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An examination of the correlation and compromises of Ofsted, The National Curriculum, and Physical Education in British Schools

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Abstract: *Physical Education (PE) is a core national requirement in the English National Curriculum (NC) that is timetabled for all children up to the age of 16. It requires students to acquire a mix of physical, social, and cognitive competence through sports. This study reports on levels of inclusiveness within the PE curriculum in a sample of 30 British secondary schools that had recently undergone an Office for Standards in Education (OFSTED) inspection. This was done through close document analysis of the PE curriculum maps of these schools, which are available in the public domain. Using a grounded theory approach, inductive thematic analysis was applied to identify themes such as sporting activities, teaching methods and pedagogy, opportunities within the curriculum, and skills and knowledge taught. The primary findings show that the information available through the school websites was disseminated mainly through the sports that the NC highlighted, implying that the schools' best approach to spreading PE knowledge is through organised sports, as well as secondary curriculum designs, knowledge, and assessments, that are more concerned with NC aims and objectives rather than considering inclusive practice and alternative sporting activities for their students.*

Keywords: *National Curriculum (NC); Ofsted Inspection Framework; Physical Education Curriculum; Sporting Activities; Pedagogy; Key Stage (KS)*

1. Introduction

The National Curriculum (NC) for Physical Education (PE) in England was last reviewed in 2013 to build on the changes made in 2007 by clarifying inclusion expectations and practices. The primary goal of the 2013 curriculum is for physical education to help every student improve their physical health, social skills, and self-development. However, the lack of precise advice on the NC, staffing requirements for PE, and delivery to promote aims and objectives creates a confusing environment, as schools have the freedom to construct a curriculum using the NC guidance as a proposal (Fletcher and Meir, 2019).

Attention to PE came in 2022, when the England women's football team, called Lionesses, reached the Euro 2022 final. Due to this success, the Lionesses wrote to the UK government

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requesting that all schoolgirls have access to football and two hours of physical education [PE] per week. The letter emphasised the importance of PE and sports in schools, as outlined in the National Curriculum [NC] (DfE, 2013), which mandates that secondary school students aged 11 to 16 participate in PE as a core subject. The Lionesses' extraordinary success was recognised with a £30 million fund that was aimed at approximately 30 new facilities to support more women and girls in grassroots sport. Thousands of women and girls across England are set to benefit from this cash injection that was approved by the government and The Football Association (FA). This meant to turbocharge the development opportunities for the next generation of Lionesses. In 2023, the Youth Sport Trust Foundation completed a survey with over 18,500 girls aged between 7 and 18, with the data showing only 64% of all girls enjoyed PE in comparison to 86% of all boys. The gap is particularly pronounced at secondary school, where just 59% of girls say they enjoy PE. As a result, a national study was conducted examining gender practices in secondary school PE in England highlighted that single-sex arrangements in core PE were the most common setting (Wilkinson and Penney, 2023). It was suggested that the arrangements were based in positively supporting gender diversity within PE, with a small number of schools organising PE in mixed-sex classes to be more inclusive. Equally relevant topic is that not all schools give it equal priority to PE, with some only providing 96 minutes of PE per week. Quality PE should meet NC standards and promote physical activity, but this is contingent on the school's understanding of PE and compliance with the NC and Office for Standards in Education (Ofsted) (2023). . Ofsted, a regulatory body for education in England, carries out inspections to assess consistency and discrepancies against the NC for PE and Ofsted's framework for educational quality. The 2019 revamp of Ofsted's Education Inspection Framework renewed emphasis on a critical area: ensuring that all students receive a high-quality education. This framework emphasises three crucial aspects:

- Education Quality: This assesses curriculum design, implementation, and impact, striving for an ambitious and inclusive curriculum that equips all students with the knowledge, skills, and cultural capital they need to succeed.
- Behaviour and Attitudes: This evaluates students' well-being, aspirations, and the overall school environment, fostering a positive learning space where students feel safe, supported, and motivated.
- Personal Development: This examines how the curriculum goes beyond academics to nurture holistic development, encompassing social, emotional, and

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physical growth, ensuring students acquire the necessary life skills to navigate the world beyond the classroom.

