Bridging the Gap: Understanding Teacher Perspectives on Humanoid Robots in Education

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This study explores the readiness of 233 teachers, comprising 124 in-service teachers from diverse Slovenian schools and 109 pre-service teachers from two faculties, to integrate humanoid robots – defined as robots with human-like features and capabilities – into educational settings. By evaluating attitudes, along with perceived benefits such as challenges including technological accessibility and ethical concerns, the study assesses readiness across teaching status (in-service vs- pre-service) and levels (primary vs. secondary). Utilizing Mann-Whitney U test and two-way ANOVA, findings reveal moderate readiness without significant differences between groups, but a wide range of individual attitudes. The results suggest the necessity of further research to explore the link between perceived readiness and effective integration strategies, including the development of ethical guidelines and support mechanisms for teachers. This contribution highlights the importance of a collaborative approach to integrate humanoid robots responsibly and effectively into educational environments.

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PREMAGOVANJE VRZELI: RAZUMEVANJE STALIŠČ UČITELJEV O HUMANOIDNIH ROBOTIH V IZOBRAŽEVANJU

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Ključne besede:
izobraževalna tehnologija, nove tehnologije, predmetna stopnja, pripravljenost učiteljev, razredna stopnja

Študija raziskuje pripravljenost 233 učiteljev, 124 zaposlenih učiteljev iz različnih slovenskih šol in 109 študentov pedagoških študijskih smeri iz dveh slovenskih fakultet, za integracijo humanoidnih robotov – roboti s človeku podobnimi lastnostmi in sposobnostmi – v izobraževalna okolja. Z ocenjevanjem stališč študija ocenjuje pripravljenost glede na status poučevanja (zaposleni učitelji oz. študenti pedagoških smeri) ter stopnjo poučevanja (razredna oz. predmetna stopnja). Z uporabo Mann-Whitneyjevega U-testa in dvosmerne ANOVE so ugotovitve pokazale zmerno pripravljenost brez bistvenih razlik med skupinami, vendar s širokim razponom individualnih stališč. Rezultati kažejo na potrebo po nadaljnjih raziskavah, ki bi raziskale povezavo med zaznano pripravljenostjo in učinkovitimi strategijami vključevanja, vključno z razvojem etičnih smernic in podpornih mehanizmov za učitelje. Ta prispevek poudarja pomen skupnega pristopa za odgovorno in učinkovito vključevanje humanoidnih robotov v izobraževalna okolja.

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1 Introduction

In the dynamic field of educational technology, humanoid robots – robots designed to mimic human appearance and behavior – represent a significant leap forward from traditional learning tools. Defined as programmable entities that resemble and act like humans (Graefe & Bischoff, 2003; Ting et al., 2014), these robots transition from science fiction to classroom facilitators, offering novel, interactive learning experiences (Dautenhahn, 2007; Engwall & Lopes, 2022). Unlike other educational technologies, humanoid robots provide a unique combination of interaction, embodiment, and adaptability, positioning them at the forefront of pedagogical innovation.

Empirical research underscores the specific advantages of integrating humanoid robots into education (e.g., Belapme et al., 2018; Movellan et al., 2009). Studies have demonstrated their ability to not only enhance learning outcomes, such as reading skills and interactive discussions as evidenced by tools like the NAO robot (Breßler & Mohnke, 2023), but also advance language learning (Kanda et al., 2004) and reduce stress (Buchem & Thomas, 2022). Beyond these benefits, research indicates that humanoid robots can significantly pique interest in learning among elementary school students, offering promising prospects for robot-assisted education (Chin et al., 2011). As teaching assistants, these robots excel by being programmable, agile, stable and lifelike (Tuna et al., 2019), qualities that enable them to support computational thinking, logical skills, and effective classroom management (Gouraguine et al., 2022; Ospennikova et al., 2015). These robots augment teaching, offering assistance and enrichment beyond traditional methods by acting as tutors, playmates, and entertainers (Christodoulou et al., 2020; Pande & Mishra, 2023; Wang, Sang & Huand, 2023), thereby improving student understanding, engagement, and nonverbal communication (Kennedy et al., 2015).

