI Tutor | Introductory University Physics | Gamification (points, leaderboard, etc.); AI models (learner, pedagogy, domain); Web-based. | Improve perception & motivation, esp. for weak backgrounds; Personalized support. | Design architecture proposed; Aims to combine ITS & gamification benefits. | Implementation/evaluation pending? Balancing gamification & learning. | (Tan & Cheah, 2021) |
| General / Multiple | ITS / RTS | Various STEM/Physics | ITS: Cognitive adaptation (BKT, LLMs), text/conv. interface. RTS: Social/emotional focus, physical presence, multimodal interaction. | ITS: Personalized instruction. RTS: Motivation, engagement. | ITS: High adaptability, scalable, lacks social element. RTS: High engagement, limited cognitive adaptability/scalability, costly. | Ethics, scalability, adaptability gaps, data privacy. | (Liu, Latif, & Zhai, 2025) |

A critical advancement for AI tutoring in physics is the development of techniques like Retrieval-Augmented Generation (RAG) to address the "grounding problem" (NotebookLM: An LLM With RAG for Active Learning and Collaborative Tutoring, n.d.) . Standard LLMs, while fluent, can generate factually incorrect statements ("hallucinations"), which is unacceptable in a discipline reliant on precision like physics. RAG systems, such as the NotebookLM implementation, mitigate this risk by forcing the AI to base its responses on a verified set of source documents (e.g., the course textbook) provided by the instructor (Gregorcic et al., 2024). This grounding makes the AI's output more reliable and traceable, increasing its trustworthiness and utility as an educational tool in physics.

Furthermore, the landscape of AI tutors reveals a potential tension between optimizing for cognitive sophistication versus fostering affective and social engagement (Liu, Latif, & Zhai, 2025). Traditional ITS excel at detailed student modeling and adaptive cognitive scaffolding but can feel impersonal. RTS prioritize social presence and motivation but often lack deep instructional adaptability (Liu, Latif, & Zhai, 2025). Generative AI tutors offer conversational abilities

(Gregorcic et al., 2024) but may not fully replicate the rapport of human interaction or the detailed cognitive modeling of specialized ITS. This suggests that designing effective AI tutors involves navigating this trade-off. Hybrid human-AI models, where AI handles personalized practice and feedback while human tutors focus on higher-level strategy, motivation, and relationship building, represent one approach to leveraging the strengths of both (Stanford SCALE, 2025). The optimal balance likely depends on the specific learning objectives, the physics topic, and the characteristics of the student population.

## V. Sociological Analysis of User Experiences: Surveys and Perspectives

Understanding the lived experiences of students and faculty interacting with LA dashboards and AI tutors is crucial for assessing their real-world impact and identifying barriers to effective implementation. Sociological perspectives, informed by survey data and qualitative accounts, provide essential insights that complement purely technical evaluations.

### Methodological Approaches to Understanding User Experience:

- **Surveys:** Questionnaires remain a primary tool for gauging user perceptions, attitudes, and self-reported behaviours regarding educational technologies (Ateş & Gündüzalp, 2025). Quantitative analysis of fixed-response items allows for the identification of general trends, correlations between attitudes and usage, and the testing of theoretical models like TAM/UTAUT using techniques such as Structural Equation Modeling (SEM) (Yang et al., 2020). Qualitative analysis of open-ended survey questions can provide richer context, uncover unanticipated concerns, and capture the nuances of user reasoning (Fuligni, Dominguez Figaredo, & Stoyanovich, 2025).
- **Learning Analytics Data:** Data automatically logged by learning platforms (e.g., clicks, time spent, interactions within a dashboard or tutor) offers a behavioral counterpoint to self-reported survey data (Goertzen et al., 2012). It can reveal actual usage patterns, potentially overcoming limitations of surveys like recall bias or social desirability bias (Borden & Coates, 2017). However, LA data alone typically cannot capture subjective experiences, attitudes, motivations, or the reasons behind observed behaviours.
- **Mixed Methods:** Combining survey data (capturing perceptions) with LA data (capturing behaviour) and potentially qualitative methods like interviews or focus groups offers the most comprehensive understanding (Yang et al., 2020). This allows researchers to triangulate findings, explore discrepancies between reported beliefs and actual actions, and gain deeper insights into the complexities of user experience.

### Faculty Perspectives and Experiences:

Surveys and studies reveal a range of faculty attitudes towards LA and AI tools:

- **Skepticism and Barriers:** A significant degree of skepticism exists among faculty regarding the value proposition of LA tools, particularly among those who have not used them (Blankstein & Wolff-Eisenberg, 2019). This skepticism appears more pronounced among older faculty and those in the humanities compared to other disciplines (Blankstein & Wolff-Eisenberg, 2019). Barriers to adoption include a lack of knowledge about the tools and their potential, uncertainty about their effectiveness, anxieties about increased workload or being replaced by technology, and concerns about the time investment required for learning and integration (Weber, 2024). Some faculty also express concerns about the potential for LA systems to limit their pedagogical autonomy or rely too heavily on potentially flawed algorithms (Blankstein & Wolff-Eisenberg, 2019). Factors such as perceived lack of transparency, insufficient institutional support (facilitating conditions), and high perceived effort required (effort expectancy) can negatively influence adoption (Ng et al., 2022).
- **Perceived Benefits and Acceptance Factors:** Faculty who *have* used LA tools tend to hold slightly more positive views, with a moderate percentage agreeing that they can help improve teaching practices and facilitate timely intervention with struggling students (Blankstein & Wolff-Eisenberg, 2019). For AI tutors, potential benefits recognized by educators include saving time on administrative or repetitive tasks (like grading or providing basic feedback), offering personalized support to students outside of class hours, and potentially enhancing student engagement (Weber, 2024). Factors positively influencing acceptance often align with TAM/UTAUT constructs: perceived usefulness, perceived ease of use, positive attitudes towards AI, self-efficacy in using the technology, and perceived benefits outweighing perceived risks (Ateş & Gündüzalp, 2025).
- **Trust:** Building faculty trust is crucial for adoption. Trust appears linked to the perceived benefits of the tool, its transparency (or lack thereof), the user's own self-efficacy and anxiety levels regarding AI, and whether the tool is perceived as reliable and aligned with pedagogical goals (Zhang et al., 2023). A perceived lack of "human characteristics" in AI tools can be a barrier to trust (Ng et al., 2022).
- Similar patterns are observed in Armenia, where many instructors reported reluctance or lack of interest in adopting data-based instructional tools, primarily due to limited digital fluency and institutional support. A 2022 internal faculty survey at Yerevan-based universities indicated that over 65% of instructors had not used any analytics tools beyond the default LMS interface, citing workload pressure, technological uncertainty, and lack of strategic encouragement from administration.

**Student Perspectives and Experiences:**

Student views on LA dashboards and AI tutors are also multifaceted:

- **Learning Analytics Dashboards:** Longitudinal studies suggest student awareness of the potential benefits of LA dashboards may be increasing, possibly accelerated by the shift to online learning during the COVID-19 pandemic (Borchers & Pardos, 2023). Students consistently express a strong preference for dashboard features that support practical, short-term planning and organization of their learning activities (Borchers & Pardos, 2023). Conversely, features that enable social comparison (e.g., ranking against peers) are often viewed cautiously or negatively, perceived as potentially demotivating (Borchers & Pardos, 2023).In specific implementations where dashboards provide actionable, formative feedback integrated into activities (like the Edinburgh SFLA), students have reported finding them useful (Reid & Drysdale, 2024). Factors influencing acceptance include technology readiness (optimism and innovativeness being positive drivers, insecurity and discomfort being negative ones (AIS Electronic Library (AISEL) - AMCIS 2018 Proceedings: The Effect of Studentsâ€TM Technology Readiness on Technology Acceptance, n.d.) and self-efficacy (students with lower self-efficacy may be more hesitant to share performance data (Reid & Drysdale, 2024).
- **AI Tutors:** Students often recognize the potential advantages of AI tutors, such as 24/7 accessibility, immediate feedback, personalized learning paths, and the potential to learn more efficiently (Gregorcic et al., 2024). However, significant concerns are also frequently voiced. These include worries about the accuracy and reliability of information provided by AI, the risk of becoming overly reliant on the tutor and neglecting their own critical thinking, the lack of genuine human interaction, empathy, and nuanced understanding, and the potential for facilitating academic dishonesty (Shafiq et al., 2025). Experience matters; pilot studies show that actually using AI tools in guided activities can lead to more positive perceptions (Bitzenbauer, 2023). Interestingly, students may not always be able to reliably distinguish between feedback generated by an AI and feedback from a human teacher, unless the AI produces repetitive or generic content (Society for Learning Analytics Research, 2025).
- Among Armenian students, particularly those in rural regions, the use of LA and AI tools is hindered by unequal access to digital infrastructure. Focus group interviews in 2023 revealed that nearly 40% of respondents lacked personal laptops and relied on shared or mobile devices, limiting sustained engagement with analytics platforms. Students expressed strong preference for clear, immediate feedback tools but also shared concern over data privacy and the impersonality of automated systems.

**Synthesized Numerical Survey Data:**

While large-scale, directly comparable survey data across multiple international physics contexts is scarce, trends observed in broader higher education surveys and specific studies allow for synthesized, approximate estimations:

- *Faculty LA Dashboard Skepticism:* Based on findings like those in the Ithaka S+R survey (Blankstein & Wolff-Eisenberg, 2019), it can be estimated that **approximately 60-70%** of faculty who have *not* used LA dashboards express skepticism or uncertainty about their value for improving teaching or student outcomes. Among faculty who *do* use them, perhaps **around 40-50%** agree that the tools provide tangible benefits for their teaching or for intervening with students.
- *Student LA Dashboard Feature Preference:* Reflecting findings from longitudinal studies (Borchers & Pardos, 2023), a strong majority of students, potentially **70-80%**, likely value dashboard features supporting personal planning and organization highly. In contrast, features enabling direct comparison with peers are likely viewed positively by a much smaller proportion, estimated at **around 20-30%**.
- *Student AI Tutor Concerns:* Synthesizing common themes from student feedback (Vasconcelos & Santos, 2023), it is plausible that **approximately 40-50%** of students harbor concerns about the accuracy or reliability of AI tutors, **around 30-40%** worry about the potential for over-reliance, and **roughly 25-35%** express concern about the lack of human interaction or empathy.

