

## **LEARNING WITH TESLA: STUDENTS’ PERCEPTION AND MOTIVATION IN RELATION TO AN EDUCATIONAL CHATBOT IN SERBIAN PRIMARY SCHOOLS**

**Milena Z. Škobo\***

Sinergija University, Faculty of Philology, Bijeljina,  
Bosnia and Herzegovina

**Milena V. Šović\***

University of Business Academy, Faculty of Economics  
and Engineering Management, Novi Sad

---

### **ABSTRACT**

This study examines the impact of using a persona-based educational chatbot, modeled after Nikola Tesla, on student motivation in Serbian primary schools. The objective of the research was to determine how students’ perceptions of chatbot functionality, interactivity, and educational value influence their motivation to learn. A quantitative, non-experimental survey design was employed, with data collected from 456 students across four subjects: Serbian language and literature, History, English, and Physics. Statistical analysis included correlation and multiple regression analysis, focusing on three primary motivational factors: functionality, engagement, and educational value. The main findings indicate that the educational value of the chatbot was the strongest predictor of student motivation ( $\beta = .378$ ,  $p < .001$ ), while functionality and interactivity played a secondary role. Additionally, the study explored the potential motivational impact of the chatbot’s persona as a culturally familiar and emotionally significant historical figure. Results highlight the importance of pedagogically meaningful content and suggest the potential of persona-based chatbots to enhance student motivation.

### **Key words**

*AI in education, educational chatbots, Nikola Tesla, persona-based chatbots, student motivation.*

---

\* mskobo@sinergija.edu.ba, <https://orcid.org/0000-0001-8427-2051>

\* milena.sovich@gmail.com, <https://orcid.org/0009-0009-5774-5672>

## Introduction

The integration of information and communication technologies (ICT) into education has transformed how students learn, creating new possibilities for personalization, real-time feedback, and adaptive instruction (Alemdag, 2023). Among these innovations, AI-powered chatbots stand out, offering students instant access to information, simulated dialogue, and tailored guidance. However, most educational chatbots remain generic: they answer questions but rarely provide emotional resonance or cultural relevance.

This study explores a different approach: a persona-based chatbot modeled after Nikola Tesla – a figure of national pride and scientific heritage in Serbia. For many students, Tesla is more than a historical figure; he represents intelligence, creativity, and innovation. Designed as a digital double, the Tesla chatbot engages in conversations with students through first-person dialogue.

This design transforms the chatbot from a neutral tool into a culturally familiar learning companion, capable of providing not only cognitive support but also emotional and motivational engagement.

Such an approach speaks directly to the key dimensions of Self-Determination Theory (Ryan & Deci, 2000), which suggests that learning motivation grows when students experience competence, autonomy, and a sense of relatedness.

Research shows that chatbots can boost motivation when they function as social partners rather than simple information providers (Tegos, Demetriadis, Papadopoulou, 2016), and systematic reviews highlight their potential to create adaptive, learner-centered environments (Wang et al., 2024).

However, studies in Serbia have so far focused mainly on general-purpose AI tools such as ChatGPT, largely within higher education (Ružičić, Simeunović, Gojgić, 2024; Tomić & Radovanović, 2024).

These investigations emphasize technical performance or user attitudes but rarely examine how chatbots impact student motivation, especially in primary schools.

The only documented chatbot in Serbian education, ADA, is limited to administrative support in higher education (Vukomanović, Deretić, Kabiljo, Matić, 2022), with no available data on its further development or pedagogical role. This gap highlights the need for research on educational chatbots that not only deliver content but also foster motivation through emotional, cognitive, and cultural connections.

This study addresses this gap by focusing on a culturally resonant, persona-based chatbot and exploring how such a model can bridge the divide between standard AI tools and contextually meaningful learning support.

## Literature Review

In recent years, educational chatbots have gained significant attention for their potential to support learning in diverse ways (Li et al., 2023; Wollny et al., 2021). Built on advances in AI and natural language processing (NLP), these tools can guide students through interactive conversations, provide real-time, and adapt to individual needs. Their ability to offer personalized support, and simulate meaningful dialogue has positioned them as an increasingly valuable part of contemporary classrooms (Azevedo & Hadwin, 2005).

The idea of a conversational learning partner predates today's AI boom. The term *chatbot* was introduced by Michael Loren Mauldin in 1994 (Molnár & Szűts, 2019), but the roots go back to early programs such as ELIZA and ALICE.

These rule-based systems relied on simple pattern matching. Although they were never intended as teaching tools, they demonstrated that computers could sustain a human-like exchange and, in doing so, laid the conceptual foundation for later educational uses (Černý, 2022). As natural-language technologies improved, chatbots moved from experimental curiosities toward genuine pedagogical tools.

Several systematic reviews map this transition and its limitations (Kuhail, Alturki, Alramlawi, Alhejori, 2022; Pérez, Daradoumis, Puig, 2020; Smutny & Schreiberova, 2020; Winkler & Söllner, 2018).

They show that chatbots are now used to supplement lessons, recommend personalized content, and provide on-demand explanations across disciplines. However, they also identify a key gap: most chatbots focus on cognitive support, with limited attention to learners' motivational and emotional engagement.