Ofsted uses objective, outside assessments to pinpoint areas that need improvement. These evaluations follow predetermined standards, such as equality and safeguarding considerations, and are grounded in evidence. When it comes to delivering education, schools must design curricula that meet a variety of needs while maintaining high standards of learning. In PE, there are concerns regarding whether to emphasise fundamental motor abilities or use game-based activities, as well as whether or not students with various learning difficulties make equivalent progress to those without special educational needs. These factors emphasise the necessity for ambitious and all-encompassing curricular strategies to serve all students. Since it lays the foundation for expectations, the framework is a crucial part of the study and curriculum designs.

The 2019 framework portrays the expectations for educational quality using three 'i's: intent, implementation, and impact. It is anticipated that the department curriculum will incorporate the requirements for each area. These standards promote an approachable curriculum that helps students grow and succeed regardless of their characteristics. The benefits and drawbacks of PE have been the subject of numerous studies that have concentrated on instructional strategies and evaluation (Caena, 2014; Herold, 2020; Simmond and MacLean, 2018; Foster and Nerys, 2019), but have neglected to discuss the underlying ideology of curriculum designs. With an emphasis on how the designs adhered to PE NC recommendations and the Ofsted (2019) inspection framework, which is used to analyse and evaluate the quality of education inside schools, the current study aimed to examine PE curriculum and their designs. According to Brown and Penney (2017), curricular reforms and frameworks have an impact on pedagogy, or the practice technique, which in turn affects curriculum designs and summaries of how a subject should be taught. Overall, the NC recommends consistent physical activity [PA] to boost confidence, knowledge, and abilities in PE, as well as providing a variety of sports experiences to all students (DfE, 2018). The NC provides guidelines for various sports that can be taught, but they are not mandatory

The Physical Education National Curriculum in England

The revised NC introduced key features to support inclusion, such as adapted activities: guidelines on how to modify physical activities (PA) to be inclusive of all students with special educational needs and disabilities, which included the use of adaptive equipment and the creation of an environment conducive to participation for all. The NC recommended inclusive

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teaching strategies, such as differentiated instruction and collaborative learning, to effectively support students with diverse needs in the PE setting. Furthermore, improved methods for assessing and monitoring the progress of students with special educational needs and disabilities in PE were introduced with the intention to ensure that all students have equal access to physical education and receive appropriate support. PE is the only discipline where the major emphasis is on the body and the development of physical competence. As a result, PE curricula must address both the NC and the impact of a variety of physical and social opportunities such as confidence, self-esteem, and self-worth (Harris and Cale, 2018). All of these are taught through a practical environment but may not be explicitly outlined and drawn within the curriculum (Griggs and Fleet, 2021). Previously, curriculum designs were based on a variety of underpinning philosophies, ranging from sports education, which focuses on the development of sports and skill acquisitions, to personal, learning, and thinking skills, which are promoted through sports, with little emphasis on sport and physical literacy. However, Westbrook et al. (2013) debates that the underlying philosophy of curriculum design must consider a wide range of factors, such as inclusivity, while remaining unique to the school.

2. Theoretical framework

Developed by Glaser and Strauss (1967), grounded theory can offer important insights into the coherence and integration of curricular components when analysing PE curricula in light of the NC and the Ofsted framework. Grounded theory can be used by researchers to examine how different teaching methods conform to national regulations and to pinpoint the underlying links and structures that influence the curriculum. This theoretical framework does not define the concept of reality about a piece of research, but rather the moment and focal point(s) within it; the theories developed are an attempt to define and understand a phenomenon, in this case, the term inclusion within PE. The framework was used to monetize critical data-driven assumptions by extending existing knowledge (Grant and Osanloo, 2014). Therefore, the thirty widely available documents were analysed to reveal patterns and differences in how teachers understood and implemented inclusive practices.

