Emotive Design of a Robot Study Companion to Support University Learning

Miriam Calafa'[1] Farnaz Baksh[2] Matevž B. Zorec[3] Karl Kruusamäe[4]

Abstract— **University students often face challenges in self-regulated learning, including low motivation, stress, and emotional fatigue. Socially interactive robots offer promising support, yet many fall short in emotional expressivity and contextual relevance at the university level. This paper presents the design and implementation of a multimodal emotional expression system for the Robot Study Companion (RSC), aimed at enhancing engagement and emotional support in higher education contexts.**

A set of six emotions: joy, caring, pride, anger, fun, and surprise, was selected based on their documented positive effects on learning outcomes and mapped to common academic scenarios. Emotional expressions were developed across motion, facial design, color, and voice using a digital twin framework. The result is a simulation of 18 emotional responses combining scenario, emotion, and voice profile.

This work serves as the foundation for future user testing, including cross-cultural studies in Guyana and Estonia, with the potential to expand to additional locations. Planned evaluations will assess emotion recognition, user acceptance, and the effectiveness of the robot's expressivity, informing the design of emotionally intelligent and culturally adaptive learning companions.

I. INTRODUCTION

Unlike primary or secondary school students, university learners are expected to engage in self-regulated learning, which requires a high level of discipline, cognitive effort, and emotional resilience [1]. Many students struggle with maintaining motivation, managing their time effectively, and coping with the isolation of independent study. These challenges can negatively impact academic performance, often leading to stress and burnout [2].

In this context, socially interactive robots have emerged as potential learning companions, offering personalized academic support, fostering emotional engagement, and creating dynamic, interactive learning experiences [3]. Social robots can enhance both academic outcomes and student well-being by providing tailored interaction and support. However, despite their potential, robotic study companions often fall short when it comes to effectively supporting students in higher education.

*This work was supported by the University of Tartu

[1]Miriam Calafa' is with the Institute of Technology, University of Tartu, Tartu, Ulikooli 18 51014, Estonia `miriam.calafa@ut.ee`

[2]Farnaz Baksh is with the Institute of Technology, University of Tartu, Nooruse 1 50411, Tartu, Estonia `farnaz.baksh@ut.ee`

[3]Matevž B. Zorec is with the Institute of Computer Science, University of Tartu, Narva mnt 18 51009, Tartu, Estonia `matevz.borjan.zorec@ut.ee`

[4]Karl Kruusamäe is with the Institute of Technology, University of Tartu, Nooruse 1 50411, Tartu, Estonia `karl.kruusamae@ut.ee`

Many existing systems struggle to convey emotions convincingly through facial expressions and to deliver personalized feedback. These limitations hinder the establishment of meaningful communication with students [4]. Effective learning environments require more than the delivery of content; they rely on building a sense of connection and engagement. Emotional intelligence, including the ability to recognize and respond to learners' emotions, is crucial to supporting successful educational experiences [5]. Without such meaningful interaction, students may become disengaged, limiting the impact of robotic study companions. Enhancing emotional expressivity in these systems is therefore essential for their success.

Current research in Human-Robot Interaction (HRI) has primarily focused on younger learners in primary and secondary education, yet university students face unique academic and emotional challenges [6]. To address these challenges, robotic study companions for university students must extend beyond academic assistance. They need to detect and respond to signs of stress, frustration, and disengagement, and support students in building resilience and maintaining motivation.

This study addresses these gaps by conducting a focused analysis of the HRI literature, examining both the academic needs of university students and the modalities through which a robot can express emotions to support learners in common challenges faced in higher education. To explore these aspects, a digital twin of the Robot Study Companion (RSC) [6] was developed and enhanced with improved multimodal emotional expressions tailored specifically to the support of university students, including refined facial cues, gestures, and color variations. These enhancements aim to create a more engaging and responsive study companion, bridging the gap between human-like interaction and effective academic assistance.

Our contribution establishes a foundation for future testing of the RSC system, where real-world user studies will evaluate the impact of the robot on student engagement, emotional response, and academic motivation.