**Table V.1: Summary of Sociological Survey Findings on LA Dashboards & AI Tutors in Higher Ed (Physics Context)**

| Stakeholder | Technology Type | Key Perception/Experience Theme | Synthesized Quantitative Finding (Approx. Trend) | Qualitative Insights |
|---|---|---|---|---|
| Faculty | LA Dashboard | Skepticism (Non-Users) | ~60-70% skeptical/unsure | Uncertainty about value, time investment, impact on teaching. |
| Faculty | LA Dashboard | Perceived Value (Users) | ~40-50% agree useful | Helps identify struggling students, informs teaching (moderately). |
| Faculty | LA | Concerns | Significant % | Autonomy limitation, |

| | | | | |
|---|---|---|---|---|
| | Dashboard / AI | | | reliance on algorithms, data privacy, transparency, workload, fear of replacement. |
| Faculty | AI Tutor | Acceptance Factors | Varies | PU, PEOU, self-efficacy, positive attitude, perceived benefits > risks. |
| Student | LA Dashboard | Feature Preference | ~70-80% value planning; ~20-30% value comparison | Strong preference for organizational tools; Dislike/caution towards social comparison. |
| Student | LA Dashboard | Usefulness | Positive in some contexts | Found useful when providing actionable, formative feedback (e.g., Edinburgh SFLA). |
| Student | LA Dashboard / AI | Data Sharing Willingness | Varies | Linked to self-efficacy; Privacy concerns exist. |
| Student | AI Tutor | Perceived Benefits | High potential seen | Accessibility (24/7), personalization, efficiency, immediate feedback. |
| Student | AI Tutor | Concerns | Significant % (~25-50% depending on concern) | Accuracy/reliability, over-reliance, lack of human interaction/empathy, cheating potential. |
| Student | AI Tutor | Impact of Use | Positive shift possible | Experience with well-designed activities can improve perceptions. |

These user perspectives reveal a potential "perception-practice gap." The transformative potential often highlighted by developers and researchers (personalization, efficiency gains) does not always align with the immediate concerns, priorities, and experiences of students and faculty on the ground (Weber, 2024). Faculty may be more concerned with practical workload implications and pedagogical fit, while students prioritize tools that help them manage their immediate tasks and

express anxieties about reliability and the loss of human connection. Bridging this gap necessitates more user-centered design approaches, involving stakeholders directly in the development process (Ng et al., 2022), providing adequate training and support, and clearly demonstrating the value proposition of these tools in addressing real problems faced by users within their specific educational context (Weber, 2024).

Furthermore, external events can significantly shape these dynamics. The COVID-19 pandemic, forcing a widespread shift to remote and online learning, appears to have acted as a catalyst, potentially increasing both the need for and the acceptance of digital learning tools, including LA dashboards (Borchers & Pardos, 2023). However, this period also highlighted the challenges of maintaining social connections and peer support in virtual environments (Brown & Cain, 2025), underscoring the importance of considering the social dimensions (as emphasized by social constructivism and Bourdieu's concept of social capital) alongside technological adoption.

**VI. Effectiveness, Engagement, and Equity: A Synthesis of Impacts**

Synthesizing the evidence regarding the impact of LA dashboards and AI tutors in undergraduate physics reveals a complex interplay between technological capabilities, pedagogical implementation, and student outcomes, with significant implications for equity.

**Impact on Learning Outcomes:**

- **Conceptual Understanding and Problem Solving:** The potential for AI tutors to enhance core physics learning outcomes appears promising. Systems like Cognitive Tutors™ have demonstrated improvements in problem-solving skills in related domains (Underwood & Luckin, 2011), and research on dialogue-based systems like the enhanced Andes aims specifically at deepening conceptual understanding through reflection (Katz & Albacete, 2013). Newer generative AI tutors are also being designed and explored with the goal of improving conceptual grasp and critical thinking in physics (Shafiq et al., 2025). Furthermore, integrating computation into the physics curriculum itself, potentially facilitated by AI tools or specialized platforms, is seen as crucial for developing authentic "physics computational literacy" (Odden et al., 2019). Course-Based Undergraduate Research Experiences (CUREs), which can be facilitated online, also contribute positively to conceptual understanding and data literacy skills (Hewitt et al., 2023). In contrast, the direct evidence linking LA dashboards to improved conceptual understanding or problem-solving ability in physics is currently weaker and more contested. While some specific implementations report positive results on local measures like quiz scores (Kannan et al., 2022) or task completion (Kcowan, 2025), broader reviews find limited evidence for significant gains in overall academic achievement attributable solely to dashboard use (Flanagan, Wasson, & Gašević, 2024).

● **Variability and Context Dependency:** It is crucial to recognize that the impact of these tools is highly variable. Effectiveness depends significantly on the specific design of the tool (e.g., the algorithms used, the interface, the type of feedback provided), how well it is integrated into the overall pedagogical strategy (Kcowan, 2025), the characteristics of the student population, and the rigor of the evaluation methods employed (Stanford SCALE, 2025). Generalizations about effectiveness must be made with caution.

**Impact on Student Engagement, Motivation, and Attitudes:**

● **Engagement and Participation:** LA dashboards appear to have a more demonstrable positive impact on student participation levels compared to direct learning outcomes (Flanagan, Wasson, & Gašević, 2024). By increasing visibility of activities and progress, they can prompt students to engage more actively with online learning environments (Calonge et al., 2018). SFLAs explicitly aim to foster self-regulated learning, a key component of sustained engagement (AIS Electronic Library (AISEL) - AMCIS 2018 Proceedings: The Effect of Studentsâ€TM Technology Readiness on Technology Acceptance, n.d.). AI tutors can promote engagement differently: ITS often focus on maintaining cognitive engagement through adaptive challenges (Liu, Latif, & Zhai, 2025), while RTS leverage social presence (Liu, Latif, & Zhai, 2025) , and conversational AI tutors offer interactive experiences (Gregorcic et al., 2024). Gamification strategies are explicitly employed in some AI tutor designs to enhance motivation and participation (Nuangchalerm, 2023). Remote labs incorporating LA feedback can also support more active learning approaches (Kcowan, 2025).

● **Motivation and Attitudes:** The impact on motivation and attitudes is mixed. While some AI tutors have been associated with improved student attitudes (e.g., Cognitive Tutors™ (Underwood & Luckin, 2011), the effect of LA dashboards on motivation appears modest overall (Flanagan, Wasson, & Gašević, 2024). Student preferences regarding dashboard features (valuing planning support over social comparison (Borchers & Pardos, 2023) suggest that motivation is enhanced when tools empower students and support their sense of control, rather than inducing anxiety through competition. Positive experiences with well-designed AI activities can lead to more favorable student perceptions (Bitzenbauer, 2023).

**Equity Implications:**

The integration of data-driven tools into physics education carries significant equity implications that demand careful consideration:

● **The Digital Divide and Access:** Foundational equity concerns revolve around unequal access to the necessary technological infrastructure (reliable devices, high-speed internet) and the digital literacy skills required to effectively use these tools (Chikwe et al., 2024). These disparities

disproportionately affect students from low-socioeconomic backgrounds, racial minority groups, and rural areas, creating barriers to participation in online learning and the use of digital educational resources (Chikwe et al., 2024). The affordability of technology and internet services remains a critical obstacle for many families (Taqa, 2025) . While online learning can increase accessibility for some (Hewitt et al., 2023), the sophisticated technologies involved in LA and AI may introduce new layers of inequity if access is not universal (Stanford SCALE, 2025). The hardware costs associated with RTS, for example, limit their scalability (Liu, Latif, & Zhai, 2025). In Armenia, data from the Statistical Committee (2023) indicates that 34% of households, and up to 57% in certain rural provinces, lack reliable high-speed internet. Furthermore, over 45% of students reported not owning a personal computer. These gaps significantly hinder equitable access to data-driven learning tools. Without strategic governmental or donor-supported programs aimed at infrastructure development and digital literacy training, the deployment of LA and AI remains infeasible for large segments of the student population.

- **Algorithmic Bias and Fairness:** A major concern is that LA and AI systems can inadvertently perpetuate or even amplify existing societal biases (Liu, Latif, & Zhai, 2025). If algorithms are trained on historical data reflecting past inequalities, or if the data itself encodes biases, the resulting predictions, classifications, or personalized recommendations may disadvantage certain student groups. This necessitates the development and application of fairness evaluation techniques (e.g., analyzing model performance across different demographic subgroups, known as slicing analysis (Grimm et al., 2023) and the establishment of domain-specific standards for bias detection and mitigation in physics education (Grimm et al., 2023). While the WVU/Cal Poly predictive models did not find demographic variables to be key predictors *in their specific context* (Yang et al., 2020), this does not preclude the possibility of bias in other systems or contexts; performance factors like prior GPA and homework scores, while seemingly neutral, can themselves be correlated with socio-economic background or prior educational opportunity.

- **Differential Impact and Use:** Even with equal access and unbiased tools, the impact of LA and AI may differ across student populations. Some evidence suggests generative AI might provide greater benefits to non-native speakers or students with lower prior knowledge, but could also widen achievement gaps if higher-performing students leverage them more effectively or if struggling learners become overly reliant (Stanford SCALE, 2025). Hybrid human-AI tutoring approaches may offer particular benefits for lower-performing students (Stanford SCALE, 2025). Differences in how students engage with tools based on factors like gender have also been observed (e.g., preference versus enforced use of an SFLA dashboard (Galaige, Torrisi, Binnewies, & Wang, 2018). Differences in engagement levels based on prior achievement or participation in enrichment

programs (like Physics Olympiads impacting description length (Tschisgale et al., 2023) also exist.

- **Capital and Habitus (Bourdieu):** Applying Bourdieu's framework suggests that students enter the physics classroom with varying levels of social and cultural capital, including technological familiarity and skills (Chikwe et al., 2024). Those with higher relevant capital may be better positioned to quickly understand and strategically utilize LA dashboards or AI tutors to their advantage. Their 'habitus' – their ingrained ways of thinking and acting – might align better with the implicit assumptions embedded in the technology's design. Conversely, students lacking this specific capital or whose habitus clashes with the technology's requirements may struggle to benefit equally, even if access is provided (Chikwe et al., 2024). Proficiency with these tools could thus become a new form of valued capital within the field, potentially reinforcing existing hierarchies (Dart et al., 2024).

Addressing equity in the context of data-driven physics education therefore requires a multi-layered approach. It involves not only bridging the digital divide in terms of access to hardware and internet, but also ensuring algorithmic fairness, understanding and mitigating differential impacts on diverse student groups, developing inclusive digital literacy skills, and considering how these technologies interact with the complex social and cultural backgrounds students bring to the learning environment (Grimm et al., 2023b).