This approach helps to clarify the complex relationships between policy requirements and classroom procedures, which advances teachers' knowledge of how successful education is in the context of PE (Breckenridge, 2009). There are obstacles in the way of implementing a national physical education curriculum, notwithstanding the potential advantages. Different sociocultural contexts and local control over curricula are two examples of factors that could

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make a standardised strategy difficult to adopt (Herold, 2020), thus suggesting the importance of using a subjective approach when exploring curriculum documents. Subjectivism is the philosophical view that truth and knowledge are not objective facts that are independent of human perception (i.e., leaders who create the curriculum documents) but rather are essentially based on personal experience (Al-Saadi, 2014). This relationship between the individual and society emphasises how context shapes moral judgements and subjective truths, underscoring the interdependence of individual experiences and social influences (Hossain and Ali, 2014), which in this case focuses on the design of a curriculum map to promote PE holistically for students.

3. Methodology

Using the NC and Ofsted Inspection framework policies as quality assurance viewpoints, the study aims to determine the differences and trends between the PE curriculum designs for Key Stage 3 (Ages 11 to 14) and Key Stage 4 (Ages 14 to 16) in England specifically looking at the contrast between adherence to NC requirements. Additional aim is to examine a personalised approach that allows for effective inclusive practice. Curriculum maps from 30 recently Ofsted inspected schools were studied to obtain a thorough grasp of curriculum design in PE (DfE, 2019). The "three I's"—intent, implementation, and impact—are highlighted in this approach. With an emphasis on the justification for educational objectives (intent), the strategies used to provide information (implementation), and the results obtained (impact), these components provide an organised framework for evaluating the efficacy of curricula. This method of data collection is rather structured and can be numerical which strengthens the research aims. Questionnaires may be able to offer additional way to gather a great deal of information in relatively short time which can offer considerable advantages in administration; however, due to timeframe given to carry out this research the curriculum mapping proven to be the best option.

The main goal in evaluating these curricular maps was to understand more about how these schools prioritise and organise PE lessons, particularly concerning inclusion and promoting pedagogical development. Curriculum maps and related documentation were crucial to this study because they document the expected learning process for students and are consistent with educational theories and previous research. Additionally, this method was convenience and it was freely available on the school’s website. This also ensured that the research was more ethical, as it did not involve human participation. According to research by Richards (2013),

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these documents are essential l for showing how teaching methods and learning objectives have changed over time because they reflect the methodical, step-by-step approach to curriculum design that encourages ongoing pedagogical development. A department's overall approach to teaching physical education is reflected in these materials, which range from particular sports skills to more general learning goals like physical literacy, teamwork, and personal growth.

Although the grounded theory approach offers an unequalled approach to learn about programme impacts and outcomes, curriculum maps have limitations, according to Bryman (2004) and Karl (2010). It was claimed that they do not provide enough specific information about teaching methods, student needs, and larger school policies that affect instruction. For example, a curriculum map might include the sports or subjects that are taught each term, but it might leave out important details about instructional practices, differentiation tactics, or how school policies affect the classroom's atmosphere. Curriculum maps are frequently made by school administrators and leaders rather than classroom teachers, which can result in documents that emphasise alignment with the NC guidelines but may not fully capture the nuances of classroom interactions and adaptations made by teachers to meet diverse student needs. This discrepancy is especially significant. Despite these drawbacks, curricular maps are nevertheless useful tools for this research. They offer a structured, hierarchical perspective of how physical education departments organise and rank their instruction. Through analysing these documents, the grounded theory are fashioned directly from the emerging analysis of the data (Glaser and Strauss, 1967) more can be learnt about the department's goals for the growth of PE students, such as the variety of sports available, the term-specific themes, and any particular knowledge or abilities that students should eventually learn.

3.1. Sample

Thirty recently inspected secondary schools were included (between 2019 – 2023) in this study. Schools were identified using the Ofsted search engine ("Find an Ofsted inspection report," 2017). To preserve sensitive information, the names and identities of the schools were kept anonymous. Out of the forty-three schools that were recently analysed, only thirty have curricular maps that are easily accessible in the form of Microsoft Word documents, Excel spreadsheets, or Portable Document Format (PDF). A sample size of 30 represents the number of schools that were recently inspected before, during, and after COVID pandemic since the 2019 Ofsted framework is pertinent. From the 30 schools listed, a total of 38 papers were gathered, stored, and uploaded to the NVivo 12 cloud.