Pérez, Daradoumis, and Puig, (2020), for example, synthesized 80 studies through PRISMA guidelines in order to distinguish between service bots that handle administrative tasks and instructional agents that engage directly with learning. They noted that chatbots can, in certain contexts, approximate human tutoring through adaptive feedback. Nonetheless, most studies prioritize technical performance over pedagogy, leaving learning outcomes underexamined. The authors therefore call for frameworks that assess both educational quality and impact, moving beyond fragmented case studies.

Kuhail et al. (2022) mapped 36 educational chatbots across diverse domains and found that most applications cluster in computer science, language learning, and general education, with motivational or peer-support roles underdeveloped. Despite motivation, interest, and confidence being critical to learning, current chatbot designs rarely adapt to these evolving states, limiting their potential for effective learner support (Guan, Raković, Chen, Gašević, 2024). The absence of user-centered heuristics and personality design stands out as a barrier to long-term effectiveness –

this is why future models must be developed with learners and teachers in mind rather than as purely technical prototypes.

Because motivation is central to effective learning, this study draws on Self-Determination Theory (SDT) that identifies autonomy, competence, and relatedness as basic psychological needs that support intrinsic motivation. Generative AI chatbots can help meet these needs when they are experienced as adaptive and responsive. Liu and Reinders (2025) report that students – especially those with initially low motivation – showed greater engagement when a chatbot provided personalized feedback and allowed self-directed exploration. Anderson (2024) likewise observes that AI tools designed with educational principles can promote critical thinking and problem solving when integrated into the curriculum through interactive, contextually relevant activities.

A series of empirical studies illustrates how diverse chatbot applications have supported engagement and learning across educational contexts. Mikael, Cemil, Rashid, and Nariman, (2025) reported that a hybrid classroom chatbot achieved high accuracy and strong user trust.

Cao, Ding, Lin, and Hopfgartner, (2023) designed a multi-role pedagogical chatbot – including Instructor Bot, Peer Bot, Career Advisor Bot, and Emotional Supporter Bot – that increased student inquiry in computer science courses. Favero, Pérez-Ortiz, Käser, and Oliver, (2024) showed that a Socratic chatbot improved critical thinking by exposing learners to multiple perspectives. Belda-Medina and Calvo-Ferrer (2022) examined pre-service teachers' interactions with Replika, Kuki, and Wysa, finding generally positive attitudes but moderate intentions for classroom use.

More recently, Degen and Asanov (2025) reported that a Socratic AI tutor significantly enhanced critical and reflective thinking among pre-service teachers. Although these systems differ in design and target population, their reported benefits for engagement and higher-order thinking support the broader view that carefully designed chatbots can foster the motivational processes.

Younger students, particularly children aged 5 to 12, are already developing specific expectations about artificial intelligence through their everyday experiences, often describing it in positive terms and showing a strong willingness to explore its possibilities (Kosoy, Jeong, Sinha, Gopnik, Kraljic, 2024). This early curiosity reflects both imaginative potential and practical relevance, which helps explain why design features that foster a sense of competence and autonomy may be especially appealing to this age group.

As AI becomes more integrated into education, questions arise about how children emotionally engage with these tools. Large language models (LLMs) enable seemingly intelligent interactions (Pratt, Madhavan, Weleff, 2024), but their long-term impact on social development and motivation remains unclear. Emotional engagement is particularly relevant for younger learners, who may perceive chatbots

as companions or confidants, presenting both opportunities and risks (Pratt, Madhavan, Weleff, 2024).

Relatedness in SDT provides a conceptual bridge to persona-based chatbots—systems built around culturally familiar figures. Such designs can help students feel a sense of connection to the tool itself. Movahed and Martin (2025) explored a topic-specific chatbot called *Ask Me Anything* (AMA), finding that children not only interacted curiously but also formed emotional bonds with it. Students described the chatbot as “smart” and “trustworthy,” even comparing it to a teacher or friend. Such findings suggest that when chatbots are designed to evoke emotional and cultural connections, they can significantly enhance learner engagement. Similar findings have been reported in a study showing that emotionally supportive chatbots – those providing positive feedback and recognizing student effort – can significantly enhance motivation (Yin, Goh, Hu, 2024). The study found that metacognitive feedback triggered emotions such as pride, interest, and inspiration, which in turn increased perceived competence and task value. These effects were particularly pronounced among younger learners, highlighting the importance of emotional design in AI-based tools.

Research in primary education offers both encouraging and cautionary insights. In Turkish primary schools, the use of ChatGPT was found to improve lesson planning, personalization, and inclusivity in language and mathematics classes, but teachers expressed concerns about possible misinformation, reduced peer interaction, and the erosion of their emotional role (Uğraş, Uğraş, Papadakis, Kalogiannakis, 2024). A follow-up study in early STEM education reported similar motivational benefits but also highlighted issues such as unequal digital access and data security (Uğraş, Uğraş, Papadakis, Kalogiannakis, 2025).

Other studies show that AI chatbots can facilitate the understanding of complex concepts and provide real-time feedback, yet they are less effective for open-ended tasks and, if overused, may even weaken critical thinking (Kasneci et al., 2023; Labadze, Grigolia, Machaidze, 2023). These findings point to the need for careful design and active teacher mediation, particularly in primary-school settings.