II. BACKGROUND

A. *ROBOTIC STUDY COMPANION*

The RSC (Figure 1) is an open-source tabletop robot designed to enhance university students' learning experience. It supports a range of multimodal interaction methods to increase engagement and adapt to diverse learning preferences [6]. These modalities include:

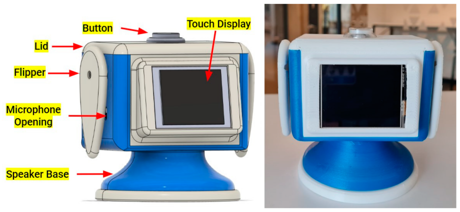

Fig. 1. Computer-Aided Design (CAD) RSC model (left) and fully assembled 3D-printed RSC (right) [6].

- Voice-Based Interaction: The RSC uses microphones and speakers to process natural speech via Speech-to-Text (STT) and Text-to-Speech (TTS) systems, enabling user conversational exchanges.
- Gesture-Based Communication: Equipped with servo-controlled flipper-like arms, the robot uses expressive gestures to convey responsiveness and social presence.
- Tactile Interaction: A large arcade-style button enables touch-based input, offering an alternative to voice commands. This button is surrounded by an LED ring capable of changing both color and intensity, enabling dynamic visual feedback.
- Touchscreen Display: The integrated screen allows for direct interaction through settings adjustments, and can display visual information enriching the learning experience.

These flexible modalities can be used independently or in combination, making the RSC highly adaptable to a variety of user needs and learning environments.

B. EMOTIONS AND SCENARIOS

In learning environments, emotions play a critical role by influencing attention, memory, motivation, and self-regulation. Just as human tutors' emotional expressions can significantly affect student engagement and academic outcomes, robots' emotional expressivity also holds considerable potential in shaping the learner experience [7].

The following emotions have been identified as having a positive impact on learning, particularly when expressed appropriately by a tutor (robotic or human):

- **Joy:** Promotes motivation and engagement. Tutors who foster a positive emotional atmosphere help enhance students' affective states and overall academic success [8].
- **Caring:** Strengthens the student-tutor relationship by creating a supportive environment. Expressions of care can reduce anxiety, improve mental well-being, and increase both motivation and academic performance [9].
- **Pride:** When tutors (or robots) express pride in student achievements, it reinforces learners' self-esteem and encourages continued effort. This emotional reinforcement strengthens students' belief in their own capabilities [10].
- **Fun:** Playful or gamified interactions help reduce stress, improve mood, and sustain attention. Fun encourages active participation and long-term engagement [11].
- **Surprise:** Expressions of genuine astonishment at student progress can boost confidence and motivation. Surprise enhances the perceived value of tutor feedback and increases engagement with learning content [12].
- **Constructive Anger:** When used thoughtfully, a mild display of frustration or seriousness can heighten attention and signal the importance of a concept or mistake. This may enhance memory retention and academic performance [13].

These emotions are associated with common academic experiences where emotional support is most beneficial. Table I summarizes the tutor emotions previously analyzed and the corresponding learning scenarios in which they are most effective.

TABLE I
COMMON STUDENT SCENARIOS AND THE MOST EFFECTIVE TUTOR EMOTION FOR SUPPORT

Emotion	Learning Scenario
Joy	When students achieve a milestone, such as completing a task or mastering a concept [14].
Caring	When students are struggling, feeling frustrated, or expressing confusion [9].
Pride	When students show noticeable improvement or accomplish a challenging goal [14].
Anger	When there is a need to emphasize the seriousness of repeated mistakes or neglected tasks [13].
Fun	When there is a need to break the monotony during long study sessions or repetitive exercises [15].
Surprise	When students perform better than expected or find creative solutions [12].

C. COLORS

Color is a powerful modality for conveying emotions. In robotics, integrating color with other expressive channels, such as facial expressions, can significantly enhance emotion recognition and improve the quality of human-robot interaction [16].

Research indicates that the use of facial colors aligned with principles from color psychology can increase emotion recognition accuracy by up to 25% [17].