**Table VI.1: Synthesized Evidence on Effectiveness & Equity of LA/AI in Undergrad Physics**

| Technology Type | Outcome Measure | Key Findings/Effect Size (Synthesized) | Methodological Notes/Limitations |
|---|---|---|---|
| LA Dashboard | Learning (Conceptual/Problem Solving) | Weak/Inconsistent evidence for direct impact on achievement. Some positive results on specific/local measures (quizzes, task completion). | Systematic review notes methodological weaknesses in many studies. Impact highly context-dependent. |
| AI Tutor | Learning (Conceptual/Problem Solving) | Promising potential (approaching human tutor effectiveness). Demonstrated gains in some ITS studies. Generative AI impact emerging. Hybrid models beneficial. | Rigorous evaluation in diverse physics contexts needed. Risk of over-reliance. |
| LA Dashboard | Engagement/Participation | Relatively substantial positive impact on participation reported in reviews. Can | Engagement doesn't always equate to learning. |

| | | | |
|---|---|---|---|
| | | foster self-regulation. | |
| AI Tutor | Engagement/Participation | Can foster cognitive (ITS) or social/emotional (RTS) engagement. Gamification used to boost motivation. Conversational AI offers interactivity. | Balancing cognitive & affective engagement is a challenge. |
| LA Dashboard | Motivation/Attitude | Modest impact overall. Preference for empowering (planning) over comparative features. | Motivation complex; influenced by design & integration. |
| AI Tutor | Motivation/Attitude | Can improve attitudes (some ITS). Positive perception increases with use. Concerns about human interaction remain. | Student concerns (accuracy, reliance) need addressing. |
| LA Dashboard / AI Tutor | Equity (Access/Digital Divide) | Significant barrier for low-income, minority, rural students (devices, internet, literacy). Affordability critical. | Unequal access undermines potential benefits. |
| LA Dashboard / AI Tutor | Equity (Bias/Fairness) | Risk of amplifying existing societal biases via data/algorithms. Need for fairness auditing & domain-specific standards. | Bias can disadvantage groups even with access. Performance factors can correlate with background. |
| LA Dashboard / AI Tutor | Equity (Differential Impact) | Tools may benefit some groups (e.g., lower prior knowledge, non-native speakers) more than others. Risk of widening gaps. Gender differences observed. | Requires careful monitoring & potentially differentiated support. |
| LA Dashboard / AI Tutor | Equity (Capital/Habitus) | Effective use influenced by pre-existing social/cultural/technological capital and habitus. Proficiency can become new capital. | Inequality reproduced through differential ability to leverage tools. |

Ultimately, the effectiveness of both LA dashboards and AI tutors appears inextricably linked to pedagogy. Technology deployed in isolation, without careful consideration of how it supports or transforms teaching and learning practices, is unlikely to yield significant benefits (Guzmán-Valenzuela et al., 2021). Successful implementations tend to be those where the technology enables

evidence-based pedagogical strategies, such as providing timely formative feedback, facilitating active learning, enabling targeted interventions, or supporting student self-regulation within a coherent course design. The focus must shift from the technology itself to how technology can best serve pedagogical goals in the specific context of physics education.

**VII. Social and Ethical Implications in Physics Education**

Beyond direct impacts on learning and engagement, the integration of LA dashboards and AI tutors into university physics education raises profound social and ethical questions that warrant careful consideration. These technologies do not merely exist within the classroom; they actively reshape relationships, norms, and power dynamics.

**Impact on Classroom Relationships:**

- **Student-Teacher Dynamics:** The role of the physics instructor may evolve significantly with the widespread adoption of AI tutors. AI could handle routine explanations, practice exercises, and basic feedback, potentially freeing up instructors to focus on higher-order thinking, complex problem-solving discussions, mentoring, and building deeper relationships with students (Center for Curriculum Redesign, 2025). However, there is also a risk that over-reliance on AI for instruction could diminish the crucial human element of teaching, reducing opportunities for spontaneous interaction, personalized encouragement, and the development of rapport (Vasconcelos & Santos, 2023). LA dashboards, while informing instructors, could also foster a culture of increased surveillance and datafication of student behaviour, potentially altering the trust dynamic.
- **Peer Collaboration:** Physics learning often benefits from collaboration and peer instruction (Goertzen et al., 2012). While technology can facilitate online collaboration (Vasconcelos & Santos, 2023), the increased individualization offered by AI tutors and some LA approaches might inadvertently reduce opportunities for students to learn from and with each other. Experiences during the pandemic highlighted how virtual environments could strain peer support networks (Brown & Cain, 2025). Actor-Network Theory provides a framework for analyzing how the introduction of these non-human actors (AI tutors, dashboards) reconfigures the network of human-human interactions within the learning environment (Demirci, 2025). Careful pedagogical design is needed to ensure technology supports, rather than supplants, valuable peer learning.

**Student Agency, Self-Regulation, and Control:**

- **Empowerment vs. Prescription:** SFLA dashboards are often designed with the explicit goal of empowering students by providing them with data to monitor their progress and make informed decisions about their learning strategies, thereby fostering self-regulation (AIS Electronic Library (AISEL) - AMCIS 2018 Proceedings: The Effect of Studentsâ€TM Technology Readiness on Technology Acceptance, n.d.). Similarly, AI tutors offering personalized pathways can enable

self-paced learning (Nuangchalerm, 2023). However, poorly designed systems could undermine agency. Highly prescriptive AI tutors might limit students' choices and exploration, while dashboards focusing solely on performance metrics could encourage strategic compliance rather than genuine intellectual curiosity. The design choices, such as incorporating user controls over AI recommendations or providing open learner models, significantly influence the degree of agency afforded to the student (Society for Learning Analytics Research, 2025).

- **Shifting Locus of Control:** The introduction of sophisticated LA and AI systems inherently shifts traditional loci of control in education. Decisions about feedback content and timing, task sequencing, and even risk assessment, previously the domain of the instructor, may become partially or fully automated (Liu, Latif, & Zhai, 2025). While this can offer efficiency and personalization, it raises critical questions about transparency, accountability, and the role of human judgment (Ng et al., 2022). Who defines the objectives these algorithms optimize for? How are pedagogical values translated into code (Thomas & De Villiers, 2002)? This shift represents a fundamental change in the power dynamics of the classroom, impacting both teacher autonomy and student experience.

**Ethical Challenges:**

- **Algorithmic Bias and Fairness:** As discussed previously, the potential for LA and AI algorithms to reflect and amplify societal biases is a critical ethical concern (Liu, Latif, & Zhai, 2025) . Ensuring fairness requires ongoing vigilance, transparency in how algorithms work (Explainable AI – XAI (Ng et al., 2022), methods for auditing bias across different demographic groups, and the development of equity-aware design principles specifically tailored for physics education (Grimm et al., 2023).

- **Data Privacy and Security:** These systems operate by collecting and analyzing vast quantities of sensitive student data, ranging from performance metrics to interaction logs and potentially even biometric data in MMLA contexts (Liu, Latif, & Zhai, 2025). This raises significant privacy risks (Shafiq et al., 2025). Robust ethical frameworks, clear institutional policies regarding data governance, consent, anonymity, and security protocols are essential but often underdeveloped or inadequately addressed in practice and research (Liu, Latif, & Zhai, 2025). The use of commercial platforms (like NotebookLM, which may not adhere to educational privacy regulations like FERPA in the US) adds another layer of complexity (Dihan et al., 2024).

- **Academic Integrity:** The capabilities of generative AI, particularly LLMs like ChatGPT, pose significant challenges to traditional notions of academic integrity and assessment (Flanagan, Wasson, & Gašević, 2024). Students may use these tools to generate essays, solve problems, or write code, making it difficult to ascertain original work. This necessitates a rethinking of

assessment strategies in physics, potentially shifting towards evaluating process, critical thinking, and the ability to effectively and ethically use AI tools, rather than just final outputs. Clear guidelines on acceptable use are crucial.

- **Deskilling and Over-Reliance:** A pedagogical concern is that excessive reliance on AI tutors for answers or step-by-step guidance could hinder the development of students' own problem-solving abilities, critical thinking skills, and fundamental conceptual understanding (Shafiq et al., 2025). Educators must design interactions that encourage students to grapple with concepts and use AI as a thinking partner or scaffold, rather than a replacement for effortful learning.
- **The Need for Responsible Innovation:** Addressing these multifaceted social and ethical implications requires a commitment to responsible learning analytics and AI development (Nuangchalerm, 2023). This involves prioritizing human values, ensuring transparency and accountability, actively seeking stakeholder input (including students and teachers) throughout the design and implementation process (Fuligni, Dominguez Figaredo, & Stoyanovich, 2025), and critically examining the potential unintended consequences of these powerful technologies within the specific context of physics education.

The promise of personalization, a key driver for adopting LA and AI (Liu, Latif, & Zhai, 2025) , itself carries potential downsides. While tailoring content can address individual needs, hyper-personalization driven by opaque algorithms could lead to educational "filter bubbles," limiting students' exposure to diverse approaches or challenging problems essential for robust scientific development. It might optimize for narrow, easily measurable performance indicators at the expense of fostering deeper, transferable understanding or the collaborative skills vital in scientific practice (Hewitt et al., 2023). If personalization relies on potentially biased student profiles, it could also lead to inequitable learning pathways (Grimm et al., 2023). Thus, the goals and methods of personalization require careful ethical scrutiny.

## VIII. Conclusion and Future Directions

The integration of data-driven learning strategies, specifically Learning Analytics (LA) dashboards and Artificial Intelligence (AI) tutoring systems, into undergraduate physics education presents a landscape of significant potential tempered by considerable challenges. This analysis, drawing on international evidence and sociological perspectives, suggests that while these technologies offer appealing prospects for personalized learning, enhanced engagement, improved feedback mechanisms, and increased accessibility, their effectiveness and ethical implementation are far from guaranteed.

## SUMMARY AND CONCLUSIONS

LA dashboards and AI tutors are not inherently transformative educational solutions. Their impact is highly contingent on a complex interplay of factors. Key conclusions emerging from this analysis include:

1. **Context Matters:** The effectiveness of these tools varies significantly based on the specific physics course context, the institutional culture, the characteristics of the student population, and the mode of delivery (blended vs. fully online). The Armenian experience reinforces the broader lesson that technological innovations cannot be meaningfully implemented in a vacuum. Infrastructural limitations, faculty preparedness, and cultural attitudes towards data use shape the success of LA and AI tools. These insights argue for increased investment in local capacity building and context-sensitive adaptation strategies, rather than mere replication of international models.
2. **Pedagogy is Paramount:** Technology alone yields limited benefits. Successful implementations are those where LA dashboards or AI tutors are thoughtfully integrated into sound pedagogical frameworks that support active learning, provide meaningful formative feedback, facilitate timely interventions, and foster student self-regulation. The technology must serve pedagogy, not dictate it (Guzmán-Valenzuela et al., 2021).
3. **Effectiveness Evidence is Mixed:** While AI tutors show strong potential for improving learning outcomes (approaching human tutor effectiveness in some cases (Underwood & Luckin, 2011), the evidence for LA dashboards directly boosting academic achievement is currently weaker and requires more rigorous investigation (Flanagan, Wasson, & Gašević, 2024). Both tool types show more consistent promise for enhancing student participation and engagement, though motivation impacts are complex (Flanagan, Wasson, & Gašević, 2024).
4. **User Acceptance is Critical:** Faculty skepticism, anxiety, and lack of training, alongside student concerns about accuracy, privacy, over-reliance, and the loss of human connection, represent significant barriers (Weber, 2024). User-centered design and clear demonstration of value are essential for adoption (Ng et al., 2022).
5. **Equity is a Central Challenge:** The digital divide remains a fundamental barrier (Chikwe et al., 2024). Beyond access, the potential for algorithmic bias, differential impact on diverse student groups, and the interplay with existing social and cultural capital demand proactive and ongoing attention to ensure these technologies do not exacerbate existing inequalities (Stanford SCALE, 2025).
6. **Sociological Lenses are Essential:** Understanding the adoption, use, and impact of these socio-technical systems requires frameworks like TAM/UTAUT (for individual

acceptance), ANT (for network dynamics and technology agency), and Bourdieu's theory (for power, capital, and social structures).