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3.2. Data analysis

NVivo 12 is important for inductive coding because it can effectively handle and evaluate large policy documents. Mikuska (2021) particularly highlights its usefulness for managing large amounts of text data and facilitating systematic analysis within a research. For academics looking to assess the effects of policies and provide information for decision-making processes, this software is a vital resource since it facilitates the methodical investigation of themes, connections, and patterns in qualitative data (Elliott-Mainwaring, 2021). Coding is an essential stage in converting unprocessed qualitative data into conclusions because it makes it possible to categorise and characterise the results' relevance. The curricular documents, as previously stated, were given as qualitative data. Each segment can be named and identified, enabling the researcher to present the research findings (Saldana, 2015). While deductive coding uses pre-existing codes that offer a framework-like approach to study, inductive coding necessitates the researcher to generate codes directly from the data (Linnerberg & Korsgaard, 2019). Inductive analysis was more suitable for the current study due to the volume, diversity, and openness of the research topics and data gathered, as it enabled the examination of a broad range of features present in the maps. By using NVivo 12, it enabled to save curriculum documents and use inductive coding to create themes that mirrored the goals and objectives of the study. The freedom to examine the data was made possible by inductive coding, as was previously explained. The research was able to systematically aggregate the data because the codes included specific tags or highlighted colours. This is where application of the grounded theory proven to be useful, as it intends to free the researcher from pre-conceived or a priori assumptions. Seventeen sub-codes were established after the six fundamental codes including sporting activities, skills and knowledge, lesson objectives, teaching style and, and curricular options. As it looks for and understands the events, processes, opinions, and worldviews that lie behind the data, the inductive technique seems to be far more flexible (Cooper & Endacott, 2007; Cresswell, 2009).

Data-driven decisions were the main focus of the first coding round, and the information collected was based on concepts of physical education and the secondary school criteria established by Ofsted. The following phases were finished via a hybrid approach akin to that employed by Joffe (2019) and Braun and Clarke (2006): (1) becoming acquainted with the data; (2) creating preliminary codes using conceptual information from NC guidelines and Ofsted Criteria; (3) evaluating the codes in light of the goals of the study; and (4) creating more sub-codes that refer to the main codes and have more thorough descriptive summaries. A manual

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thematic analysis provided flexibility and accessibility for interpreting qualitative data when referring to theory, in this case, the NC and Ofsted framework (Braun and Clarke, 2006). As a result the study was able to: (1) identify key codes that referenced the study's objectives; (2) assess themes and evaluate both concerning education; and (3) do additional sub-codes and interpretative analysis by looking at either patterns or compromises. The following table shows the emergent themes (Table 1.):

Table 1. Thematic coding results obtained through Nvivo 12, regarding curriculum details and information

Subthemes	number of codes/nodes	Themes
opportunities within the NC; tactics and strategies; performance analysis; formative and summative assessment	45	Teaching Methods and Pedagogy
striking; fielding; net and wall; invasion games; gymnastics, trampolining, dance	287	Sporting activity
creative movement; theoretical knowledge; practical skill; life skills	167	Skills and Knowledge taught
alternative opportunities within PE; coaching, leading, refereeing;	57	Opportunities within the curriculum
assessment methods; skills and knowledge thaught; NC; methods of engagement	68	KS4 National Curriculum aims
assessment methods ; NC; engagement	69	KS3 National Curriculum aims

4. Research Results

Using the 2019 Ofsted Inspection Framework and National Curriculum Aims, 35 papers from 30 schools were inductively coded. Six major codes, seventeen sub-codes, and 426 tags were obtained through a manual thematic analysis (Appendix 1) (Mauthner and Doucet, 2003) (Fig 1.).