Frameworks like Plutchik's Wheel of Emotions incorporate color to represent emotional intensity, further supporting its relevance in emotional design. In the context of human-robot interaction, color not only enhances perceived emotional intelligence but also contributes to the lifelikeness and social presence of artificial agents [18].

However, the impact of color is highly context-dependent. For example, red may signal anger when applied to the face but can indicate vitality or health when localized to the cheeks [19]. Additionally, background colors influence how facial expressions are perceived, though facial coloration tends to exert a stronger effect [20].

Given that color perception is shaped by cultural and contextual factors, designers must carefully consider these variables when incorporating color-based emotional cues into robotic systems [21].

D. FACIAL EXPRESSION

Emoticons serve as a powerful means to convey emotions, mirroring the way facial expressions function in face-to-face interactions. Research indicates that people perceive emoticons as being just as effective as empathetic verbal expressions in communicating emotions [22]. While much of the research has focused on their use in digital written interactions, their application in HRI is also gaining attention.

In the past decades, the HRI community has discovered the potential of using inspirations from cartoons and animation in robotic design [23]. In this connection, the emotional expressiveness of the face can be enhanced by the principle of exaggeration [24] and the use of different eye shapes and movements.

Symbolic elements, such as hearts, stars, or expressive marks, can be incorporated around the eyes to reinforce emotional messages. This technique, inspired by Japanese comics and animation, enhances visual intuitiveness and emotional clarity [25].

E. MOTION

Emotions can also be effectively expressed through movement patterns. Specific gestures and motion dynamics help communicate affective states, enhancing the robot's social presence and emotional clarity in interactions. Below are examples of how motion can be aligned with different emotional expressions:

- **Joy:** Expressed through high-energy, smooth, and expansive gestures that communicate excitement and positivity [26].
- **Caring:** Characterized by gentle, flowing, and calm movements that reflect warmth and attentiveness [27].
- **Pride:** Expressed through slow, supportive gestures and calming, affirming movements. These reinforce student achievements and signal approval [28].
- **Anger:** Conveyed through abrupt, forceful gestures with strong, sudden motions and shaking, representing high arousal and intensity [26].
- **Fun:** Represented using rhythmic, sinusoidal movements that evoke spontaneity, playfulness, and lightheartedness [29].
- **Surprise:** Communicated through sudden and exaggerated motions, such as quick arm-raising or leaning back, to highlight unexpectedness [30].

F. VOCAL EXPRESSION

Vocal expression plays a key role in shaping user perception of empathy and emotional intelligence in robots. Research in HRI consistently shows that users prefer robots capable of conveying empathy through vocal tone and prosody. Emotional alignment between vocal delivery and contextual content enhances engagement, especially in educational settings. The consistency between vocal emotion and the user's affective state is crucial for successful human-robot communication [31].

Human-like voices are generally favored for their naturalness and familiarity, which help establish a more relatable interaction. However, characterized or stylized voices, when properly modulated, can be more effective in conveying specific emotional states with clarity [32].

III. IMPLEMENTATION

This chapter outlines the implementation of the RSC's emotive responses, developed using a digital twin framework. Building on insights from the reviewed literature, as well as design decisions informed by practical considerations and user-centered intuition, the robot's emotional output was refined across three key modalities: motion, facial expressions combined with colors, and vocal feedback. These implementations aim to create a coherent and context-sensitive emotional profile for future user testing and evaluation.

A. EMOTIONS AND SCENARIOS

To enable the RSC to respond appropriately in real learning contexts, specific scenarios were developed for each target emotion in Table II. These scenarios are grounded in an analysis of when particular tutor-like emotions are most effective in supporting student learning, i.e., enhancing motivation, engagement, emotional support, and comprehension, as explained in Table I.