7. **Ethical Vigilance is Non-Negotiable:** Issues of data privacy, algorithmic transparency, academic integrity, and the potential impact on student-teacher relationships necessitate robust ethical guidelines and a commitment to responsible innovation (Nuangchalerm, 2023).

**Challenges and Research Gaps:**

Despite growing research, significant gaps remain:

- **Rigorous Evaluation:** There is a pressing need for more large-scale, longitudinal, and methodologically robust studies (including randomized controlled trials where feasible) evaluating the impact of LA dashboards and AI tutors on deep conceptual understanding, critical thinking, problem-solving skills, and long-term retention in diverse undergraduate physics settings (Flanagan, Wasson, & Gašević, 2024).
- **Equity-Focused Research:** Research must move beyond simply identifying disparities to actively developing and testing strategies for mitigating bias in algorithms and ensuring equitable access and outcomes for all student groups within physics (Stanford SCALE, 2025) . Investigating the intersectional effects of multiple identity factors is crucial.
- **Understanding Long-Term Impacts:** Most studies focus on short-term effects. Research is needed on the long-term consequences for student learning trajectories, motivation, career choices, and the development of scientific identity and belonging (Hewitt et al., 2023).
- **Teacher Education and Support:** Effective integration requires knowledgeable instructors. More research is needed on how to best prepare and support physics faculty in using these complex tools effectively and ethically within their teaching practices (Weber, 2024).
- **Affective and Social Dimensions:** The impact on student well-being, anxiety, motivation, collaborative skills, and the quality of student-teacher and peer relationships requires deeper investigation, particularly with the rise of conversational AI (Liu, Latif, & Zhai, 2025).
- **Theoretical Integration:** Further work is needed to refine theoretical frameworks that integrate insights from sociology, learning sciences, and human-computer interaction to provide more comprehensive models of technology-mediated learning in physics (Odden et al., 2019).

**Future Directions:**

Promising avenues for future development and research include:

- **Hybrid Human-AI Models:** Designing systems that leverage the strengths of both AI (personalization, scalability) and human instructors/tutors (empathy, complex reasoning, relationship building (Society for Learning Analytics Research, 2025).
- **Explainable and Controllable AI:** Developing LA and AI systems that are more transparent in their reasoning and allow users (students and instructors) greater control over their functionality and data (Ng et al., 2022).
- **Multimodal Learning Analytics (MMLA):** Carefully exploring the potential of richer data sources (e.g., gaze, audio, physiological data) to provide deeper insights into learning processes, while rigorously addressing the heightened ethical concerns (Ng et al., 2022).
- **Domain-Specific AI for Physics:** Creating AI tutors and LA models specifically informed by Physics Education Research (PER), incorporating known student difficulties, effective representations, and validated pedagogical strategies relevant to physics.
- **Fostering Higher-Order Thinking:** Designing tools that explicitly target the development of critical thinking, metacognition, scientific argumentation, and computational literacy, moving beyond basic content delivery or procedural practice (Shafiq et al., 2025).

In conclusion, data-driven learning strategies hold the potential to significantly reshape undergraduate physics education. However, realizing this potential in a way that is truly beneficial and equitable requires moving beyond technological enthusiasm towards a critical, evidence-based, sociologically informed, and ethically grounded approach. The focus must remain firmly on enhancing learning and supporting all students, using technology as a carefully considered tool within a rich and humanistic educational endeavor.

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# HAND MASS: IT'S SIGNIFICANCE IN PIANO PERFORMANCE†††

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***Abstract***

*The art of piano playing is a complex learning process that requires careful study of the movements of the piano apparatus. The extent to which students use the masses of their hands correctly is the extent to which sound and technique change proportionately while playing the piano.*

*Teachers can achieve this goal with the help of game methodology, as well as using the application of modern technologies, such as the program "Ableton Live". With the help of the program "Ableton Live", using it in pedagogical practice, we will be able to visually see the graphical change of dynamic tones, which will help us (with the help of an electronic piano), visually see the change in the strength of the sound (note) from (0-127).*

*Thus, the relevance of the study is due to the theoretical and practical importance of the correct use of the mass of the hand in performing art on the piano.*

***Keywords:*** *the art of playing the piano, pedagogical practice, proper use of hand weight, exercises for each finger in both hands without touching the instrument, teaching methodology in game form.*

## INTRODUCTION:

The importance of hand mass (hand weight) in piano performance has been studied and developed since the time of Bartolomeo Cristofori, who built the first piano in Italy in 1709. The very term "hand weight" or "weight playing" on the piano refers to the pianist's ability to freely use one's body weight while playing the piano (adding weight to the keyboard as needed, or conversely, lightening your touch).

It is very common for physical and emotional constrictions to become intertwined while playing the piano. This occurs when the pianist fails to properly distribute their weight in the keyboard. We can see how to properly use the mass of the hand and achieve the correct sound the art of performing on the piano in the works of such authors as:

E. Lieberman “Work on Piano Technique”, A. Korto “Rational Principles of Piano Technique”, H. Neuhaus “On the Art of Piano Playing”, I. Zolotova “History of Piano Art”, Sh. Apoyan “Armenian Piano Music”, C. Ganon “Pianist-Virtuoso”, V. Yuzefovich “Aram Khachaturian”.

To give an example from the works of the above-mentioned authors, A. Korto “Rational Principles of Piano Technique”, drew the attention of teachers to the necessity of correct sitting in front of the instrument. The normal sitting height, he believed, should be between 40-45 cm for an average player's height.

E. Lieberman's “Work on Piano Technique” repeatedly drew attention to the fact that the foundation of the pianist's technique depends on the feeling of contact with the keyboard, as well as sound production from the keyboard with the weight of the free hand. He believed that contact with the keyboard varies according to the nature of the music, tempo, dynamics and texture.

C. Ganon's “Pianist - Virtuoso”, in all 60 exercises, the two hands play the same notes on different octaves. Ganon suggested “lifting the fingers higher”, but at the same time not forgetting the freedom of the hands, so that they also work smoothly and synchronously despite the technical difficulties.

From the first notes of piano playing - from an early age in music schools, we teachers can facilitate the difficult path into the world of music. There are various pedagogical directions and methods to help the pupil to achieve hand liberation regardless of natural data, the ability to express himself in music with full command of his body.

It is also important in pedagogy for the student to feel joy in the process of learning to play the piano. The above is possible when the process of learning the mass of the hand in students is done consciously. The initial period of hand placement in piano performance in students is very important.

L. V. Nikolaev said: “A pianist's hands should be set in the same way as a singer's voice. The laws of hand placement cannot be individual for each pianist - they are common to all. They are based partly on the laws of physiology, partly on the laws of mechanics, and most of all on common sense and expediency”.

Heinrich Gustavovich Neuhaus wrote: “It is important to know practically that the anatomical structure of the human hand, which from the pianist's point of view is perfectly reasonable, convenient, and expedient, gives the richest possibilities for extracting the most diverse sounds from the piano”.

Anton Rubinstein said: “The piano is my favorite instrument, because it is a musical whole; every other instrument, not excluding the human voice, is only half of it”.

Teachers need to create that model, teaching methodology, of “Proper Use of Hand Mass”, in a playful way on the piano, so that it is accessible - to students of different ages, in music schools, colleges, as well as higher general music education.

We teachers need to compare and find out the weaknesses and strengths of the methodology, with the help of theoretical, practical lessons in musical institutions, and with the help of modern technologies - the program “Ableton Live”, to compare the result of the methodology, and how much the use of modern technologies will help us in the performing art on the piano.

**PLAYFUL TEACHING METHODOLOGY**

The methods of teaching in game form were conducted in three locations:

- Armenia, Yerevan - A. Spendiaryan Music School,
- Armenia Abovyan - Zare Sahakyants Music School,
- USA- Bellevue School of Music and Arts.

Pedagogical practice was conducted for students of different age groups, with thirty-five students participating in each age group:

- The youngest group of students is three to nine years old.
- The middle group of students ranges from ten to fourteen years old.
- The older group of students are eleven to sixteen years old.
- Students range in age from seventeen to sixty-five years old.

First, before starting the technique of teaching “Proper Use of Hand Mass” in a playful way with students, it is necessary for students to completely release their upper and lower body. Two chairs should be used for this technique. The teacher and the student sit opposite each other; it is very important that the height of the chair is such that their feet touch the floor, and the back of the chair supports the spine of the student and the teacher - while teaching.

Attention should also be paid to the distance between the teacher and the student. The distance should be such that the palm of their hands touch each other without unnecessary tension. It is also necessary to pay attention to the student's shoulders, so that they are free.

Next, the teacher asks the student to keep his (or her) eyes closed at this point in the training, to have the student place his (or her) hands in his (or her) lap, and to completely release the upper and lower body.

Students are usually very tense at this stage. This is noticeable by the fact that their shoulders are raised. Continuing the teaching process, the teacher tells the student to relax his (or her) upper and lower body, without opening his (or her) eyes. With eyes closed at this stage of instruction is more helpful for students to relax their upper and lower body than with eyes open.

Noticing that the student's shoulders are relaxed, not elevated, and have come to the correct position, (i.e., down), and sitting with a straight posture, the instructor tells the student that he (or she) may open his (or her) eyes. At this point, the instructor asks that the student take a deep breath and exhale. The instruction continues without getting up from the chair.

The teacher shows by example that the right hand should be on the right foot and the left hand should be free on the left foot. To find out what is the correct hand placement of the student, we can check it as follows. The location of the fingertips of the hands should be close to the student's knees.

The instructor, in his (or her) example, with his (or her) left hand raises the index finger of his (or her) right hand above his (or her) head without stopping, in a free fall, the instructor's right hand comes down on his (or her) right knee (looking at the first and second photo).

Photo (1)

Photo (2)

Before performing the same action for the left arm, the instructor asks the student what he (or she) noticed, after raising the arm above the head, during the free fall the arm fell quickly, or slowed down in the process before touching his (or her) knee? If they cannot answer this question,

the instructor repeats the same action until the answer is yes, which means that the hand falls on the knee without acceleration, and without deceleration, in free fall.

The teacher, having completed the method of “Proper Use of Hand Mass”, by example, can continue teaching the same scheme with the students. It is necessary to pay attention at this stage in the practical lessons that the hands of the pupils, when they are in a position above their heads, fall to the bottom, in free fall (without deceleration, as well as without acceleration).

The result of the research on the method “Proper Use of Hand Mass” is outlined below. In the younger group of pupils - from three to nine years old, during practical lessons, physical participation of the teacher was necessary. During instruction in the younger group of pupils, hand clenching was observed, in the process, when the hands were in a position above the head and lowered to the bottom.