4.1. Key Stage 3 and 4 National Curriculum Aims

A total of 68 references from 35 publications made mention to the KS3 and 4 NC goal codes. The materials primarily cited the NC recommendations, with only minor additions and modifications created for the individual. One institution remarked, for instance,

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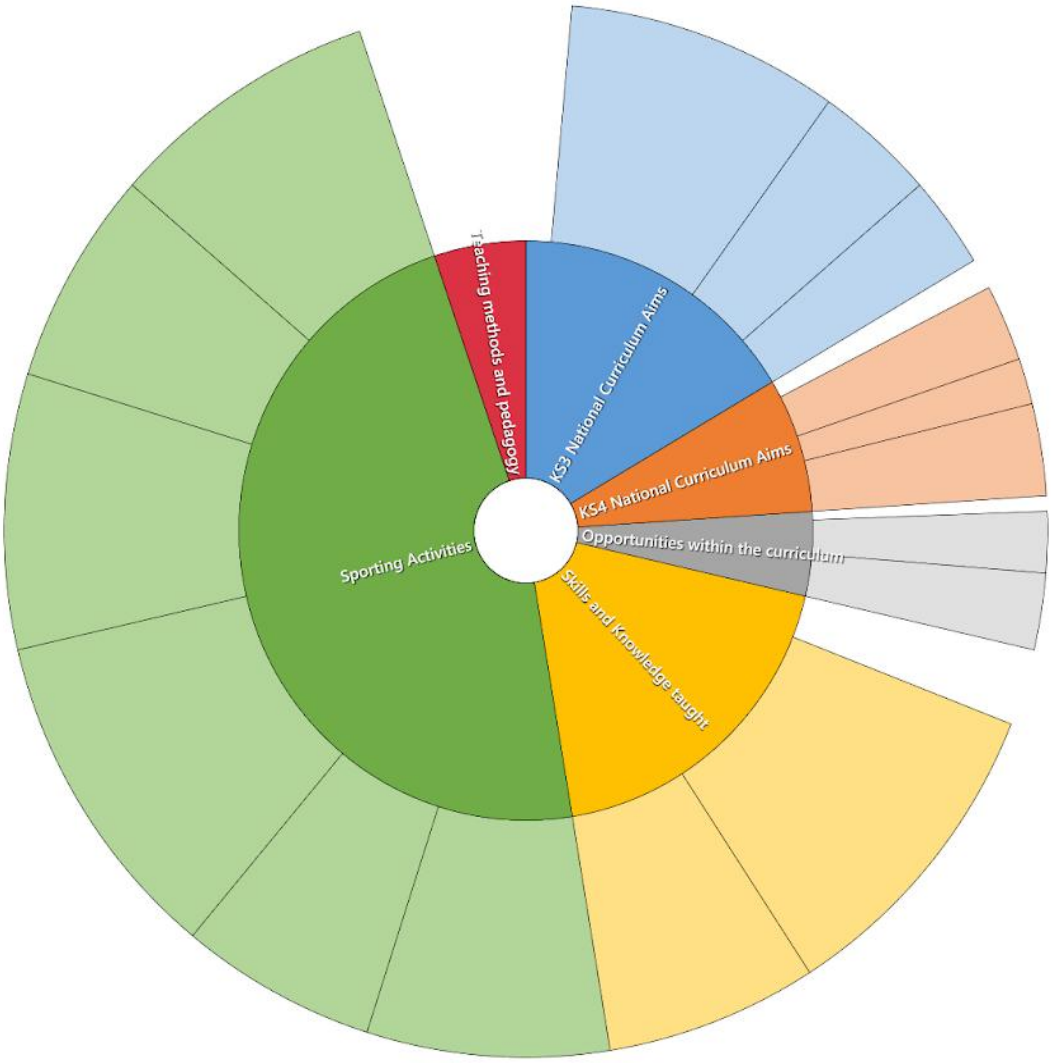
"*Develop their technique and improve their performance in competitive sports such as athletics and gymnastics" - Secondary School in Lancashire*