TABLE II

EFFECTIVE TUTOR'S EMOTION FOR A SPECIFIC STUDENT SCENARIO

Emotion	Final Scenario Description
Joy	You just finished all the tasks for the study session so now you can enjoy your free time and relax.
Caring	You are anxious while juggling multiple deadlines and you're stressed. You would like to rest but you know that you still have a lot of things to do. You are also discouraged, you feel like you are not able to finish everything on time.
Pride	You finally just understand a challenging topic you've been struggling with for weeks. You feel proud of your perseverance and growing mastery of the subject.
Anger	You are supposed to study for an upcoming exam but you are instead scrolling through social media & procrastinating. You are aware of the importance of the task, but you are unmotivated and you don't want to start working for it.
Fun	You have been reading for hours, looking passive and feeling disengaged. You are struggling to memorise and remember your work. You are bored and unmotivated.
Surprise	You have a complex task to do: solving a set of challenging course problems. You expected it to take several hours, but you finished it in just 30 minutes.

Each scenario reflects common academic experiences encountered by university students, allowing the RSC's emotional responses to feel natural, timely, and contextually appropriate.

B. COLORS AND FACIAL EXPRESSIONS

The RSC's facial expressions were designed to clearly and intuitively convey emotions using a combination of color backgrounds, symbolic visual elements, and exaggerated facial features (Figure 2). Drawing inspiration from emoticons, cartoons, and animated films, the design emphasizes clarity and expressiveness through stylized features and dynamic transitions.

Each emotion is represented by a unique combination of facial elements, including eye shapes, eyebrow positions, mouth design, accent symbols, and background color, carefully selected to align with the emotional tone. The final facial expressions are as follows:

- **Joy**: A vivid yellow background. Features include a big smile, large open eyes with a lower cut-off, raised eyebrows, and rosy cheeks.
- **Caring**: A soft pink background. The face includes big, expressive eyes, a small gentle smile, thin curved eyebrows, rosy cheeks, and a heart symbol on the forehead.
- **Pride**: A soft green background. The eyes have a lower cut-off, eyebrows are gently arched, and the face shows a subtle smile with prominently blushed cheeks.
- **Anger**: A bold red background. Sharp, straight-lined eyes and eyebrows convey intensity, with a firm straight mouth and an anger symbol on the forehead.
- **Fun**: A bright orange background. The face includes a wide, playful smile, one eye closed in a wink, and star-like sparkles on the forehead.
- **Surprise**: A light blue background. Features include wide open eyes, raised eyebrows, an astonished open mouth, lightly blushed cheeks, and sparkle accents around the face.

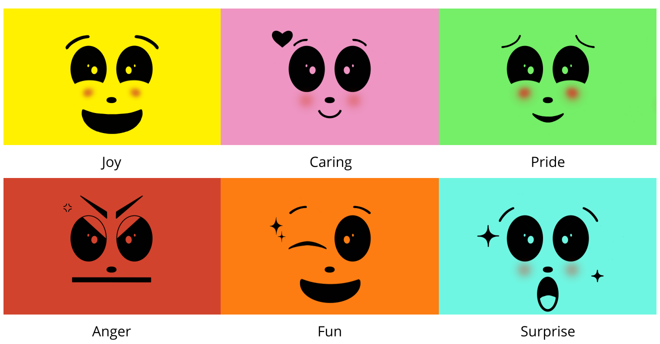

Fig. 2. Final facial expressions of the RSC for the selected emotions.

Fig. 3. Neutral face of the RSC used for emotional transition.

To enhance the realism of emotional expression and transitions to and from the neutral face (Figure 3), smooth and expressive facial animations were developed using the Veo2 AI tool [33]. These animations combine dynamic facial feature movements with background color changes to create more emotionally coherent interactions.

For each emotion, three short animated clips were generated: a transition from the neutral face to the emotional expression, a return from the emotional expression to the neutral face, and a continuous loop of the emotional expression in motion.

C. DIGITAL TWIN

The development process began with the creation of a Unified Robot Description Format (URDF) file to support digital twin simulation. The digital model includes different components connected via fixed joints, while the flippers were assigned rotational joints to enable dynamic movement, replicating the RSC functionality, as shown in Fig. 4.