To help the student release his (or her) hands, and perform the correct movement during instruction, the teacher in the process supported the student's hand when the hands were in a position above the head, also assisting him (or her), before when the hand was to come down in a free fall (without slowing down as well as accelerating).

In this phase of the study, the following questions were posed to the students:

Do their arms, legs, or shoulders move while they sleep?

Are their upper or lower bodies relaxed during sleep?

Can students monitor whole body movement when they are asleep?

In practical lessons in the younger group of pupils, the study showed us that asking the above questions helped them in that the pupils began to visualize themselves while sleeping, and at that time they were more relaxed, both physically and psychologically. The study showed us educators, that after the questions were asked, their hands went down in free fall (without slowing down as well as accelerating). The model of teaching took place in a more accessible way in a game form, (we can also give examples from the fairy tale “Sleeping Beauty” by Sh. Perrault).

The result of the research on the method of “Proper Use of Hand Mass” continues to be outlined below for the middle age group. In this group of students - ten to fourteen years old, during the learning process, in the practical sessions, the teacher only asked the above questions, but did not support the students' hands when they were in a raised state up above their heads.

The practice sessions with the middle group of students showed us that the teaching model needed to be performed several times with the hands in a position above the head - the movement was repeated until the students' hands came down to the bottom in free fall, without deceleration as well as acceleration.

The result of the research on the method of “Proper Use of Hand Mass” for the older age

group and for students of different age is outlined below. In the older group of students - from eleven to sixteen years old, as well as for students of different ages - from seventeen to sixty-five years old, showed us that during the learning process, in practical lessons, the teacher only asked the above questions.

In the practice sessions for the older group of students, and the students of different ages, the teaching model showed us that it was not necessary to repeat the movements several times, when the hands were in a position above the head, and the students' hands went down to the bottom in free fall, without deceleration as well as acceleration.

While continuing to work on the method of "Proper Use of Hand Mass", at this stage, we can also use the method of "Exercises for each finger in both hands without touching the instrument". The teacher and the student sit opposite each other; it is very important that the height of the chair is such that their feet touch the floor, and the back of the chair supports the spine of the student and the teacher - while teaching.

As a reminder, one should pay attention to the distance between the teacher and the student, the distance should be such that the palms of their hands touch each other, without unnecessary tension and pay attention to the shoulders of the student, so that they are free. The student and the teacher have their hands in their laps, in an open position so that they can visually see all their fingers in both hands, (look at the third and fourth photo).

Photo (3)

Photo (4)

The teacher using him (or herself) as an example, without raising the hands and fingers in both hands, raises only the first fingers (thumbs) in both hands to the top. The second, third, fourth and fifth fingers in both hands remain unchanged on their knees. Continuing our teaching, the pupil

repeats, according to the same scheme, the same movements made by the teacher.

At this point in the activity, we tell the students to visualize those fingers that remain on their knees and do not go to the top, to keep them unchanged and visualize as if the fingers were attached to their knees.

Following the same scheme, the teacher, using the same example, raises only the second fingers upwards in both hands (index fingers), but the lagging fingers - the first, third, fourth and fifth fingers - remain unchanged on the teacher's lap in both hands. Continuing our teaching, the pupil repeats according to the same scheme, the same movements that were made by the teacher.

In the same scheme, the teacher, using the same example, raises only the third fingers upwards in both hands (middle fingers). The first, second, fourth and fifth fingers in both hands remain unchanged, on the teacher's lap in both hands. Continuing our teaching, the pupil repeats, according to the same scheme, the same movements made by the teacher.

We continue the method, and according to the same scheme, the teacher, using the same example, raises only the fourth fingers upwards in both hands (ring fingers), but the lagging first, second, third and fifth fingers, in both hands, remain unchanged on the teacher's lap in both hands. Continuing our teaching, the pupil repeats, according to the same scheme, the same movements made by the teacher.

We continue the method, and according to the same scheme, the teacher, using the same example, raises only the fifth fingers upwards in both hands (little fingers), but the lagging first, second, third and fourth fingers, in both hands remain unchanged on the teacher's knees in both hands. Continuing our teaching, the pupil repeats, according to the same scheme, the same movements that were performed by the teacher.

When working with students on the method “Exercises for each finger in both hands without touching the instrument”, we teachers should not forget about their free sitting, i.e. shoulders should be in a natural position (pay attention that they should not be raised).

It is necessary to pay attention during training, when the fingers of students in the process are on their knees, and begins the work of simultaneous lifting the same fingers in both hands to the top (for example, the first), the rest of the lagging fingers on their knees should continue to be without movement, with relaxed muscles of the hands, as well as not strongly pressing the fingers to the bottom.

We, teachers, using the method, “Exercises for each finger in both hands without touching the instrument”, carried out in practical lessons with students as follows:

Practicing with the students was done at a slow rhythm, (i.e. finger movement, going up to the top slowly).

Practicing with the students was done at a medium rhythm (that is, the movement of the fingers, rising to the top not very fast and not very slow).

Practicing with the students was done in a fast rhythm (i.e. finger movement, rising to the top quickly).

The result of the research on the method “Exercises for each finger in both hands without touching the instrument”, in practical work with students of all group ages showed us teachers that it is better to carry out the method in a slow rhythm.

When the technique was conducted at a slow rhythm, the students were more attentive to the learning process. They could observe their movements. The students' posture was in a natural position, and the students were able to use the hand movements in both hands correctly. The muscles in both hands were not tense during the teaching process.

Practical lessons with pupils conducted in medium rhythm (i.e. the movement of the fingers were not very fast and not very slow) and in fast rhythm (i.e. the movement of the fingers were fast), showed us teachers that the muscles in both hands were tense, the shoulders were raised upwards, which made us aware of the pupil's improper posture, as well as the feeling of discomfort in the upper part of the body during training.

We can also, in the same method “Exercises for each finger in both hands without touching the instrument”, use another model of teaching in a game form. The teacher and the student sit opposite each other; it is very important that the height of the chair on which the student and the teacher sit is such that their feet touch the floor, and the back of the chair supports the spine of the student and the teacher - while teaching.

It is also necessary to pay attention to the distance at which the teacher and the student are, the distance should be such that the palms of their hands touch each other without unnecessary strain, and to pay attention to the shoulders of the student, so that they are free.

On themselves, the teacher brings his (or her) right and left hands close to each other so that the palms and fingers of the hands touch each other and are at the same distance (look at the fifth and sixth picture).

Photo (5)

Photo (6)

At this stage, the teacher opens the first fingers (thumbs) in both hands in different directions. Simultaneously, the thumb in the right hand moves to the right side, and the thumb in the left hand moves to the left side, while the other, second, third, fourth and fifth fingers in both hands remain in their places unchanged (without changing the initial position). Continuing in the same pattern, the student repeats the same movement.

Continuing the teaching according to the same scheme so that the palms and fingers of the hands touch and are at the same distance (without changing the initial position), the teacher opens his second fingers (index fingers) in both hands in different directions, the rest of the first, third, fourth and fifth fingers in both hands remain in their places without changes (without changing the initial position). Continuing in the same pattern, the student repeats the same movement.

Continuing the teaching according to the same scheme, so that the palms and fingers of the hands touch each other and are at the same distance (without changing the initial position), the teacher opens his third fingers (middle fingers) in both hands in different directions, the rest, first, second, fourth and fifth fingers in both hands, remain in their places without changes (without changing the initial position). Continuing in the same pattern, the student repeats the same movement.

Continuing the teaching according to the same scheme, so that the palms and fingers of the hands touch each other and are at the same distance (without changing the initial position), the teacher opens his fourth fingers (ring fingers) in different directions, the rest, the first second third and fifth fingers in both hands, remain in their places without changes (without changing the initial position). Continuing in the same pattern, the student repeats the same movement.

Continuing the teaching according to the same scheme, so that the palms and fingers of the hands touch each other and are at the same distance (without changing the initial position), the teacher opens his fifth fingers (little fingers) in different directions, the rest, first, second, third and fourth fingers in both hands remain in their places without changes (without changing the initial position). Continuing in the same pattern, the student repeats the same movement.

“Exercises for each finger in both hands, without touching the instrument”, were carried out

in practical lessons with the pupils as follows:

Practicing with students was done at a slow rhythm, (i.e. finger movements, opened in different directions slowly).

Practicing with students was done at a medium rhythm (i.e., finger movements opened in different directions, not very fast and not very slow).

Practicing with students was done at a fast rhythm (i.e., the movement of the fingers opened in different directions quickly).

The result of the research on the method "Exercises for each finger in both hands without touching the instrument".

In practical work with pupils of different age groups on the method "Exercises for each finger in both hands without touching the instrument" showed us teachers that it is better to carry out the method in a slow rhythm.

When the technique was conducted in a slow rhythm, the students were more attentive to the learning process and could observe their movements. The posture was also in a natural position, the students could use the arm movement correctly, and the muscles in both arms were not tense.

The model of learning slow rhythm was performed by the students correctly, the palms of their hands and fingers of their hands, were at the same distance, without changing the starting position, while opening in different directions only those fingers of the hands that were necessary during learning.

After learning the method, we can move on with our students to learning musical literacy and the piano keyboard. Further, when studying works of small and large form, in practical lessons we applied the method of "Proper Use of Hand Mass".

As we continue our studies, we can compare the result of the methodology, "Proper Use of Hand Mass", with the use of modern technology - the program "Ableton Live", and how much the use of modern technology will help us in the art of performing on the piano.

It's important to note that "Ableton Live" was the superior program to use for our purposes, we compared similar technologies and found that "Ableton Live" provides a clear visual of MIDI input data (velocity and pitch) without needing to composite multiple screenshots to show the midi data. Logic Pro X, Pro Tools and about 2 dozen other programs also show information in a similar fashion but Ableton Live is platform agnostic, working on both Mac and PC devices, and is easier to use than a program such as Pro Tools which requires a lot of niche knowledge of key commands to work effectively.

How to set up Ableton Live for Velocity Demo.

To use Ableton Live as a tool for velocity demonstration there are several required steps that

need to be taken in order to create an Ableton Live Set (.ALS file).

Open Ableton Live. By default, Ableton Live will load with 2 Midi Tracks and 2 Audio Tracks. For the purposes of this demonstration, we want to start by deleting one (1) of the Midi Tracks, and both Audio Tracks. After Ableton opens, press the shift key on your keyboard and select the tracks as shown in Photo (7) below and then press the delete/backspace key on your keyboard, or right click on one of the tracks and select the "Delete" option.