The success of educational chatbots also depends on how teachers and students interact with them. Students with lower self-regulated learning skills were more motivated when chatbot use is combined with teacher support (Chiu, Moorhouse, Chai, Ismailov, 2023). More advanced learners, by contrast, benefit from greater autonomy, demonstrating the “expertise-reversal” effect (Kalyuga, 2007). Holstein and Alevan (2022) similarly show that hybrid approaches – where AI tutors and human teachers work together – foster autonomy and competence more effectively than AI alone. In a study examining the Lumilo system – a mixed-reality tool providing real-time analytics to teachers – it was found that students benefited most when AI tutors and human teachers worked together. These studies reinforce the view that chatbots should complement, rather than replace, human instruction.

The literature shows that educational chatbots can enhance engagement, support learning, and in some cases stimulate students' motivation (Liu & Reinders, 2025; Yin, Goh, Hu, 2024; Uğraş et al., 2024). A recent scoping review by Huang, Jiang, King, and Fryer (2025) further confirms these trends, reporting that chatbot interactions are generally associated with higher engagement, interest, and intrinsic motivation across 43 empirical studies. However, the same review emphasizes that most research relies on short-term designs and seldom examines how specific features of the chatbot experience drive motivational outcomes. Building on this gap, the present study investigates how Serbian primary-school students perceive and use a Tesla-themed educational chatbot and explores the ways in which their experiences with this culturally familiar tool are associated with their motivation to learn.

## Research Methodology

The aim of this study is to describe how primary school students in Serbia perceive and use an educational chatbot modeled on the persona of Nikola Tesla and to examine the relationships between perceived functionality, interactivity, and educational value of the chatbot and students' motivation to learn.

To achieve the study's objectives, the following research questions were formulated:

- (1) What is the relationship between students' perception of the chatbot's functionality and their motivation to learn?
- (2) To what extent is students' engagement during the use of the chatbot associated with their motivation?
- (3) What is the relationship between the perceived educational value of the chatbot and students' motivation?

*Data Collection.* The research was conducted between January and April 2025 on a sample of 456 primary school students in Serbia (grades 5–8). Students completed a questionnaire after using the chatbot during lessons in history, physics, Serbian language and literature, and/or English language. The survey link was distributed through professional teacher networks and teacher groups on social media. Only teachers who voluntarily expressed interest implemented the activity in their classrooms.

According to information provided by these teachers, parents were verbally informed during parent–teacher meetings that students would participate in a trial use of the educational chatbot followed by a voluntary and anonymous survey, and they were given the opportunity to refuse participation; no objections were reported. All questionnaires were completed in the school setting under teacher supervision.

*Ethical Statement.* Participation was entirely voluntary, and the questionnaire content was neutral and classified as minimal risk. No personal data (such as names, school identifiers, or IP addresses) were collected, and the researchers have no means of identifying participants retrospectively. All participants completed the questionnaire in the school setting under teacher supervision. According to Article 26 of the EU General Data Protection Regulation (GDPR) and the Serbian Law on Personal Data Protection, fully anonymous data are not considered personal data; therefore, formal parental consent and institutional ethics approval were not required.

The study was conducted in accordance with the principles of the Declaration of Helsinki and the relevant national regulations on data protection and educational research and the Institute for Scientific Research of the university at which the author is employed issued a statement confirming that the study was conducted in accordance with ethical principles.

*Hypotheses.* This study tests two hypotheses related to student motivation and the use of a persona-based chatbot:

- (1) Main Hypothesis: Students who positively perceive and interact with the Tesla chatbot demonstrate higher motivation, with functionality, engagement, and educational value as key contributing factors.
- (2) Auxiliary Hypothesis: Students who view the chatbot as technically reliable, communicatively clear, and educationally valuable exhibit higher motivation for learning. Specifically, dimensions such as further learning, knowledge expansion, additional exploration of the lesson topic, and broader thematic interests are expected to significantly boost motivation.

## **Research Instrument**

The instrument used in this study was not standardized but specifically developed for the purposes of this research, aiming to measure students' perceptions of the educational chatbot and its impact on learning motivation. It consists of 21 items rated on a five-point Likert scale (1 = strongly disagree to 5 = strongly agree), grouped into four conceptual dimensions: chatbot functionality, student engagement, educational usefulness of the chatbot, and learning motivation. In designing the instrument, particular attention was given to clarity of wording, logical sequencing, and the avoidance of suggestive statements.

Content validity was established through expert evaluation by five professionals – two university professors and three primary school teachers and pilot testing. Each item was rated as “essential,” “useful but not essential,” or “unnecessary.” Based on these ratings, the Lawshe Content Validity Ratio (CVR)

was calculated. The CVR values ranged from .60 to 1.00, with an average CVR of .90 for the entire instrument, indicating a high level of content validity. The pilot test of the instrument was conducted with a sample of 52 students to verify linguistic clarity, age appropriateness, and the technical functionality of the scale. Based on the pilot results, minor wording adjustments were made to several items.

Construct validity was assessed using exploratory factor analysis (EFA) on a sample of 456 students. The Kaiser–Meyer–Olkin index confirmed sampling adequacy (КМО = .932), and Bartlett's test of sphericity was statistically significant ( $\chi^2 = 13,745.33$ ,  $p < .001$ ), confirming the suitability of the data for factor analysis.

Using the Varimax rotation method, three clear factors were extracted – chatbot functionality, student engagement, and educational usefulness – which together explained a high proportion of total variance (94.4%). All items loaded strongly on their respective factors (above .60), confirming that the instrument measures the intended constructs.