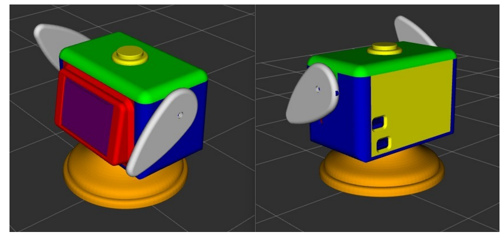

Fig. 4. The result of the URDF file in the rviz environment. Different colors have been used to clearly show the different parts used.

D. MOTION

To enable the RSC to express emotions through movement, a unique motion pattern was designed for each target emotion (Figure 5). These patterns are implemented through a dedicated control node per emotion, allowing the robot to convey affective states using its flipper mechanisms. The motion designs are informed by prior research and refined through iterative testing and personal observation.

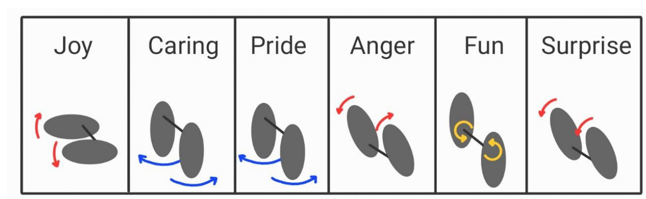

Fig. 5. The flipper movement schematic for each emotion developed. Red means fast movement, Blue means slow movement, and Yellow means intermediate-speed movement. The length of the arrows represents the width of the motion

- **Joy**: The RSC raises its flippers to the horizontal plane and shakes them rhythmically in opposite directions, reflecting energy, excitement, and happiness.
- **Caring**: Gentle, smooth flipper motions in opposite directions simulate a nurturing and calming gesture, conveying warmth and attentiveness.
- **Pride**: Slow, controlled flipper movements in opposing directions reinforce a sense of support and recognition, expressing encouragement for the student's achievement.
- **Anger**: The flippers are raised close to the top position and then shaken rapidly in opposing directions, producing erratic and forceful motion to represent frustration or urgency.
- **Fun**: Continuous spinning of the flippers in opposite directions creates a playful and animated movement, reinforcing a lighthearted atmosphere.

- **Surprise**: The flippers are quickly raised to an almost fully extended position and briefly shaken to emphasize an abrupt, startled reaction.

E. VOCAL EXPRESSION

A set of responses was developed (Table III) to allow the RSC to react appropriately in different learning scenarios, using emotionally aligned vocal expressions to enhance the interaction.

TABLE III
VOCAL EXPRESSIONS FOR DIFFERENT EMOTIONS

Emotion	Vocal Expression
Joy	"Wow, you did it! This is such a big achievement, and it shows just how much effort and determination you've put into your work. Let's celebrate this win together, and remember, accomplishments like this are what make all the hard work worth it."
Caring	"It's completely okay to feel nervous. Let's take a deep breath together and start with the first task of the list. You worked hard until now, don't give up. You've got this, and I'm here to help you every step of the way."
Pride	"That's absolutely incredible! You've demonstrated real discipline, perseverance, and growth throughout this process, and it's clear that all your hard work has paid off. Achievements like this aren't easy, and you should feel truly proud of yourself for what you've accomplished."
Anger	"This is not acceptable! You're wasting time that you can't afford to lose. This work is important, and you need to take it seriously. Put your phone away, you will check it when you will finish here. Let's start right away!"
Fun	"Hey, let's mix things up! Stand up and move a little bit, some stretching will help! And then, how about a silly riddle to wake your brain up? I don't have a heart but I can care, I break the monotony and help you prepare, who am I? . . . YOUR SOCIAL ROBOT!"
Surprise	"Wow, you just finished that so fast! I didn't expect it to be done already—this is amazing! You must feel so good about this! This is the final proof that you should never underestimate yourself, you are capable of great things!"

Three voice profiles were developed for the RSC using various online tools [34] [35], offering users a choice based on personal preference: a warm and supportive female voice, a calm and reassuring male voice, and an artificial but still emotional robotic voice.

F. FINAL EMOTIONAL RESPONSE SIMULATION

Once all components of the RSC's emotional expressions were developed and finalized, they were assembled into a unified simulation to demonstrate the full interaction experience (Figure 6).