Such a statement is a carbon copy of the KS3 NC aim, bullet point two (*National curriculum - physical education key stages 3 and 4 - gov.uk* 2013). Another school stated;

"During year 9 students will have started to develop their knowledge of how to measure sporting performance" - Secondary School in Merseyside



Red - Teaching Methods and Pedagogy Green - Sporting activity; Yellow- Skills and Knowledge taught; Grey - Opportunities within the curriculum Orange - KS4 National Curriculum aims

Blue - KS3 National Curriculum aims

Fig. 1. The six primary codes and their corresponding sub-codes, which were painstakingly created from the curricular maps, are shown visually.

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The curriculum maps consistently emphasised "game-like circumstances" as a key way to show understanding and development. Curriculum maps showed a focus on practical performance by using NC guiding points one and three as a guide. For instance,

> *"Games: To learn how to outwit an opponent in face to face competition. This will include Invasion Games (Football, Netball, Basketball, Rugby). Become more competent and confident performing skills in progressively challenging practices and be able to apply them across a range of activities in competitive situations" - Secondary School in Chester*

Whilst other curriculum maps focused on how the competitive situation would be assessed;

> *"Students will be required to peer and self-assess their own and others performances in Core PE. They will do this through a variety of methods such as observation checklists, video analysis and other worksheets. Success Criteria will always be referenced when referring to self and peer feedback" - Secondary School in Staffordshire*

The fifth KS3 NC target is mentioned in the statement. Additionally, there were no references that mentioned KS4 PE assessment techniques. This indicates that while the curriculums made mention of the NC KS4 goals, they did not specifically define how they would measure or evaluate the objectives. Most citations concentrated on the growth of learning and enjoyment for lifetime engagement but provided no specific direction on how such requirements would be met.

> "*Inspiring a lifelong love of sport for all pupils through excellence, knowledge and opportunities" - Secondary School in Staffordshire*

However, a small minority of schools had more personalised references to the NC aims.,

> *"Due to low-class numbers, particularly on the girls' side of PE, we can give students a choice of activities. Students develop skills in isolation and gameplay, as well as tactics and evaluating performance" - Secondary School in Surrey*

Students can get a sense of the school's goals and values for NC counselling from these claims. Even though departments may alter their teaching and learning to meet the needs of their schools through different identities, many departments do not provide specifics on how they plan to implement the NC goals to meet their standards. It might be argued that such a policy is more likely to be developed to show compliance with NC criteria and the Ofsted Inspection

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framework for curriculum designs than it is to serve as the mechanism that supports the curriculum design.

4.2. Skills and knowledge taught

Specific learning objectives and how physical education would be used to teach these skills were described in the curricular guidelines. The focus placed on 118 references to practical skills and 24 references to theoretical knowledge indicate that practical development is an important part of physical education courses. Nonetheless, a debate concerning the lack of coherence in the curriculum designs resulted from the differences in the theoretical knowledge and skills that were taught. For instance,

> *"Games: To learn how to outwit an opponent in face-to-face competition. This will include Invasion Games (Football, Netball, Basketball, Rugby). Striking & Fielding(Cricket, Softball, Rounders & Tennis). Net & Wall games (Volleyball & Table Tennis). Focus will be on skill development in isolation progressing to executing skills in modified competition" - Secondary School in Chester*

Whilst another school would state:

> *"Build upon the physical development and skills learnt in year 7. Become more competent and confident performing skills in progressively challenging practices and be able to apply them across a range of activities in competitive situations" - Secondary School in Manchester*

Although one statement emphasises athletic activities and the other more general growth, both show how practical abilities can be enhanced. But we need to look at the skills that are being taught right now. How can a physical education curriculum show proficiency and overall development? Additionally, the majority of schools placed more emphasis on the development of skills than on theoretical knowledge, which was supported by the curriculum assessment methods. Variations in PE training can be attributed to a variety of factors, including the department's vision and aim as well as the availability of resources. Some curriculum documents were very specific,

> *"Students acquire the following skills: Rolling, jumping, landing, control, supporting and sequencing" - Secondary School in Dudley*