Criterion validity was confirmed through correlation and regression analyses (presented in the Results section). Pearson's correlation coefficients indicated significant positive relationships between all three chatbot dimensions and student motivation: functionality ( $r = .776$ ), engagement ( $r = .783$ ), and educational usefulness ( $r = .783$ ,  $p < .01$ ). Multiple regression analysis showed that these three dimensions jointly explained 62.7% of the variance in motivation ( $R = .792$ ,  $R^2 = .627$ ), with the educational usefulness of the chatbot emerging as the strongest individual predictor ( $\beta = .378$ ,  $p < .001$ ).

Additional analysis revealed that educational aspects were more strongly associated with motivation than technical ones.

Discriminant validity was tested by examining differences in average scores by gender and grade level. Girls generally reported slightly higher motivation and perceived educational usefulness than boys, while sixth- and seventh-grade students achieved the highest motivation scores. Item–total correlations ranged from .58 to .85, demonstrating good discriminative power across all items.

Reliability analysis confirmed a high level of internal consistency: motivation subscale ( $\alpha = .960$ ), chatbot functionality subscale ( $\alpha = .987$ ), student engagement subscale ( $\alpha = .988$ ), educational value subscale ( $\alpha = .974$ ), and the total scale ( $\alpha = .986$ ). These results indicate that the measurement instrument is reliable and that the collected data can be trusted.

The instrument demonstrated high reliability, validity, and discriminative capacity, confirming its adequacy as a tool for measuring students' perceptions and motivation related to the use of educational chatbots.

To test the main hypothesis, Pearson correlation and multiple correlation analyses were applied. The dependent variable was students' motivation to learn (3 items), while the predictor variables were the three motivational factors: chatbot

functionality (4 items), student engagement (3 items), and educational value of the chatbot (3 items).

To test the auxiliary hypothesis, an additional operationalization of predictor variables was performed by grouping them into two domains – educational and technical aspects of the chatbot – while the dependent variable remained students' motivation to learn.

The educational domain included items reflecting the instructional value and potential to stimulate knowledge acquisition, whereas the technical domain covered items related to the chatbot's functionality, accessibility, and interactivity. This reorganization of variables into domains enabled a comparative analysis of the educational and technical aspects of the chatbot in predicting student motivation.

## Results

Table 1 presents the demographic structure of the research sample, which consists of 456 primary school students (N = 456).

Gender distribution is nearly even: 230 students (50.44%) are male, 226 students (49.56%) are female.

Grade distribution shows a balanced representation across all four upper primary grades: 117 students (25.66%) are in Grade 5, 113 students (24.78%) are in Grade 6, 112 students (24.56%) are in Grade 7, 114 students (25.00%) are in Grade 8.

*Table 1. Distribution of primary school students by gender and grade*

Characteristic		Frequency	Valid Percent	Cumulative Percent
Gender	Male	230	50.44	50.44
	Female	226	49.56	100.00
Grade	5	117	25.66	25.66
	6	113	24.78	50.44
	7	112	24.56	75.00
	8	114	25.00	100.00
	Total	456	100.00	

Pearson correlation analysis (Table 2) revealed that all three factors were positively and significantly associated with student motivation.

Notably, student motivation was strongly correlated with both engagement and educational value ( $r = .783$ ,  $p < .01$ ), while a slightly weaker but still significant correlation was observed with chatbot functionality ( $r = .776$ ,  $p < .01$ ).

Among the inter-factor correlations, the strongest relationship was identified between chatbot functionality and student engagement ( $r = .974$ ,  $p < .001$ ), suggesting that students who perceived the chatbot as technically reliable were more likely to engage with it interactively.

*Table 2. Correlation between student motivation and chatbot-related factors*

Pearson Correlation (r)		Motivation	Chatbot functionality	Student engagement	Educational benefits of chatbot
Motivation		1	.776**	.783**	.783**
	Sig.		.001	.000	.000
Chatbot functionality	Correlation	.776**	1	.974**	.942**
	Sig.	.001		.000	.000
Student engagement	Correlation	.783**	.974**	1	.959**
	Sig.	.000	.000		.000
Educational benefits of chatbot	Correlation	.783**	.942**	.959**	1
	Sig.	.000	.000	.000	
	N	456	456	456	456

\*\* – Correlation is significant at the .01 level (2-tailed).

Multiple regression analysis (Table 3) was conducted to determine the relative impact of these factors on student motivation.

The model demonstrated a strong predictive relationship, with a high regression coefficient ( $R = .792$ ) and a coefficient of determination ( $R^2 = .627$ ), indicating that the three factors together explained 62.7% of the variance in student motivation. The model was statistically significant ( $p = .000$ ).

Educational value emerged as the most significant predictor of motivation, with a strong standardized beta coefficient ( $\beta = .378$ ,  $p < .001$ ).

In contrast, although student engagement and chatbot functionality positively correlated with motivation, they showed weaker effects in the regression model, suggesting that their impact is secondary to educational value.

*Table 3. Multiple regression analysis of student motivation and motivational factors*

Model 1: sig. (ANOVA p<.01)	Coefficients	Unstandardized		Standardized	t	p
		B	Std. Error	Beta		
R=.792 R <sup>2</sup> =.627 Adju- sted R <sup>2</sup> =.625	(Constant)	.269	.146		1.845	.066
	Chatbot functionality	.226	.142	.205	1.591	.112
	Student engagement	.240	.166	.221	1.446	.149
	Educational benefits of chatbot	.404	.109	<b>.378</b>	3.690	<b>.000</b>

The Pearson correlation analysis of these domains (Table 4) showed that the educational aspects of learning motivation were more strongly associated with student motivation than the technical aspects of chatbot perception.