Movement and LED color changes were implemented and visualized using RViz2, and screen recordings were used to capture these sequences. The facial expressions and voice responses were then added by video editing, aligned with each emotional scenario.

The final result is a set of six university-relevant scenarios, each paired with three vocal variations (female, male, and robotic), resulting in a total of 18 video simulations representing the emotional responses of the RSC.

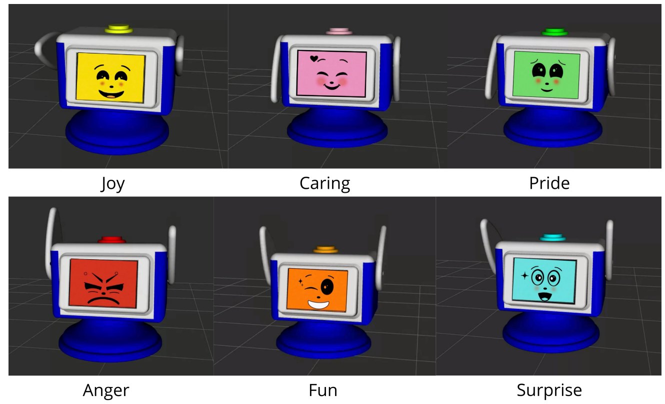

Fig. 6. Screenshots of the final simulation results for each emotion

IV. DISCUSSION AND CONCLUSIONS

This study explored the design and implementation of a multimodal emotional expression system for the RSC, aimed at supporting university students in common academic scenarios. By drawing from existing research in HRI and affective computing—while also applying design intuition—the project delivered a cohesive set of expressive behaviors spanning motion, facial design, color, and voice.

Each emotional response was carefully aligned with a realistic learning scenario, ensuring contextual sensitivity and relevance to the student experience. The use of a digital twin allowed for fast iteration and testing of expressive modalities without the constraints of physical hardware. The integration of these elements into animated simulations created a compelling demonstration of the RSC's capacity to convey social and emotional presence.

The project highlights the potential of emotionally expressive robots in higher education contexts, where emotional support is often lacking during self-regulated learning. While this work is primarily exploratory and design-focused, it lays an important foundation for future empirical validation.

V. FUTURE WORK

Future work will focus on the empirical validation of the RSC's emotional expressions through a series of user studies. A cross-cultural approach will be adopted, beginning with testing sessions in Guyana and Estonia, with the potential to expand to other cultural contexts. This will allow the evaluation of how cultural differences influence the perception and acceptance of robot-expressed emotions.

Several layers of testing are planned. The first will assess emotion recognition, user feedback, and the overall acceptance of the robot's expressive behavior. Participants will interact with the RSC's simulated emotional responses and evaluate the clarity and appropriateness of each expression.

As the RSC is still a flexible prototype, additional URDF versions have been developed to explore extended motion capabilities, such as torso rotation. Future studies will examine which movement patterns most effectively convey specific emotions, helping to refine the robot's expressive range.

Another important aspect of the upcoming research is validating the selection of the emotional set itself. User feedback will inform whether the chosen emotions are appropriate and sufficient for the academic scenarios being simulated, or whether additional emotional states should be incorporated.

These evaluations will inform future iterations of the RSC's design, improving both emotional accuracy and cultural adaptability in real-world learning environments.

References

[1] J. Giblin, "Fostering self-regulated learning in first year courses," in Self-Regulated Learners: Strategies, Performance, and Individual Differences, 2018, pp. 121–153.

[2] C. M. Vizoso Gómez and O. Arias Gundín, "Estresores académicos percibidos por estudiantes universitarios y su relación con el burnout y el rendimiento académicos," Anuario de Psicología, vol. 46, no. 2, 2016, pp. 90–97.

[3] S. Bano, K. Atif and S. A. Mehdi, "Systematic review: Potential effectiveness of educational robotics for 21st century skills development in young learners," Educ Inf Technol, vol. 29, 2024, pp. 11135–11153.