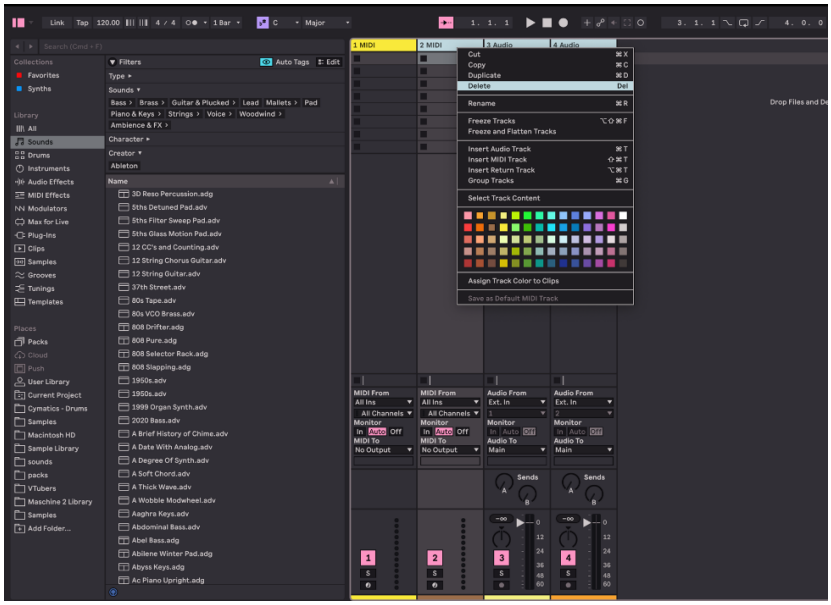



Photo (7)

Now that we have our lone midi track, we will need to add an instrument plugin so that we have a piano sound output for our midi input. Using the content browser on the left side of the window, navigate to the "Instruments" header in the leftmost column, and using the search bar at the top of the content browser type the word "piano". You will be presented with a list of all currently installed pianos (different versions of Ableton Live will have different pianos), we will use the "Grand Piano option" in this example. Double click on the "Grand Piano.adg" option or drag and drop it on to the midi track (yellow box on the right of Photo (8) below).

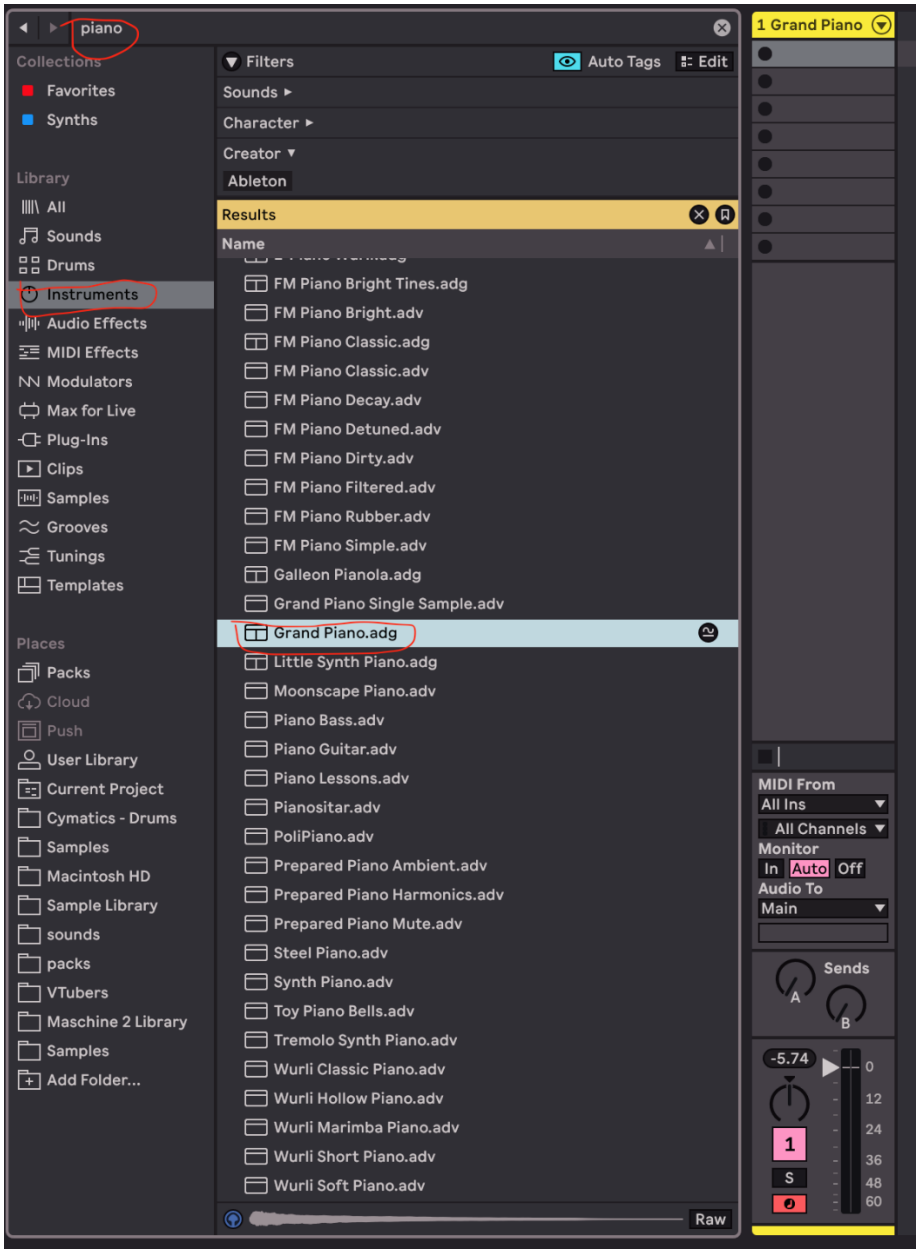



Photo (8)

The track name (text in the yellow header) will change to reflect the assigned instrument, in this case Grand Piano. Usually at this stage Ableton will automatically “Arm” the track, allowing it to accept MIDI input and generate an audio output. If you press a key on your input device and do not hear any audio, you may need to arm the track. In the lower right corner of the above image, you can see the number “1” in pink, and two additional buttons below that number. The lowest button, the red square with a small black circle in the center is the track arm button. If this button is not red like in the above image, click on it one time and it should illuminate. The track is now armed, and you should hear audio output.

Next, we will need to add a “Midi Effect” so that you are able to monitor MIDI inputs in real time. Again, using the content browser on the left of the window, navigate to the header labeled “MIDI Effects” and scroll down until you find an entry labeled “MIDI Monitor”. As we did with

the grand piano MIDI instrument, you will double click on this option to load it on to your track.

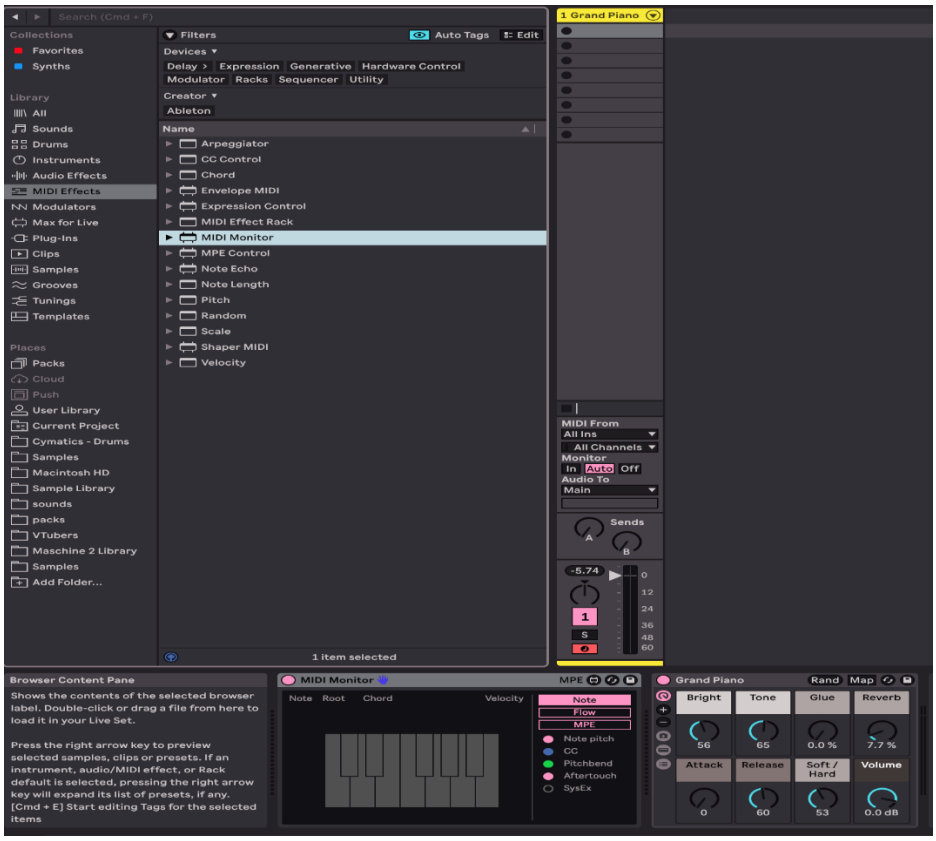



Photo (9)

Double check that the MIDI Monitor is functioning by playing a few notes on your keyboard, you should see the corresponding keys illuminate in the plugin window, as well as a real time display of the note being played as well as the velocity of those inputs. At this point the Ableton session is almost ready to go, but in order to review inputs we will want to press the “Tab” key on our keyboard to change Ableton from “Session View” (the view in all previous screenshots, to “Timeline View”. After pressing “Tab”, your Ableton window should look like the below. Once you have completed this step, you can save the Ableton file in the location of your choosing, and this file will be what you hand off to your students for the exercise.

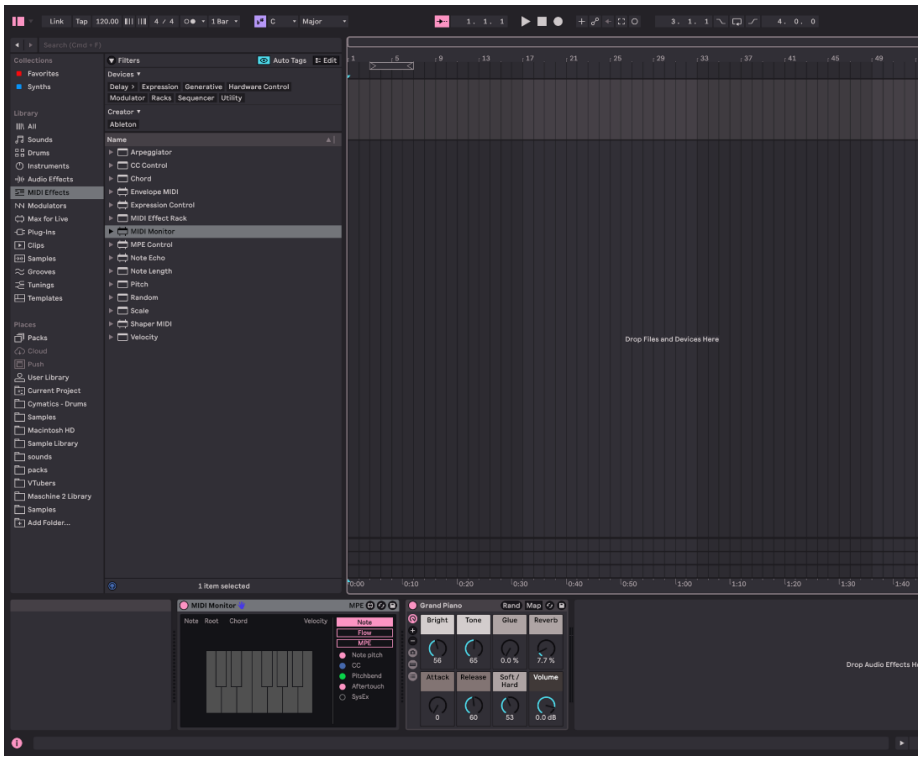



Photo (10)

Using the Ableton Live File for Demonstration

Find your Ableton Velocity Demo Project folder, double click it to open the folder. The folder will contain 2-3 items, the one we are looking for will be labeled Velocity Demo.als and look like the below screenshot (Photo (11). Double click it and the file will open in Ableton.