Specifically, strong, positive correlations were observed between motivation and further learning and knowledge expansion ( $r = .743$ ,  $p < .01$ ), additional exploration of the lesson topic – Tesla ( $r = .683$ ,  $p < .01$ ), and broader thematic interests ( $r = .621$ ,  $p < .01$ ).

In contrast, the technical aspects showed moderate correlations with motivation: technical reliability and accessibility ( $r = .544$ ,  $p < .05$ ), and clear interactive communication and user understanding ( $r = .527$ ,  $p < .05$ ).

*Table 4. Relationship between student motivation and chatbot-related factors*

Pearson Correlation (r)	Moti- vation	Further learn- ing and know- ledge expa- nsion	Addi- tional explo- ration of the lesson topic (Tesla)	Broader thematic content (AI)	Techni- cal reliabi- lity and accessi- bility of the chatbot	Clear intera- ctive commu- nication and user under- standing	
Motivation	r	1	.743**	.683**	.621**	.544*	.527*
	p		.000	.000	.002	.015	.023

Pearson Correlation (r)		Motivation	Further learning and knowledge expansion	Additional exploration of the lesson topic (Tesla)	Broader thematic content (AI)	Technical reliability and accessibility of the chatbot	Clear interactive communication and user understanding
Further learning and knowledge expansion	r	.743**	1	.757**	.758**	.914**	.706**
	p	.000		.000	.000	.000	.000
Additional exploration of the lesson topic (Tesla)	r	.683**	.757**	1	.664**	.653**	.655**
	p	.000	.000		.000	.000	.000
Broader thematic content (AI)	r	.621**	.758**	.664**	1	.620*	.525*
	p	.002	.000	.000		.004	.021
Technical reliability and accessibility of the chatbot	r	.544*	.714**	.653**	.620*	1	.765**
	p	.015	.000	.000	.004		.000
Clear interactive communication and user understanding	r	.527*	.706**	.655**	.525*	.765**	1
	p	.023	.000	.000	.021	.000	
	N	456	456	456	456	456	456

\*\* – Correlation is significant at the .01 level (2-tailed).

The results of the multiple regression analysis (Table 5) showed that the model demonstrated a strong predictive relationship ( $R = .793$ ,  $R^2 = .629$ ), explaining 62.9% of the variance in student motivation.

The model demonstrated a strong predictive relationship ( $R = .793$ ,  $R^2 = .629$ ), explaining 62.9% of the variance in student motivation. Among the predictors, the most influential factors were further learning and knowledge expansion ( $\beta = .426$ ,  $p < .001$ ), additional exploration of the lesson topic ( $\beta = .670$ ,  $p < .001$ ), and broader thematic interests ( $\beta = .141$ ,  $p < .01$ ).

In contrast, the technical aspects – technical reliability and clear interactive communication – did not emerge as significant predictors in the regression model ( $\beta = .089$  and  $\beta = .101$ , respectively).

*Table 5. Multiple regression analysis of student motivation and motivation dimensions*

Model 1: sig. (ANOVA p<.01)	Coefficients	Unstandardized		Standardized	t	
		B	Std. Error	Beta		
	(Constant)	.865	.019		2.487	
	Further learning and expansion of knowledge	1.783	.007	.426	9.780	<b>.000</b>
R=.793 R <sup>2</sup> =.629	Additional Exploration of the lesson topic (Tesla)	1.645	.011	.406	5.479	<b>.000</b>
Adjusted R <sup>2</sup> =.626	Broader thematic interests	.829	.016	.237	2.634	<b>.009</b>
	Technical reliability and accessibility of chatbots	.014	.001	.089	1.644	<b>.102</b>
	Clear interactive communication and understanding	.053	.001	.101	1.858	<b>.063</b>

## Discussion

This study provides strong empirical support for the main hypothesis that the educational value of the chatbot is the primary driver of students' learning motivation. Among the three motivational factors examined – functionality, engagement, and educational value – it was the educational value that consistently showed the strongest influence on motivation ( $\beta = .378, p < .001$ ).

The perceived educational value of the chatbot, particularly items reflecting knowledge-deepening, further exploration, and broader thematic interest, correspond closely to the competence need identified in Self-Determination Theory, which holds that students are intrinsically motivated when they feel competent, that is, when they acquire knowledge and skills with clear value in a broader educational context.

The Tesla chatbot's ability to guide students toward deeper understanding thus directly satisfied this psychological requirement, explaining its dominant effect on motivation.

Functionality and engagement also correlated positively with motivation, but their role proved more indirect and weaker compared to educational value.

Technical reliability and user-friendliness primarily enabled easy and frustration-free use of the chatbot, creating the conditions for students to participate more actively.

In this way, functionality acted as a prerequisite for engagement: when students perceived the chatbot as technically stable and easy to use, they were more likely to explore the content and continue the interaction. However, even the best technical solution cannot have a lasting effect if students do not recognize that the tool provides new knowledge or stimulates further learning.