[4] S. Tilden, K. Parish, D. Mishra, et al., "Humanoid Robots as Learning Assistants? Useability Perspectives of Grade 6 Students," Tech Know Learn, vol. 30, 2025, pp. 241–262.

[5] A. T. Al Jaberi, K. Alzouebi, and O. Abu Khurma, "An Investigation into the Impact of Teachers' Emotional Intelligence on Students' Satisfaction of Their Academic Achievement," Social Sciences, vol. 13, no. 5, 2024, pp. 244.

[6] F. Baksh, M. B. Zorec, and K. Kruusamäe, "Open-Source Robotic Study Companion with Multimodal Human–Robot Interaction to Improve the Learning Experience of University Students," Applied Sciences, vol. 14, no. 13, 2024, pp. 5644.

[7] S. A. Abimbola, Y. Li, and X. Liu, "Effect of Emotions on Students Learning Strategies," in Proceedings of the 2019 8th International Conference on Educational and Information Technology (ICEIT 2019), New York, NY, USA: Association for Computing Machinery, 2019, pp. 153–156.

[8] J. He, Y. Lee, B. Young and F.-K. Chiang, "A Study on the Effect of Joyful Learning Application upon Undergraduate English Vocabulary Learning," 2017 International Conference of Educational Innovation through Technology (EITT), Osaka, Japan, 2017, pp. 288–292.

[9] S. Hasanzadeh, S. Shayesteh, and R. Pishghadam, "Investigating the role of teacher concern in EFL students' motivation, anxiety, and language achievement through the lens of self-determination theory," Learning and Motivation, vol. 86, 2024, 101992.

[10] M. Marini, S. Livi, A. Cecalupo, F. Scarci, F. Santini, C. Parisse, and G. Benvenuto, "I feel good with my teachers. The effects of positive teacher-student relationship on students' self-esteem and perceptions about their future," Psychology Hub, vol. 40, no. 1, 2023, pp. 63–72.

[11] D. Rai et al., "Repairing Deactivating Negative Emotions with Student Progress Pages," in Artificial Intelligence in Education. AIED 2013, H. C. Lane, K. Yacef, J. Mostow, and P. Pavlik, Eds., Lecture Notes in Computer Science, vol. 7926, Berlin: Springer, 2013.

[12] T. Wubbels, M. Brekelmans, T. Mainhard, P. den Brok, and J. van Tartwijk, "Teacher–Student Relationships and Student Achievement," in Handbook of Social Influences in School Contexts, 1st ed. Routledge, 2016, pp. 16.

[13] E. A. van Doorn, G. A. van Kleef, and J. van der Pligt, "How instructors' emotional expressions shape students' learning performance: the roles of anger, happiness, and regulatory focus," J Exp Psychol Gen, vol. 143, no. 3, 2014, pp. 980–984.

[14] Derakhshan, A., & Zhang, L. (2024). Introduction to Special Issue: New Insights into the Study of Classroom Emotions: Emerging Research Methods for Exploring the Implications of Positive and Negative Emotions in Language Education Environments. Iranian Journal of Language Teaching Research, 12(3 (Special Issue)), 1-8. doi: 10.30466/ijltr.2024.121574

[15] J. P. Mazer, "Students' Discrete Emotional Responses in the Classroom: Unraveling Relationships with Interest and Engagement," Communication Research Reports, vol. 34, no. 4, 2017, pp. 359–367.

[16] T. Dzhoroev, H. Park, J. Lee, B. Kim and H. S. Lee, "Human Perception on Social Robot's Face and Color Expression Using Computational Emotion Model," in 2023 32nd IEEE International Conference on Robot and Human Interactive Communication (RO-MAN), Busan, Korea, Republic of, 2023, pp. 2484–2491.

[17] T. Ariyoshi, K. Nakadai and H. Tsujino, "Effect of facial colors on humanoids in emotion recognition using speech," 13th IEEE International Workshop on Robot and Human Interactive Communication (RO-MAN 2004), 2004, pp. 59–64.

[18] K. Terada, A. Yamauchi and A. Ito, "Artificial emotion expression for a robot by dynamic color change," in 2012 IEEE RO-MAN: The 21st IEEE International Symposium on Robot and Human Interactive Communication, 2012, pp. 314–321.