However, the adoption of humanoid robots in education is not without its challenges. Ethical considerations surrounding privacy, potential attachment, and the risk of reduced human interaction highlight the need for a careful and balanced approach (Rani et al., 2022; Rsang, 2020; Sharkey, 2016). The humanoid appearance and anthropomorphic characteristics of these robots necessitate thoughtful considerations in their application, tailored to the research domain and age group participants (Sharkey, 2016; Tuna et al., 2019).

Research Problem

Educator attitudes are critical components of the educational process, influencing not only the acceptance and integration of new technologies such as humanoid robots, but also the overall learning environment and student outcomes. Understanding these attitudes, their formation, and their impact is crucial for effective integration of innovations into educational settings. The views of teachers, who act as the main agents in the educational system, are shaped by the intricate interaction of affective, cognitive, and behavioral factors (Maio & Haddock, 2010). These attitudes are significant, as educators shape the learning process (Darling-Hammond, 2000) and the educational milieu to a substantial degree (Ballantine & Spade, 2006). Given that the attitudes of educators significantly co-shape their agreement on or opposition to curricular changes (Alkhateeb, 2018), the awareness and understanding of these attitudes is crucial. Influencing the attitudes of educators through targeted and quality education in specific areas, such as the integration of humanoid robots into educational settings, can lead to more informed and supportive stances towards these technological advancements.

Research Focus

Most studies show that educators have a mostly positive attitude towards the integration of modern technologies in the classroom (e.g. Akram et al., 2022; Chocarro et al., 2023; Sailer, 2021). However, the integration of humanoid robots in education could represents a significant pedagogical shift, necessitating the support and acceptance of educators. It is essential to understand their perspective on this integration to gauge its future in teaching and learning. Studies reveal varied insights into teacher readiness, concerns, and perceived pros and cons of using humanoid robots, shaping a holistic view of their impact and the evolution of educational practices. Demirbilek (2022) found that most K-12 teachers have not used humanoid robots but are open to it, mainly as a supportive tool. Reich-Stiebert and Eyssel (2016) observe that despite the enthusiasm of students, teachers prefer robots in limited roles, due to their unfamiliarity and integration challenges. Alcorn et al. (2019) noted that, while educators see benefits in using robots for students with autism, they are wary of potential over-reliance on them. Istenič et al. (2021) identified a disconnect between the efforts of researchers in making robots more human-like and the level of acceptance by pre-service teachers, highlighting the need

for teacher education on robot integration. Zemljak and Kerneža (2023) surveyed 211 Slovenian teachers, who hesitate on or even reject the use of humanoid robots in their classroom, especially if the robots were also showing emotion (Kerneža et al., 2023). To overcome these concerns, Zemljak and Kerneža (2023) recommend a comprehensive approach for robot integration, ongoing assessment, strategic planning, practical implementation, and continual evaluation to enhance both teaching and learning experiences with these emerging technologies.

Research Aim and Research Questions

The primary aim of this research is to systematically explore and understand the attitudes of in-service and pre-service teachers toward integrating humanoid robots into education. The study aims to identify key factors influencing the readiness of educators to adopt such technologies and to examine the implications of these attitudes on the teaching and learning process. The survey explores:

- What is the overall readiness of teachers for the use of humanoid robots in education?
- What is the readiness of teachers for the use of humanoid robots in education, based on their teacher status?
- What is the readiness of teachers for the use of humanoid robots in education, based on their teaching level?
- What is the readiness of teachers for the use of humanoid robots in education, based on their teacher status and their teaching level?