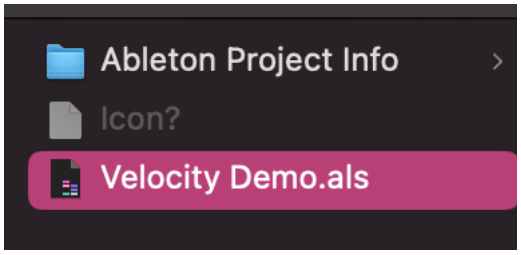



Photo (11)

Because of the set-up work we did in the previous steps the file should be loaded and ready for use in a live demonstration. Play a few notes on your keyboard and verify you are hearing the piano. From this screen the student will be able to clearly see what notes they are playing, and what velocity values are being assigned to the notes they are playing. When doing a real-time demonstration this is all the set-up that is needed. For demonstration of more than single notes, we will need to use the recording function in Ableton, which will show the notes and velocities for all inputs laid out against a timeline.

To use the recording function in Ableton, direct your attention to the upper center of the screen, where you will see “Playhead controls” (Play, Stop, and a black circle which denotes

"Record").

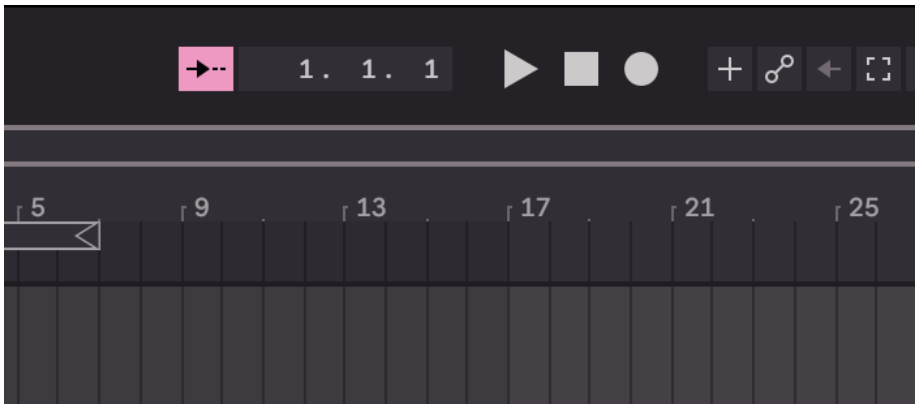



Photo (12)

If you click on the black (or in this case white) circle icon, Ableton will begin recording your inputs. After clicking the record button, it will turn red, and the play button will turn green, creating a "clip" on your timeline. All note inputs will be recorded in this clip and Ableton will continue to record. To stop the recording, press the space bar on your computer keyboard, or if supported, the record button on your midi keyboard. The clip will stop moving and you now have recorded MIDI information on your timeline.

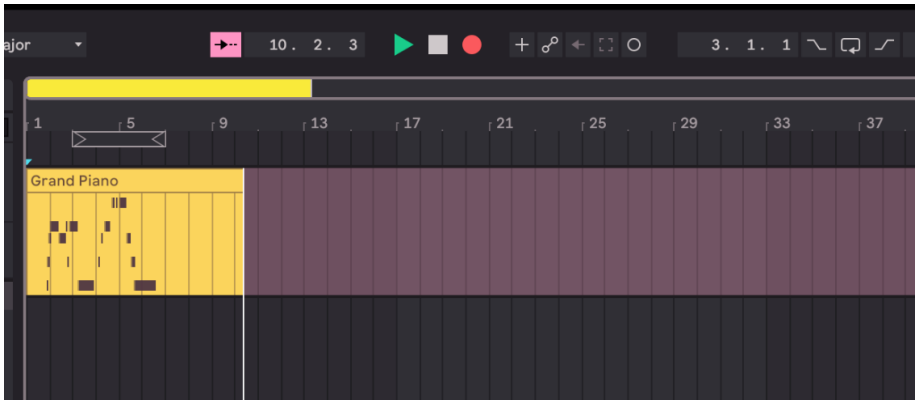



Photo (13)

10. To view the midi information, you will need to click on the name of the clip you just created. In the above example, you would double click on the portion labeled "Grand Piano", this will open the Note Editor shown in Photo (14).

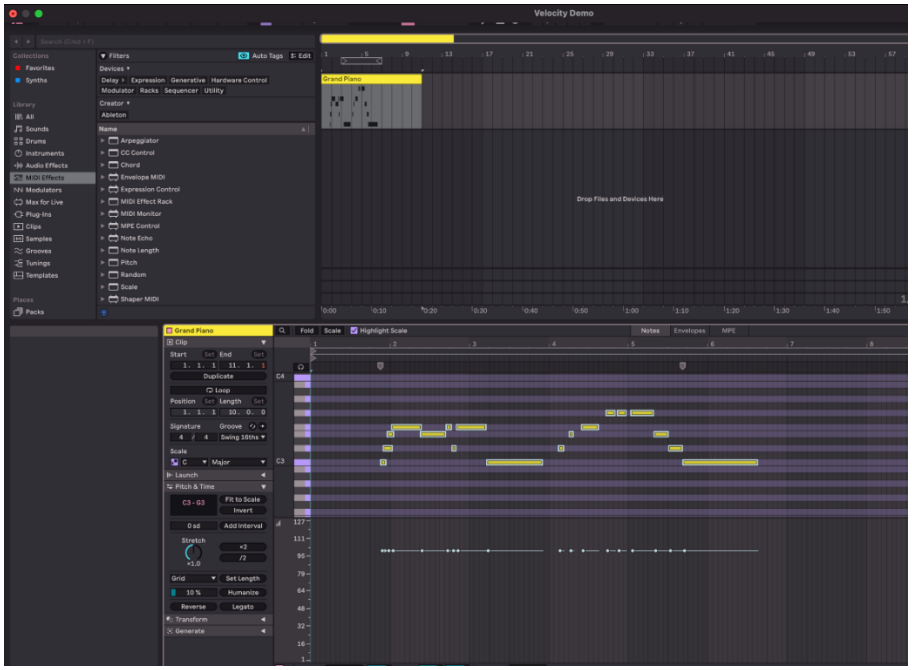



Photo (14)

11. This is the note editor view. The top portion of the window will show MIDI note values (pitch) while the lower half will show the velocity information (numeric values between 0 and 127). By pressing the space bar or the play button at the top of the window, Ableton will play back this recorded information. This view can be used to check the performance of the student against the assigned objective (playing Piano or Forte as an example). The higher the velocity value, the greater the intensity of the note, while lower values would correlate to softer playing.

If you are having your students record multiple exercises you can do all this within the same track. Select an open space to the right of the existing MIDI clip and you will notice a light blue highlight on the timeline. This denotes your “playhead position” which is where the next recording will start from. This can be repeated infinitely as needed. See the screenshot below for reference on what it looks like when the playhead has been moved. Note that Ableton will always default back to this position if you are using the space bar to start or stop playback/recording. If you use the square “Stop” button in between the play and record buttons mentioned in step 8, your playhead will move back to position 1.1.1. or the very beginning of the timeline. Ableton will record over existing MIDI depending on the playhead position, so be mindful of this when working with students so they do not accidentally record over their work. If work is accidentally recorded over, the standard Control + Z or CMD + Z (Mac) “undo” commands will revert to the pre-recorded state.

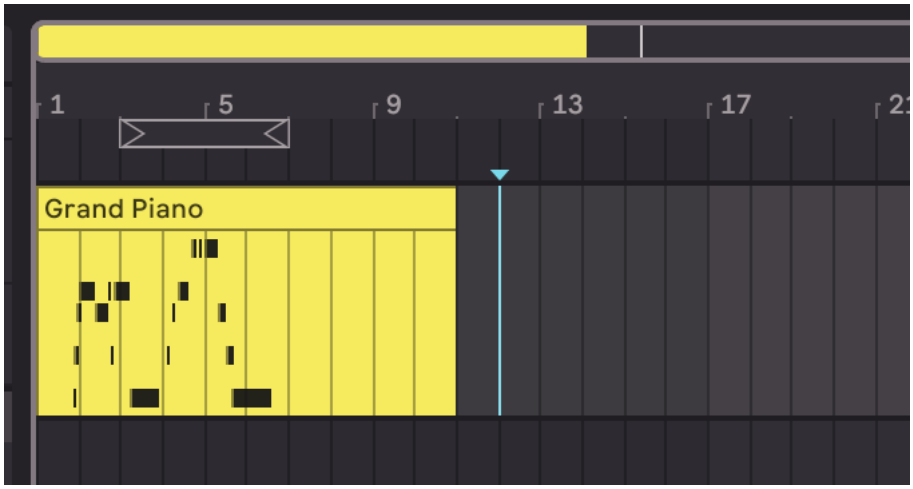



Photo (15)

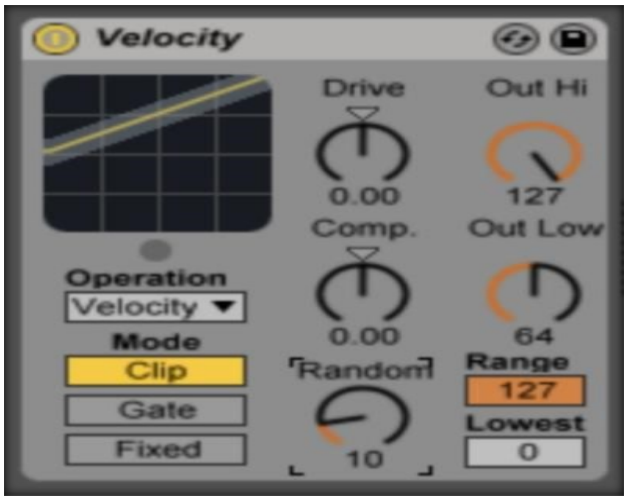
Pedagogical practice was conducted for students of different age groups, with thirty-five students participating in each age group:

- The youngest group of students is three to nine years old.
- The middle group of students ranges from ten to fourteen years old.
- The older group of students are eleven to sixteen years old.
- Students range in age from seventeen to sixty-five.
- The following works were done with the pupils during practical lessons:

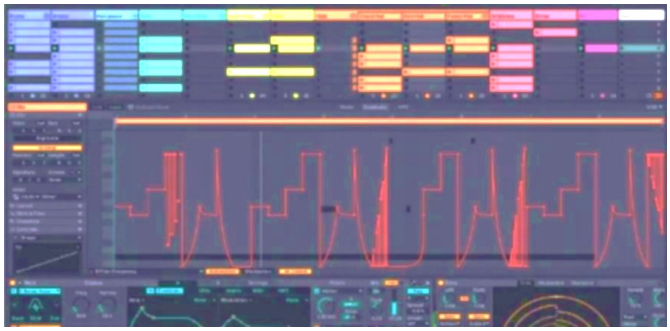
Kabalevsky – “Little Polka”,
E. Gnesin – “Etude”,
I. Philip – “Lullaby”,
B. Bartok – “Peasant Dance”,
L. Mozart – “Bourrée”,
Y. Slonov – “Polka”,
E. Grieg – “Forest Song”,
A. Corelli – “Sarabande”,
P. Tchaikovsky – “Waltz”,
A. Khachaturian – “Andantino”,
G. Handel – “Menuet”,
R. Schumann – “Soldier's March”,
C. Czerny – “Etude”,
C. Prokofiev – “Petya”,
A. Gedike – “Russian Song”,
L. Beethoven – “Sonatina”,
R. Gliere – “Rondo”,
R. Schumann's “First Loss”,
B. Bartok – “Piece”,
W. A. Mozart – “Menuet”.