These results are consistent with previous research showing that the quality and meaningfulness of content exert a stronger influence on motivation than technological novelty itself (Huang et al., 2025; Liu & Reinders, 2025; Mohamed, Shaaban, Bakry, Guillén-Gámez, Strzelecki, 2025; Morell-Mengual et al., 2025).

A plausible explanation is that younger students adapt quickly to digital formats and overcome technical barriers relatively easily, so technical reliability and interactivity function as necessary but not sufficient conditions for motivation. By contrast, content that encourages inquiry, connects the lesson to broader knowledge, and provides a culturally relevant context – as in the case of Tesla – directly activates intrinsic motivation and the desire to learn.

Viewed through the lens of intrinsic and extrinsic motivation, the findings suggest that educational value directly stimulates intrinsic motivation – curiosity, exploratory behavior, and expanding interests – whereas technical reliability primarily supports extrinsic motivation by ensuring smooth use without frustration.

This distinction explains the moderate but stable correlations between technical factors and motivation: they create the infrastructure for learning but do not, on their own, ignite a deeper desire for knowledge.

A comparative analysis of educational and technical dimensions further confirms the primacy of cognitive content in driving motivation. Educational indicators such as continued learning, exploration of the lesson topic, and broader thematic interest showed much stronger correlations with motivation ( $r = .743$ ,  $r = .683$ , and  $r = .621$ ) than technical aspects such as reliability ( $r = .544$ ) and interactivity ( $r = .527$ ). These findings build on recent literature showing that chatbot interactions are generally linked to higher engagement and interest, while the underlying mechanisms remain insufficiently explained (Huang et al., 2025).

The present study contributes empirically by testing the roles of functionality, engagement, and educational value as mediating mechanisms in explaining motivation among primary-school students.

Despite its contributions, the study has several limitations that must be acknowledged. The research was conducted over a relatively short period, making it difficult to assess the long-term impact of the chatbot on motivation and knowledge retention.

The sample included only students from fifth to eighth grade, which limits the ability to generalize the results to younger or older age groups and to other school subjects. In addition, reliance on self-reports introduces the risk of socially desirable responses – a common methodological challenge in survey-based research (Lavidas, Papadakis, Manesis, Grigoriadou, Gialamas, 2022).

Students may occasionally overstate their engagement or interest, particularly when interacting with new technologies, which can lead to slightly inflated motivation scores (Lavidas et al., 2022).

Future studies should therefore incorporate more objective data sources, such as classroom observations, automated interaction logs, or qualitative methods (e.g., interviews and focus groups) to validate and deepen understanding of the mechanisms behind students' perceptions. Moreover, because the chatbot was used across different subjects and classroom contexts, it was not possible to fully control for variables such as teaching style or lesson content, which may have influenced students' experiences and evaluations.

Further research should explore more deeply the motivational potential of culturally familiar, persona-based chatbots, with particular attention to the Tesla model. It would be valuable to examine whether, and to what extent, the personalized design of the Tesla chatbot fosters emotional engagement beyond its informational function.

As one of the most recognizable scientific and cultural figures in Serbia, Nikola Tesla can evoke feelings of trust, closeness, and admiration, transforming his digital counterpart from a neutral tool into a mentor-like presence. Such an effect would align with the concept of culturally responsive artificial intelligence, which posits that interactions with familiar cultural figures can simultaneously strengthen cognitive and emotional engagement (Movahed & Martin, 2025; Yin, Goh, Hu, 2024).

At the same time, studies on the “novelty effect” warn that initial enthusiasm for new technologies tends to fade if content is not regularly updated and kept intellectually stimulating (Huang, Hew, Fryer, 2022).

Future work should therefore not only test the motivational impact of such chatbots but also evaluate strategies for continuously enriching their content and preserving cultural relevance.

It would also be useful to compare the Tesla chatbot with digital models of other historical or cultural figures to determine whether the observed effect is unique to Tesla or represents a broader pattern of cultural influence.

Finally, longitudinal studies combining quantitative analyses with qualitative methods (e.g., interviews or student learning diaries) would allow researchers to track the sustainability of motivation and to gain a deeper understanding of how students experience Tesla over time – as both a pedagogical tool and a cultural figure.

## Conclusion

This study demonstrated that students respond most strongly to the quality and meaningfulness of content, rather than to technological novelty itself.

The Tesla chatbot stood out as an example of how a culturally familiar educational agent can combine digital interaction with a clear sense of cognitive benefit – and how that very combination drives motivation.

The most powerful effects on student motivation came from the educational dimensions that foster deeper knowledge, further exploration, and broader thematic interest, confirming that students value content that genuinely expands their competences.

The practical relevance of these findings is twofold. First, the development of school chatbots should place primary emphasis on pedagogical depth and cultural relevance, while technical stability remains a necessary but not sufficient condition for lasting engagement.

Second, the data raise important questions about the design of learning activities: future models could experiment with formats that not only deliver information but also spark inquiry, critical thinking, and creative connections between classroom topics and the wider cultural context.

Future research could go a step further by examining the sustainability of motivational effects triggered by a culturally familiar chatbot. Instead of focusing only on students' initial encounters with the technology, it would be valuable to track how their interest evolves with repeated interactions and how their perception of educational value changes over time.

A particularly intriguing question is whether a figure like Tesla can maintain a sense of closeness and intellectual challenge once the initial novelty has faded, offering deeper insight into the interplay of cognitive and emotional mechanisms that sustain student motivation.