2 Research Methodology

General Background

This research addresses the readiness of both in-service and pre-service teachers to integrate humanoid robots into education. It explores the gap between understanding and acceptance, crucial for successful implementation of these technologies. The study investigates the willingness, interest, perceived potential, and awareness of educators, and compares attitudes between pre-service and in-service teachers. The goal is to gain a detailed understanding of these issues to inform

strategies for overcoming challenges and leveraging opportunities in integrating humanoid robots into educational settings. For this purpose, a descriptive non-experimental study was conducted.

Sample

In this study, 124 in-service teachers, regularly employed as teachers at primary or secondary level, were surveyed using simple random sampling, including 38 primary and 86 secondary school teachers. Their experience ranged from 0 to over 35 years, distributed as follows: 9 teachers with 0-5 years, 31 with 6-15 years, 48 with 16-25 years, 20 with 26-35 years, and 16 with over 35 years of experience. For pre-service teachers, 109 participants, students from two Slovenian faculties, one in science education and one in social science education field of study, were surveyed through convenience non-random sampling, comprising 80 primary and 29 secondary school teacher candidates. The study uses "teacher status"' to refer collectively to pre-service and in-service teachers, and "teaching level" to denote whether they are involved in primary or secondary education.

Instruments and Procedures

In September 2022, a pilot study with 14 in-service teachers (7 primary, 7 secondary school) and 7 pre-service teachers was conducted to develop the final survey questionnaire. Feedback from participants and validation by two independent educational research experts helped refine the questionnaire. The main study was carried out with in-service teachers in autumn 2022 and pre-service teachers in spring of 2023, using the online survey platform "1ka". Participants were greeted with welcoming message that introduced study, outlining its objectives and significance, a description of humanoid robots was given. They were told that humanoid robots are robots that resemble humans in shape (Yoshida, 2019), but in addition to appearance, they also mimic human behavior and successfully replicate functions such as sensing, decision-making and interaction (Yang, 2019). It also emphasized the ethical considerations integral to the research. It was ensured that all participants were fully informed about the nature of the study, the voluntary basis and their right to withdraw at any time without any consequences. The survey targeted primary and secondary school teachers (pre-service and in-service). Participants rated their readiness to integrate robots into teaching on a 5-point Likert

scale (1 – strongly disagree; 2 – disagree; 3 – neutral; 4 – agree; 5 – strongly agree), covering their eagerness to use robots (I wish to use robots in teaching as soon as possible), interest in their application (I am interested in the field of application and integration of robots into teaching), perceived potential in teaching generally (I see significant potential in using robots in teaching in general) as well as in specific subjects (I see significant potential in using robots in my specific subject area), and awareness of progress in this field (I follow progress in this field). They also provided information on their teacher status (pre-service or in-service teacher) and their teaching level (primary or secondary school).

The questionnaire's reliability was verified calculating item-total and inter-item correlations. To determine how well each item correlates with the total score of all other items in the questionnaire, item-total correlations were calculated. All observed items show at least modest reliability, most excellent reliability. In line with established psychometric standards, suggesting that the questionnaire is both valid and effective for measuring the intended construct (Table 1).

Table 1: Item-Total Correlations for the Questionnaire

	I wish to use robots in teaching as soon as possible.	I am interested in the field of application and integration of robots into teaching.	I see significant potential in using robots in teaching in general.	I see significant potential in using robots in my specific subject area.	I follow progress in this field.
I wish to use robots in teaching as soon as possible.	1	.753	.809	.797	.477
I am interested in the field of application and integration of robots into teaching.	.753	1	.837	.820	.458

	I wish to use robots in teaching as soon as possible.	I am interested in the field of application and integration of robots into teaching.	I see significant potential in using robots in teaching in general.	I see significant potential in using robots in my specific subject area.	I follow progress in this field.
I see significant potential in using robots in teaching in general.	.809	.837	1	.905	.452
I see significant potential in using robots in my specific subject area.	.797	.820	.905	1	.489
I follow progress in this field.	.477	.458	.452	.498	1

To assess the consistency among all items, indicating whether they are measuring similar aspects of the construct, inter-item correlations were checked (Table 2).