Whilst others were more ambiguous,

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> *"Pupils will learn to choose, combine and perform a variety of skills with accuracy and control" - Secondary School in Gloucestershire*

The quotes mentioned earlier highlight the glaring disparities in the curriculum materials' standards; some documents do not specify how each activity would be taught, while others do not cover all of the knowledge and abilities that would be taught throughout the major stages. The curriculum texts, however, with their ambiguous remarks, had more approachable evaluation techniques, emphasising assessment without levels,

> *"Throughout Key Stage 3, students will develop using the following three themes; Self-belief (Linked to Greatness whole school value), Cooperation (Linked to Honesty whole school value), and Resilience (Linked to Strength whole school value)" - Secondary School in Oxford*

or a GCSE PE level 1 to 9 sporting activity criteria to promote ongoing growth. For example,

> *"We wish to develop theoretical knowledge, applying knowledge to sporting examples and furthering knowledge to be able to begin to evaluate, using our A03 assessment criteria from GCSE PE. Students will then be able to make reasoned arguments about important issues such as performance enhancement, Components of fitness and Types of Training to confidently articulate their opinions and challenge their peers' opinions using evidence to support their argument" - Secondary School in Chester*

The Ofsted Inspection Framework's emphasis on curriculum effect, which mandates that curriculum designs demonstrate how learning influences development and progress, may be the basis for such a procedure. As a result, skill-specific curricula created assessment methods that demanded that talents be tried and completed to satisfy specific requirements, thereby demonstrating a degree of impact.

4.3. Sports activities

The purpose of physical education is to encourage all students to succeed in physically demanding activities by promoting high-quality physical education, according to the introduction of the NC PE guidelines. The majority of curriculum resources are based on sports. Invasion Games (55), Striking and Fielding (22), Net and Wall (24), Athletics (17 references), Creative Movement (18), and Other Activities were the sub-codes for the sports (23). The other categories might have depended on space management and availability, with some schools able to offer "fitness and gym," while others could have offered rock climbing, even though invasion

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games had the most references. The NC guidelines for grades three and four provide suggestions for teaching sports (in square brackets) and how they relate to learning goals. The NC guidance clearly states,

> *"Schools are not required by law to teach the example content in [square brackets]."*

The sports included in square brackets, however, make up the majority of the sports discussed in the newspaper. To meet the requirements of an Ofsted inspection, schools might adhere to the NC guidance. Additionally, staff members might be hesitant to enhance their knowledge and delivery abilities to teach new and emerging sports like paddle ball, hurling, and ultimate frisbee. To demonstrate the connections and consistency of the English physical education curriculum, schools and departments could feel that the available sports should be contrasted with the NC examples. The curricula may then demonstrate that they satisfy the requirements of the inspection framework in terms of having a well-defined goal, resources to carry out the activities, and methods to evaluate their impact. Incorporating new or emerging sports may make people feel vulnerable in terms of meeting NC criteria. Despite this, academies are not required to follow the NC advise. Furthermore, student experiences, demographic demands, and the liberation of physical ability through athletics could not be considered in the curricula.

4.4. Opportunities within the curriculum

The Ofsted inspection framework (2019) was used to construct the following code, which places a strong emphasis on inclusive teaching practices. Curriculum papers must demonstrate how they implement inclusiveness by incorporating alternative possibilities within their designs. This knowledge is derived from the NC development recommendations and the inspection framework's requirements for teaching, learning, and pedagogy. Two sub-codes were established using the terms "alternative possibilities within PE" and "development of life skills." A total of 12 references were highlighted among the 35 papers.