The result of the study showed us teachers that it was very interesting for pupils to observe the change of sound strength with the help of electronic piano and “Ableton Live” program. Pupils visually saw how the range of sound strength (notes) changes from 0 -127 performing the above-

mentioned pieces.




"Ableton Live" Program

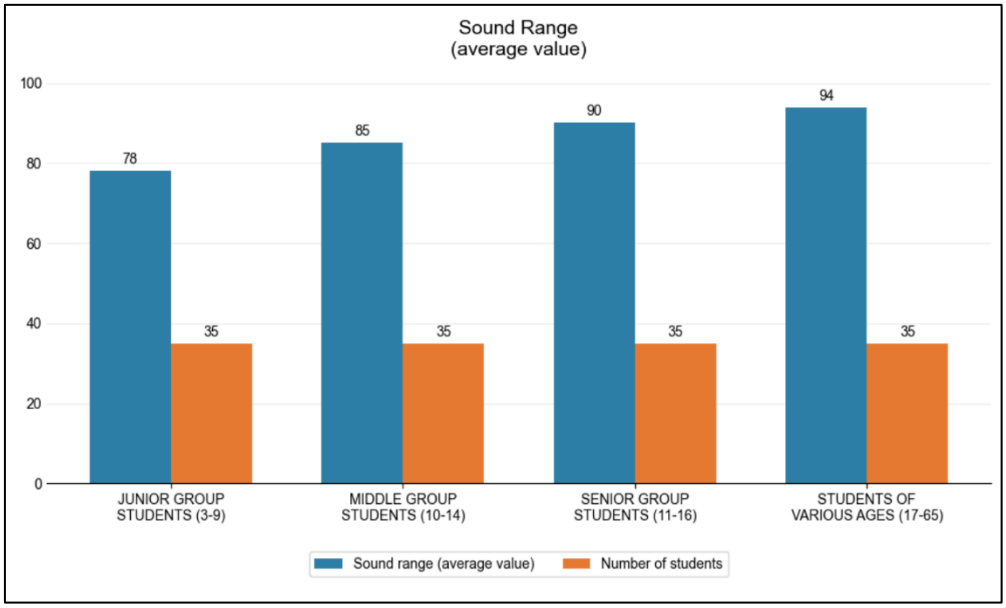


"Ableton Live" Program

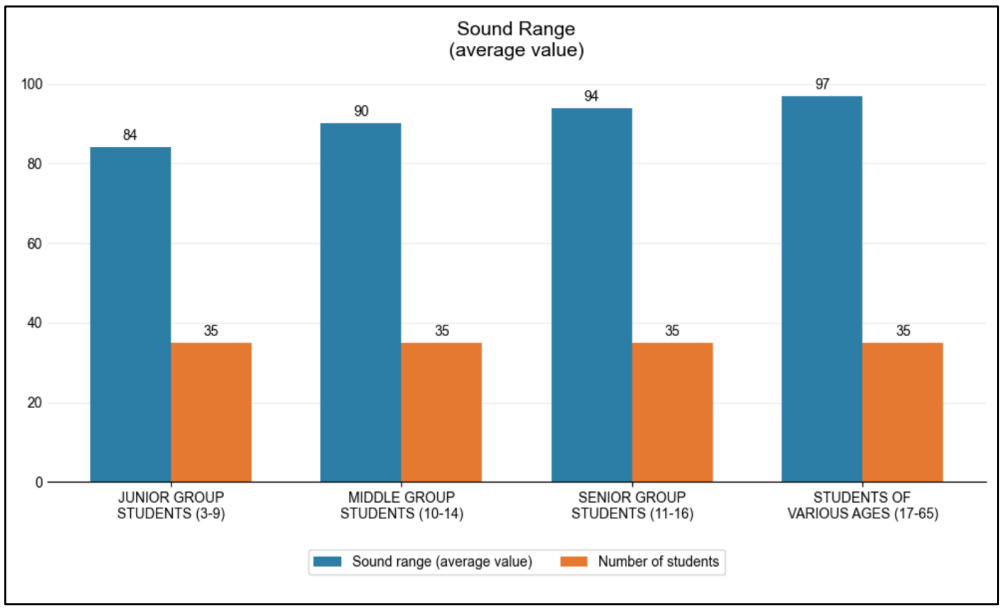
During the research process, we educators concluded that the outcome of the study was positive - for students of all age groups.

The students were taught in a playful way, with great interest. The students were able to observe the changes in dynamic tones in parallel, and they were also able to see the result of "Proper Use of Hand Mass" while playing the piano.

The result of averaging the sound range of the students using modern technology - the program "Ableton Live", as well as the methodology of "Proper Use of Hand Mass".




Sound range (average value recorded at the start of the study).




Sound range (average value after 8 weeks).

The result of the experiment shows a significant increase of sound range for students in all age groups after 8 weeks of practicing the “Proper Use of Hand Mass” methodology.

The students understood and were able to express dynamic nuances. They were able to convey the fold of the composition, the lines of development, the climax, and to express the message to be conveyed in the content of the above works.

We educators compared the result of the study - before teaching the methodology of “Proper Use of Hand Mass” and the program “Ableton Live”, and after its’ training, and concluded that by examining in the same students in all age groups - the result before the training was negative:

Pupils performed works of small and large form with their hands not free.

Students were unable to express dynamic nuances.

The pupils were not sufficiently able to express the climax as well as the thought to be conveyed in the content of this piece.

Pupils did not cope with the technical challenges that arose during the performance of works of small and large form.

## CONCLUSIONS

In the beginning the result of the initial study showed us that with the help of the method, "Proper Use of Hand Mass", and the "Ableton Live" program, the students felt more confident when playing piano in small and large pieces. Also, when performing small and large works with free hands, the students were able to organize and hear the compositional intent of the piece at a higher level.

Pupils also managed to move smoothly (without technical difficulties) from one musical structure to another musical structure in works of small and large form.

After 8 weeks, the result of the studies showed us teachers that with the help of the method "Proper Use of Hand Mass", and the "Ableton Live" program, students not only gained hand freedom in the performance of small and large works, but also regularly using the "Proper Use of Hand Mass" methodology, as well as the "Ableton Live" program, helped the students to independently follow the changes in sound strength. In the performance of works of small and large form, the students were able to reproduce, finding the appropriate dynamic tone much more easily.

They were able to independently analyze and follow the process of their work. It was also noticeable that the students improved the physiological position of the hand, hand placement, strength and dexterity of the fingers. By using an electronic piano and the program "Ableton Live", which allowed to record and graphically track changes in the force of the sound, (or the mass of the hand), students were able to hear and visually see their weaknesses and strengths. There was a noticeable improvement in these following techniques:

Performing trills,

Scales,

Arpeggios,

Double notes,

Chord technique,

Wrist technique (horizontal movements, vertical movements)

Students spent more time on the instrument, working on the tasks that needed to be done in order to be able to convey the artistic intent of the piece.

The long-term use of the combined “Proper Use of Hand Mass” methodology and “Ableton Live” program opens up unique advantages when performing on the piano for students of various ages. Giving students a greater opportunity to play music of varying difficulty and genre.

H. Neuhaus “He who is shaken to the depths of his soul by music and works like a man possessed on his instrument, he who passionately loves music and the instrument, he will master virtuoso technique, he will be able to convey the artistic image of the work, and he will be a performer”.

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***Availability of data and materials:*** *All supporting data generated or analyzed for this study are available upon request.*

***Ethics approval and consent to participate:*** *Not applicable.*

***Consent for publication:*** *Not applicable.*

***Competing interests:*** *The authors declare that they have no competing interests.*

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## GOLDEN PAGES

# JOHN GOTTMAN: A PIONEER IN RELATIONSHIP PSYCHOLOGY

John Mordechai Gottman (b. 1942) stands as one of the most influential figures in modern psychology, acclaimed for transforming the scientific study of relationships. With a career spanning over 50 years, Gottman's research into marital stability, emotional connection, and interpersonal trust has earned him global recognition and admiration.

At the University of Washington, where he served as a distinguished professor of psychology, Gottman pioneered the use of rigorous scientific methods to analyze couples' interactions, famously predicting with over 90% accuracy whether a marriage would succeed or fail. His "Four Horsemen of the Apocalypse" — criticism, contempt, defensiveness, and stonewalling — are now considered classic indicators of relationship deterioration worldwide.

In 1996, Gottman and his wife, psychologist Dr. Julie Schwartz Gottman, co-founded The Gottman Institute, which has since become a beacon for relationship counseling, therapy training, and research innovation. He introduced the concept of the "Love Lab," where couples' physiological responses and communication patterns were systematically observed, offering unprecedented insights into human intimacy.

Gottman has authored more than 190 peer-reviewed articles and over 40 books, including the international bestseller The Seven Principles for Making Marriage Work. His 5:1 positive-to-negative interaction ratio remains a foundational guideline for healthy relationships across cultures.

Named one of the top ten most influential therapists of the last quarter-century by Psychotherapy Networker, John Gottman continues to shape how millions worldwide understand, build, and preserve meaningful human bonds.

🖊️ John Gottman – Famous Quotes

*"Successful long-term relationships are created through small words, small gestures, and small acts."*

*"The greatest gift you can give your partner is your attention and emotional presence."*

*"Trust is built in very small moments."*

*"Happy marriages are based on a deep friendship."*

*"In relationships, the small things are the big things."*