Table 2: Inter-Item Correlations for the Questionnaire

	I wish to use robots in teaching as soon as possible.	I am interested in the field of application and integration of robots into teaching.	I see significant potential in using robots in teaching in general.	I see significant potential in using robots in my specific subject area.	I follow progress in this field.
I wish to use robots in teaching as soon as possible.	1.000	.753**	.809**	.797**	.477**

	I wish to use robots in teaching as soon as possible.	I am interested in the field of application and integration of robots into teaching.	I see significant potential in using robots in teaching in general.	I see significant potential in using robots in my specific subject area.	I follow progress in this field.
I am interested in the field of application and integration of robots into teaching.	.753**	1.000	.837**	.820**	.458**
I see significant potential in using robots in teaching in general.	.809**	.837**	1.000	.905**	.452**
I see significant potential in using robots in my specific subject area.	.797**	.820**	.905**	1.000	.498**
I follow progress in this field.	.477**	.458**	.452**	.498**	1.000

Note. **Correlation is significant at the .01 level.

Overall, the Table 2 shows a coherent pattern of strong positive correlations among most attitudes, suggesting that these items effectively capture related aspects of the educators' perceptions and readiness to use humanoid robots in education. The moderate correlations suggest that while important, it might be influenced by other factors, and are suitable for analysis.

Ethical Procedures

The study was conducted in accordance with the research standards and ethics of Institute of Contemporary Technology, Faculty of Natural Science and Mathematics, University of Maribor (FNM_ICT) and approved by the Ethical commission for studies involving humans (1_2022).

Data Analysis

Data were analyzed using the IBM SPSS 27 software. Basic statistics provided insights into sample characteristics. The readiness of teachers, differentiated by their status (pre-service or in-service) and teaching level (primary or secondary school), was compared across five statements using the Mann-Whitney U test for non-parametric comparison. Additionally, a two-way ANOVA test was conducted to explore the interactive effects of the teaching level and teacher status on their readiness to use humanoid robots in education. Where the results are statistically significant, the effect size (r) is also calculated in the interpretation of the results.

3 Research Results

3.1 Overall Readiness of Teachers for the Use of Humanoid Robots in Education

Table 3 shows the overall readiness of pre-service and in-service teachers to use humanoid robots in education, based on five different statements.

Table 3: Overall Readiness of Teachers to use Humanoid Robots in Education

	N	M	SD
I wish to use robots in teaching as soon as possible.	233	2.48	1.103
I am interested in the field of application and integration of robots into teaching.	233	3.09	1.252
I see significant potential in using robots in teaching in general.	233	2.79	1.155
I see significant potential in using robots in my specific subject area.	233	2.73	1.166
I follow progress in this field.	233	2.46	1.141

The mean scores from Table 3 provide insights into the overall readiness and attitudes of the teachers towards humanoid robots in education. The desire to begin using robots soon (M = 2.48) is below the neutral midpoint, indicating reluctance in adopting robots in teaching. However, there is a moderate interest in exploring robot application and integration (M = 3.09), showing a positive, yet varied (SD = 1.252) inclination towards robotic applications in education. Responses spanned from the minimum (1) to maximum (5) values on the Likert scale, reflecting a wide spectrum of opinions. The perceived potential of robots in general teaching (M = 2.79) is marginally above neutral, suggesting some recognition of their benefits in education; however, not overwhelmingly so. This is mirrored in the slightly above-neutral response for the potential of robots in specific subjects (M = 2.73), indicating cautious optimism, accompanied by varied perceptions of their relevance across different disciplines. Lastly, the score for following progress in the field (M = 2.46) is near neutral, leaning towards a lack of active engagement in current developments in educational robotics. This aligns with the overall moderate readiness for and interest in adopting robotic technology, highlighting a need for more awareness and engagement in advancements in this area to encourage a more informed and enthusiastic adoption among educators.