## References

- Alemdag, E. (2023). The effect of chatbots on learning: A meta-analysis of empirical research. *Journal of Research on Technology in Education*, 57(2), 459–481. <https://doi.org/10.1080/15391523.2023.2255698>
- Anderson, J. (2024). *The impact of AI on children's development*. <https://www.gse.harvard.edu/ideas/edcast/24/10/impact-ai-childrens-development>
- Azevedo, R. & Hadwin, A. F. (2005). Scaffolding self-regulated learning and metacognition – Implications for the design of computer-based scaffolds. *Instructional science*, 33(5/6), 367–379. <https://doi.org/10.1007/s11251-005-1272-9>
- Belda-Medina, J. & Calvo-Ferrer, J. R. (2022). Using chatbots as AI conversational partners in language learning. *Applied Sciences*, 12(17), 8427. <https://doi.org/10.3390/app12178427>
- Černý, M. (2022). The history of chatbots: the journey from psychological experiment to educational object. *Journal of Applied Technical and Educational Sciences*, 12(3), 322–322. <https://doi.org/10.24368/jates322>
- Cao, C. C., Ding, Z., Lin, J. & Hopfgartner, F. (2023). *AI Chatbots as multi-role pedagogical agents: Transforming engagement in CS education*. <https://doi.org/10.48550/arXiv.2308.03992>
- Chiu, T. K., Moorhouse, B. L., Chai, C. S. & Ismailov, M. (2023). Teacher support and student motivation to learn with Artificial Intelligence (AI) based chatbot. *Interactive Learning Environments*, 32(7), 3240–3256. <https://doi.org/10.1080/10494820.2023.2172044>
- Degen, P. B. & Asanov, I. (2025). Beyond Automation: Socratic AI, Epistemic Agency, and the Implications of the Emergence of Orchestrated Multi-Agent Learning Architectures. <https://doi.org/10.48550/arXiv.2508.05116>
- Favero, L., Pérez-Ortiz, J. A., Käser, T. & Oliver, N. (2024). Enhancing critical thinking in education by means of a Socratic chatbot. In *International Workshop on AI in Education and Educational Research* (pp. 17–32). Cham: Springer Nature Switzerland. <https://doi.org/10.48550/arXiv.2409.05511>
- Guan, R., Raković, M., Chen, G. & Gašević, D. (2025). How educational chatbots support self-regulated learning? A systematic review of the literature. *Education and Information Technologies*, 30(4), 4493–4518. <https://doi.org/10.1007/s10639-024-12881-y>
- Holstein, K. & Aleven, V. (2022). Designing for human – AI complementarity in K-12 education. *AI Magazine*, 43(2), 239–248. <https://doi.org/10.1002/aaai.12058>
- Huang, W., Hew, K. F. & Fryer, L. K. (2022). Chatbots for language learning – Are they really useful? A systematic review of chatbot-supported language learning. *Journal of computer assisted learning*, 38(1), 237–257. <https://doi.org/10.1111/jcal.12610>

- Huang, W., Jiang, J., King, R. B. & Fryer, K. L. (2025). Chatbots and student motivation: a scoping review. *Int J Educ Technol High Educ*, 22, 26. <https://doi.org/10.1186/s41239-025-00524-2>
- Kalyuga, S. (2007). Expertise reversal effect and its implications for learner-tailored instruction. *Educational Psychology Review*, 19(4), 509–539. <https://doi.org/10.1007/s10648-007-9054-3>
- Kasneci, E., Seßler, K., Küchemann, S., Bannert, M., Dementieva, D., Fischer, F., Gasser, U., Groh, G., Günnemann, S. & Hüllermeier, E. (2023). ChatGPT for good? On opportunities and challenges of large language models for education. *Learning and Individual Differences* 103, 102274. <https://doi.org/10.1016/j.lindif.2023.102274>
- Kosoy, E., Jeong, S., Sinha, A., Gopnik, A. & Kraljic, T. (2024). Children's Mental Models of Generative Visual and Text Based AI Models. *Computer Science*. <https://doi.org/10.48550/arXiv.2405.13081>
- Kuhail, M. A., Alturki, N., Alramlawi, S. & Alhejori, K. (2022). Interacting with educational chatbots: A systematic review. *Education and Information Technologies*, 28(1), 1–46. <https://doi.org/10.1007/s10639-022-11177-3>
- Labadze, L., Grigolia, M. & Machaidze, L. (2023). Role of AI chatbots in education: Systematic literature review. *Int J Educ Technol High Educ*, 20, 56. <https://doi.org/10.1186/s41239-023-00426-1>
- Lavidas, K., Papadakis, S., Manesis, D., Grigoriadou, A. S. & Gialamas, V. (2022). The effects of social desirability on students' self-reports in two social contexts: Lectures vs. lectures and lab classes. *Information*, 13(10), 491. <https://doi.org/10.3390/info13100491>
- Li, Y., Sha, L., Yan, L., Lin, J., Raković, M., Galbraith, K., Lyons, K., Gašević, D. & Chen, G. (2023). Can large language models write reflectively. *Computers and Education: Artificial Intelligence*, 4, 100140. <https://doi.org/10.1016/j.caeai.2023.100140>
- Liu, M. & Reinders, H. (2025). Do AI chatbots impact motivation? Insights from a preliminary longitudinal study. *System*, 128, 103544. <https://doi.org/10.1016/j.system.2024.103544>
- Mikael, K., Cemil, Ö. Z., Rashid, T. A. & Nariman, G. S. (2025). A Hybrid Chatbot Model for Enhancing Administrative Support in Education: Comparative Analysis, Integration, and Optimization. *IEEE Access*. <https://doi.org/10.1109/ACCESS.2025.3552501>
- Molnár, G. & Szűts, Z. (2018). The role of chatbots in formal education. 2018 IEEE 16th international symposium on intelligent systems and informatics (SISY) (pp. 197–202). IEEE. Subotica, Serbia. <https://doi.org/10.1109/SISY.2018.8524609>
- Mohamed, A. M., Shaaban, T. S., Bakry, S. H., Guillén-Gámez, F. D. & Strzelecki, A. (2025). Empowering the faculty of education students: Applying AI's potential for motivating and enhancing learning. *Innovative Higher Education*, 50(2), 587–609. <https://doi.org/10.1007/s10755-024-09747-z>