[19] F. Heydari, M. Khalili-Ardali, and A. Yoonessi, "Shades of Feeling: How Facial Color Variations Influence Emotional and Health Perception," Color Research and Application, 2024.

[20] T. Minami, K. Nakajima, and S. Nakauchi, "Effects of Face and Background Color on Facial Expression Perception," Front Psychol, vol. 9, 2018, 1012.

[21] J. H. Xin, K. M. Cheng, G. Taylor, T. Sato and A. Hansuebsai, "Cross-regional comparison of colour emotions Part II: Qualitative analysis," Color Research and Application, vol. 29, no. 6, 2004, pp. 458–466.

[22] J. P. Rodriguez Gomez, T. Iizuka, E. T. Miyamoto, C. Moon, and K. Ouchi, "An emoticon is well worth a few empathetic words," in Proceedings of the 33rd Pacific Asia Conference on Language, Information and Computation, PACLIC 2019, 2019, pp. 212–218.

[23] I. Leite, A. Paiva, and T. Ribeiro, "Emotion Modelling for Social Robots," in The Oxford Handbook of Affective Computing, R. A. Calvo, S. D'Mello, J. M. Gratch, and A. Kappas, Eds., 2014, pp. 296–308.

[24] J. E. Young, M. Xin, and E. Sharlin, "Robot expressionism through cartooning," in Proceedings of the ACM/IEEE International Conference on Human-Robot Interaction (HRI '07), New York, NY, USA: Association for Computing Machinery, 2007, pp. 309–316.

[25] G. Trovato, T. Kishi, N. Endo, et al., "Cross-Cultural Perspectives on Emotion Expressive Humanoid Robotic Head: Recognition of Facial Expressions and Symbols," Int J of Soc Robotics, vol. 5, 2013, pp. 515–527.

[26] K. Takahashi, M. Hosokawa and M. Hashimoto, "Remarks on designing of emotional movement for simple communication robot," in 2010 IEEE International Conference on Industrial Technology, 2010, pp. 585–590.

[27] J. Novikova and L. Watts, "A design model of emotional body expressions in non-humanoid robots," in Proceedings of the second international conference on Human-agent interaction (HAI '14), New York, NY, USA: Association for Computing Machinery, 2014, pp. 353–360.

[28] H. E. Andreae, P. M. Andreae, J. Low, and D. Brown, "A study of auti: a socially assistive robotic toy," in Proceedings of the 2014 conference on Interaction design and children (IDC '14), New York, NY, USA: Association for Computing Machinery, 2014, pp. 245–248.

[29] M. Cooney and A. Sant'Anna, "Avoiding Playfulness Gone Wrong: Exploring Multi-objective Reaching Motion Generation in a Social Robot," Int J of Soc Robotics, vol. 9, 2017, pp. 545–562.

[30] R. Simmons, "Perception of Emotion in Torso and Arm Movements on Humanoid Robot Quori," Companion of the 2021 ACM/IEEE International Conference on Human-Robot Interaction, n.d.

[31] J. James, C. I. Watson, and B. MacDonald, "Artificial Empathy in Social Robots: An analysis of Emotions in Speech," in 2018 27th IEEE International Symposium on Robot and Human Interactive Communication (RO-MAN), 2018, pp. 632–637.

[32] S. Ko, J. Barnes, J. Dong, C. H. Park, A. Howard, and M. Jeon, "The Effects of Robot Voices and Appearances on Users' Emotion Recognition and Subjective Perception," International Journal of Humanoid Robotics, vol. 20, no. 01, 2023, 2350001.

[33] Veo 2, [Online]. Available: https://veo2.ai/image-to-video (Accessed: 25 March 2025)

[34] Voice Generator, [Online]. Available: https://voicegenerator.io/ (EmmaMultilingual)

[35] Narakeet, [Online]. Available: https://www.narakeet.com/app/text-to-audio/?projectId=8bd93478-80ac-439d-b142-21ba63c91e9b (Raymond & Betty)