3.2 The Readiness of Teachers for the Use of Humanoid Robots in Education Based on Their Teacher Status

Table 4 compares the readiness of pre-service and in-service teachers to adopt humanoid robots in education, based on five statements.

As shown by the results in Table 4, the analysis shows that both pre-service and in-service teachers exhibit a comparable level of readiness to integrate humanoid robots into their teaching practices. The mean rank for in-service teachers is slightly higher when compared to that of pre-service teachers ($M_{pre\text{-}service}$ = 113.03, $M_{in\text{-}service}$ = 120.48) in their eagerness to adopt robots soon, but this difference is not statistically significant (U = 6325.5, z = -0.87, p = .383). Similarly, both groups demonstrate comparable interest levels in learning about the application and integration of robots ($M_{pre\text{-}service}$ = 118.19, $M_{in\text{-}service}$ = 115.96; U = 6628.5, z = -0.26, p = .794). In terms of the perceived general potential of humanoid robots in education, the mean ranks are very similar ($M_{pre.\text{-}service}$ = 118.19, $M_{in\text{-}service}$ = 115.95; (U = 6628.0, z = -0.263, p = .793), indicating no significant difference in their outlook. The readiness regarding

the potential of robots in specific subject areas also shows a marginal difference ($M_{pre\text{-}service}$ = 118.82, $M_{in\text{-}service}$ = 115.40; U = 6560.0, z = -0.40, p = .690), suggesting similar perceptions across both groups. For following progress in the field, pre-service teachers have a higher mean rank compared to in-service teachers ($M_{pre\text{-}service}$ = 121.55, $M_{in\text{-}service}$ = 113.00), but the difference is not statistically significant (U = 6262.0, z = -1.00, p = .318).

Table 4: The Readiness of Teachers for Humanoid Robots Use in Education, Based on Their Teacher Status

	Pre-service		In-service		Mann-Whitney
	N	MR	N	MR	
I wish to use robots in teaching as soon as possible.	109	113.03	124	120.48	U = 6325.5, z = -0.87, p = .383
I am interested in the field of application and integration of robots into teaching.	109	118.19	124	115.96	U = 6628.5, z = -0.26, p = .794
I see significant potential in using robots in teaching in general.	109	118.19	124	115.95	U = 6628.0, z = -0.263, p = .793
I see significant potential in using robots in my specific subject area.	109	118.82	124	115.40	U = 6560.0, z = -0.40, p = .690
I follow progress in this field.	109	121.55	124	113.00	U = 6262.0, z = -1.00, p = .318

3.3 The Readiness of Teachers for the Use of Humanoid Robots in Education Based on Their Teaching Level

Table 5 offers a comparative analysis of the readiness of primary and secondary school teachers for adopting humanoid robots in an educational context, based on their responses to five different statements.

The analysis shows distinct readiness patterns between primary and secondary school teachers (Table 5). Secondary school teachers have a higher mean rank for readiness to use robots when compared to primary school teachers ($M_{primary}$ = 108.24, $M_{secondary}$ = 125.99), with a statistically significant difference (U = 5751.0, z = -2.08, p = .037). This indicates greater readiness among secondary school teachers to engage with robotic technologies, with an effect size of -0.136, suggesting a small to medium difference in this aspect. Both primary and secondary school teachers

show similar interest levels in robot application and integration (M_{pimary} = 112.03, $M_{secondary}$ = 122.10), with no significant difference (U = 6198.5, z = -1.18, p = .237). They also perceive a similar level of potential in using robots for teaching in general ($M_{primary}$ = 118.48, $M_{secomdary}$ = 115.48; U = 6610.0, z = -0.35, p = .724) and in specific subject areas ($M_{primary}$ = 117.38, $M_{secondary}$ = 116.61); U = 6740.5, z = -0.09, p = .929). This indicates a uniform perception across both educational levels. However, secondary school teachers show a significantly higher mean rank in following advancements in the field compared to primary school teachers ($M_{primary}$ = 107.50, $M_{secondary}$ = 126.75) with a significant difference (U = 5663.5, z = -2.26, p = .024), suggesting that secondary school teachers may be more engaged in or aware of the latest developments in educational robotics, with an effect size of -.148, indicating a small to medium difference.