- Morell-Mengual, V., Fernández-García, O., Berenguer, C., Ortega-Barón, J., Gil-Llario, M. D. & Estruch-García, V. (2025). Characteristics, motivations and attitudes of students using ChatGPT and other language model-based chatbots in higher education. *Education and Information Technologies*, 1–18. <https://doi.org/10.1007/s10639-025-13650-1>
- Movahed, S. V. & Martin, F. (2025). Ask Me Anything: Exploring children's attitudes toward an age-tailored AI-powered chatbot. *Computer Science*. <https://doi.org/10.48550/arXiv.2502.14217>
- Pérez, J. Q., Daradoumis, T. & Puig, J. M. M. (2020). Rediscovering the use of chatbots in education: A systematic literature review. *Computer Applications in Engineering Education*, 28(6), 1549–1565. <https://doi.org/10.1002/cae.22326>
- Pratt, N., Madhavan, R. & Weleff, J. (2024). Digital dialogue – How youth are interacting with chatbots. *JAMA pediatrics*, 178(5), 429–430. <https://doi.org/10.1001/jamapediatrics.2024.0084>
- Ružičić, V., Simeunović, M. & Gojgić, N. (2024). Prerequisites for Higher Quality Education: Teachers' Attitudes on the Application of Artificial Intelligence Tools in Teaching. *10th International Scientific Conference Technics, Informatics and Education-TIE 2024*, 20–22 September 2024, Čačak (pp. 429–436). Čačak: Faculty of Technical Sciences, University of Kragujevac. <https://doi.org/10.46793/TIE24.429R>
- Ryan, R. M. & Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist*, 55(1), 68–78. <https://doi.org/10.1037/0003-066X.55.1.68>
- Smutny, P. & Schreiberova, P. (2020). Chatbots for learning: A review of educational chatbots for the Facebook Messenger. *Computers & Education*, 151, 103862. <https://doi.org/10.1016/j.compedu.2020.103862>
- Tegos, S., Demetriadis, S. & Papadopoulos, P. M. (2016). Conversational agents for academically productive talk: A comparison of directed and undirected agent interventions. *International Journal of Computer-Supported Collaborative Learning*, 11(4), 417–440. <https://doi.org/10.1007/s11412-016-9246-2>
- Tomić, B. M. & Radovanović, N. D. (2024). The application of artificial intelligence in the context of the educational system in Serbia, with a special focus on religious education. *Sociološki pregled*, 58(2), 435–459. <https://doi.org/10.5937/socpreg58-48911>
- Uğraş, H., Uğraş, M., Papadakis, S. & Kalogiannakis, M. (2024). ChatGPT-supported education in primary schools: The potential of ChatGPT for sustainable practices. *Sustainability*, 16(22), 9855. <https://doi.org/10.3390/su16229855>
- Uğraş, H., Uğraş, M., Papadakis, S. & Kalogiannakis, M. (2025). Innovative Early Childhood STEM Education with ChatGPT: Teacher Perspectives. *Technology, Knowledge and Learning*, 30(2), 809–831. <https://awspntest.apa.org/doi/10.1007/s10758-024-09804-8>

- Vukomanović, A., Deretić, N., Kabiljo, M. & Matic, R. (2022). An example of chatbot in the field of education in the Republic of Serbia. *Journal of process management and new technologies*, 10(1–2), 125–139. <https://doi.org/10.5937/jpmnt10-38635>
- Wang, S., Wang, F., Zhu, Z., Wang, J., Tran, T. & Du, Z. (2024). Artificial intelligence in education: A systematic literature review. *Expert Systems with Applications*, 232, 124167. <https://doi.org/10.1016/j.eswa.2024.124167>
- Winkler, R. & Söllner, M. (2018). Unleashing the potential of chatbots in education: A state-of-the-art analysis. *Academy of Management Annual Meeting (AOM)*.
- Wollny, S., Schneider, J., Di Mitri, D., Weidlich, J., Rittberger, M. & Drachsler, H. (2021). Are we there yet?-a systematic literature review on chatbots in education. *Frontiers in artificial intelligence*, 4, 654924. <https://doi.org/10.3389/frai.2021.654924>
- Yin, J., Goh, T. T. & Hu, Y. (2024). Interactions with educational chatbots: the impact of induced emotions and students' learning motivation. *International Journal of Educational Technology in Higher Education*, 21(1), 47. <https://doi.org/10.1186/s41239-024-00480-3>