Table 5: The Readiness of Teachers for Humanoid Robots Use in Education, Based on Their Teaching Level

	Primary school		Secondary school		Mann-Whitney
	N	MR	N	MR	
I wish to use robots in teaching as soon as possible.	118	108.24	115	125.99	U = 5751.0, z = -2.08, p = .037
I am interested in the field of application and integration of robots into teaching.	118	112.03	115	122.10	U = 6198.5, z = -1.18, p = .237
I see significant potential in using robots in teaching in general.	118	118.48	115	115.48	U = 6610.0, z = -0.35, p = .724
I see significant potential in using robots in my specific subject area.	118	117.38	115	116.61	U = 6740.5, z = -0.09, p = .929
I follow progress in this field.	118	107.50	115	126.75	U = 5663.5, z = -2.26, p = .024

3.4 The Readiness of Teachers for the Use of Humanoid Robots in Education Based on Their Teacher Status and Teaching Level

This section (Tables 6, 7, 8, 9, and 10) assesses teachers' readiness to integrate humanoid robots into education, categorized by teacher status (pre-service or in-service) and teaching level (primary or secondary school), across five aspects.

The Readiness to Immediately Implement Humanoid Robots in Education

Table 6: Teacher Readiness to begin using Humanoid Robots in Education as soon as possible by Teaching Level and Teacher Status

Teaching level	Teacher status	M	SD	N
Primary school	In-service	2.16	1.001	38
	Pre-service	2.40	1.014	80
	Total	2.32	1.012	118
Secondary school	In-service	2.71	1.187	86
	Pre-service	2.45	1.121	29
	Total	2.64	1.171	115
Total	In-service	2.54	1.158	124
	Pre-service	2.41	1.038	109
	Total	2.48	1.103	233

Both primary and secondary level teachers, whether pre-service or in-service, show varying degrees of readiness to use robots in teaching as soon as possible. Mean and standard deviation values (Table 6) indicate the central tendency and dispersion of readiness scores across different groups. The two-way ANOVA test results suggest no significant interaction effect between the level of education and teacher status on this aspect of readiness ($F(1, 229) = 2{,}499$, $p = .115$).

Interest in Humanoid Robot Application and Integration

Table 7: Interest in Humanoid Robot Application and Integration in Education by Teaching Level and Teacher Status

Teaching level	Teacher status	M	SD	N
Primary school	In-service	2.76	1.324	38
	Pre-service	3.10	1.176	80
	Total	2.99	1.230	118
Secondary school	In-service	3.20	1.309	86
	Pre-service	3.21	1.177	29
	Total	3.20	1.272	115
Total	In-service	3.06	1.324	124
	Pre-service	3.13	1.171	109
	Total	3.09	1.252	233

Interest levels vary among teachers based on their teaching level and teacher status. The mean ranks (Table 7) suggest that, on average, teachers are moderately interested in applying and integrating robots into teaching. However, the two-way ANOVA test indicates no significant difference based on the level of education and

teacher status, suggesting that interest is relatively uniform across these groups (F (1, 229) = .807, p = .370).

Perceived General Potential of Humanoid Robots in Education

Table 8: Perceived General Potential of Humanoid Robots in Education by Teaching Level and Teacher Status

Teaching level	Teacher status	M	SD	N
Primary school	In-service	2.61	1.198	38
	Pre-service	2.89	1.055	80
	Total	2.80	1.106	118
Secondary school	In-service	2.83	1.210	86
	Pre-service	2.62	1.208	29
	Total	2.77	1.208	115
Total	In-service	2.76	1.205	124
	Pre-service	2.82	1.099	109
	Total	2.79	1.155	233

Teachers' perceptions of the general potential of robots in teaching indicate a moderate recognition of potential across groups (Table 8). The two-way ANOVA test results show no significant interaction effect between the level of education and teacher status, meaning that both primary and secondary teachers, whether pre-service or in-service, generally perceive similar potential in using robots (F (1, 229) = 2.089, p = .150).

Perceived Subject-Specific Potential of Humanoid Robots in Education

Table 9: The Perception of Subject-Specific Potential of Humanoid Robots in Education by Teaching Level and Teacher Status

Teaching level	Teacher status	M	SD	N
Primary school	In-service	2.53	1.156	38
	Pre-service	2.83	1.088	80
	Total	2.73	1.114	118
Secondary school	In-service	2.78	1.241	86
	Pre-service	2.62	1.178	29
	Total	2.74	1.222	115
Total	In-service	2.70	1.216	124
	Pre-service	2.77	1.111	109
	Total	2.73	1.166	233

The mean scores across groups (Table 9) suggest a moderate perception of potential, with no significant differences found between teachers according to their teaching level and teacher status based on the two-way ANOVA test results ($F(1, 229) = 1.802$, $p = .181$).

Engagement in Advances in Humanoid Robots in Education

Table 10: Engagement in Progress in the Field of Humanoid Robots in Education by Teaching Level and Teacher Status

Teaching level	Teacher status	M	SD	N
Primary school	In-service	1.89	.924	38
	Pre-service	2.48	1.067	80
	Total	2.29	1.055	118
Secondary school	In-service	2.62	1.200	86
	Pre-service	2.72	1.222	29
	Total	2.64	1.201	115
Total	In-service	2.40	1.167	124
	Pre-service	2.54	1.110	109
	Total	2.46	1.141	233

In this section, the readiness to follow progress in the field of humanoid robots in education is assessed. The mean scores (Table 10) indicate that teachers are moderately keeping up with advancements, with no significant interaction effect found between the level of education and teacher status based on the two-way ANOVA test results ($F(1, 229) = 2.107$, $p = .148$).

4 Discussion

The study reveals a moderate readiness among teachers for integrating humanoid robots into teaching, characterized by a cautious approach and varied opinions. This is supported by average scores that are not strongly positive and high standard deviations across survey items, indicating a broad spectrum of readiness possibly influenced by factors like personal experience with technology and technological comfort. The varied readiness among educators, as evidenced by high standard deviations across survey items, may reflect their diverse experiences with the core definition of humanoid robots as programmable entities that that resemble and act like humans, a concept established by Graefe and Bischoff (2003) and Ting et al. (2014). Although participants were provided with definition to ensure a uniform starting point for the survey, differences in readiness, based on their experiences,

could still emerge. While the moderate level of readiness, coupled with a recognition of potential benefits, highlights a general openness to using robots in educational settings, This general openness among educators to incorporate humanoid robots into their teaching practices aligns with the novel and interactive learning experiences these robots are known to provide, as noted by Dautenhahn (2007) and Engwall and Lopes (2002).

Comparing this study to previous research, it aligns with the cautious optimism noted in works of Lytridis et al. (2020) and Tuna et al. (2019), while addressing concerns similar to those described by Sharkley (2016) and Rani (2022). The cautious yet optimistic readiness among educators echoes the benefits documented by Belapme et al. (2018) and Movellan et al. (2009), particularly enhancing learning outcomes through interactive and engaging methods. This study examines readiness across various educator settings, contributing insight into the field. However, its sampling method may limit the generalizability of the findings. The absence of significant differences in readiness between pre-service and in-service teachers suggest a broadly uniform approach to robot integration in education. Yet, observed differences between primary and secondary school teachers hint a varying readiness level, which may be influenced by factors such as curriculum complexity and technological familiarity.

The study's primary hypothesis was to assess educators' readiness for integrating humanoid robots into the educational process, aiming to provide a foundational understanding of readiness across different educational levels and statuses. While this goal has been achieved, the study's findings serve as prompt for further research rather than a basis for immediate targeted interventions. The open questions about specific factors influencing individual readiness and the long-term impact of robot integration on teaching practices highlight the need for future studies to explore these aspects in greater detail, particularly through longitudinal research and by expanding participant diversity. The findings resonate with the practical applications of humanoid robots in education, such as those demonstrated by Breßler and Mohnke (2023), where the NAO robot significantly improved reading skills and facilitated interactive discussions.

Interest in extending the scope of research to include teacher attitudes towards robots in general, beyond humanoid forms, acknowledges the diverse potential applications of robotic technology in education. This broader perspective might reveal differing levels of acceptance and readiness, influenced by the perceived utility, ease of integration, and the specific educational outcomes associated with different types of robots. Furthermore, understanding the psychological, sociological, and ethical dimensions underlying teacher engagement with robotic technologies becomes imperative. The potential of humanoid robots to advance language learning and reduce student stress, as demonstrated by Kanda et al. (2004) and Buchem and Thomas (2022), underscores the versatility of these technologies in meeting diverse educational needs. An exploration into the pedagogical implications of robotic aids, assessing their impact on student engagement and learning outcomes, will be crucial. While this study focused on educators' perspectives and readiness to integrate such technologies, the conceptual alignment with findings from other research, such as Chin et al. (2011), suggests potential for student engagement in classroom settings where humanoid robots are introduced. Future research should aim to understand how robotic technologies, in their myriad forms, can complement traditional teaching methods, enhance learning experiences, and equip students with the skills necessary for a technologically advanced future. The readiness and cautious optimism among educators also relate to the technical attributes of humanoid robots, such as their programmability and lifelike interactions, features that Tuna et al. (2019) emphasize as critical for effective educational integrationBy emphasizing the need for detailed exploration of educators' specific needs and challenges related to robot integration, this study sets the stage for future research to build upon its findings and contribute to the effective and thoughtful incorporation of robots into education.

5 Conclusions

The primary objective of this research was to assess the readiness of educators for the integration of humanoid robots into educational settings. This endeavor sought to understand the extent to which teachers are prepared to embrace this innovative technology. This study uncovered a moderate level of readiness among educators, characterized by a mixture of cautious optimism and reservations. The main findings reveal that while there is an interest in exploring the potential of humanoid robots in education, concerns regarding the practical challenges of integration,

technological comfort levels, and the potential impacts on student development persist. These results are crucial in identifying the mixed sentiments educators hold towards the adoption of such technologies in teaching and learning environments.

A notable limitation of this research is its sampling methodology, which might restrict the generalizability of the findings. The study's scope, focused on humanoid robots, also points to the need for broader exploration into educators' attitudes towards various types of robotic technologies and the specific applications they might have in education. A key limitation of this study is the survey's design, which included only five scaled questions. This limited scope restricts our analysis of the high variability in responses, as we could not delve into deeper causes beyond noting the absence of significant group differences. While providing initial insights into educator readiness for integrating humanoid robots, the study does not comprehensively evaluate their attitudes. Future research should expand the survey scope and methodology to more accurately assess and understand the factors influencing educators' attitudes, crucial for developing targeted educational interventions.

This research contributes to the broader understanding of the problem by highlighting the nuanced perspectives of educators on the integration of humanoid robots in education. It underscores the importance of addressing both the opportunities and challenges posed by this technological advancement. The study calls for further detailed research to delve into the specific needs, preferences, and apprehensions of educators regarding robotic integration. By doing so, it aims to pave the way for more informed, effective, and ethical strategies to harness the potential of robots in enhancing educational outcomes.

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