> *"CC Links • History – how did cricket travel from England to the rest of the world? PSHE – British values – rules and regulations" - Secondary School in Somerset*

Although not always, PSHE and cross-curricular integration were common topics in the majority of curriculum documents. The "breadth of learning" emphasis of the Ofsted Inspection Framework is demonstrated by integrating with other disciplines like science, geography, history, etc.Other curriculum maps demonstrated more streamlined opportunities such as;

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> *"PSHE Focus on Healthy active lifestyle, Drama- link to the Dance unit- devising from stimulus, Music- creating motifs through dance and Gymnastics" - Secondary School in West Yorkshire*

The idea of having chances in the curriculum that are directly related to the subject—for example, focussing on diet and connecting it to physical education—may be a little unclear, though. A KS3 curriculum should be different from a KS4 curriculum, according to the Ofsted Framework, so that students have access to a range of learning opportunities. GCSE and Vocational courses, which are KS4 PE alternatives, may contain a directly related curriculum. The concept does, however, indicate some opportunities for curriculum diversity, even though it is not found in all books and is used sparingly throughout. The curriculum could instead include alternative opportunities through informal written instructions that represent teaching methods and practices.

4.5. Teaching methods and pedagogy

Teaching strategies must follow and show various approaches to delivering distributive information while taking into account the Ofsted inspection framework, which forms the basis of curriculum papers. Additionally, certain recommendations for inclusive teaching practices are provided by the Ofsted inspection framework (2019). There was unmistakable evidence of teaching ideologies that were closely tied to the sports that were given.

> *"Key Methods of Delivery Guided Discovery. Students creating and implementing their own ideas/tactics Lay-up – whole part whole method TGFU" - Secondary School in Wolverhampton*

Clear indicators of teaching style and teaching focus, whilst others highlighted student outcomes.

> *"We know our students: PE teachers understand the needs and abilities of all their students. PE teachers adopt the approach of high support and high challenge within lessons, planning lessons tactfully to meet these needs and responding carefully in lessons to these needs so all students are provided with opportunities to be supported and challenged" - Secondary School in Durham*

The curriculum's structure is clear with these guiding principles since departments have given detailed descriptions of how they wish to communicate their curriculum themes. There is a

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correlation in the distributive knowledge evaluation process since the instructional tactics have an impact on student comprehension, which is the basis for distributive knowledge assessment.

5. Discussion

The study aimed to investigate the elements that support the creation of physical education curricula, as well as the connection between the National Curriculum (DfE, 2013) and the Ofsted Inspection system (Ofsted, 2019). The research also looked at the curricular materials to see how adjustments or modifications were made to the NC criteria to ensure the quality of PE instruction across KS3 and KS4. One important starting point for figuring out whether teaching pedagogy is uniform across schools was the Ofsted inspection system.

5.1. KS3 and 4 National Curriculum

A person's ideas and prior experiences have a significant impact on how they implement the idea of a national curriculum, and each school may view it differently depending on sociocultural, historical, and contextual aspects (Oh and Graber, 2019). Instead of being generated by an algorithm, staff personnel design most curriculums. Pre-context and other elements that might influence the design—from the designers' prior experience to the requirements of the school—must be considered. According to Biesta (2017), the PE NC may fail to advance the perspectives of students from specific demographic groups and backgrounds since the policies do not consider social justice. This could provide a picture of persistent problems in physical education, likeability development, social pressure to engage in physical activity, and the requirement for quantifiable results. With 68 references from 35 curriculum materials that directly relate to the KS3 and 4 National Curriculum aims and objectives, it is reasonable to assume that the majority of schools follow the NC principles when creating and implementing their curricula. The vast majority, meanwhile, do not elaborate on how they plan to use the objectives. It was evident that the common underpinning theory employed across the curriculum referred to the NC, the skills that were taught, leisure activities, and competitive scenarios since NC served as the foundation for the guiding idea. For instance, the majority of curriculum texts emphasised the value of "competitive settings" and engaging in game-like activities; nevertheless, given that sports may be relatively new, we must question the necessity and quality of both. However, because the curriculum just outlined the NC and not how it would be delivered to advance understanding, it was unclear how knowledge would be altered (Shay, 2013). Despite being well-structured and comprehensive, the curriculum papers' nature

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indicated that teachers were not given much help because they focused more on teaching, development, and advancement than the content that was indicated concerning the Ofsted curriculum standards. Given that the evidence suggests that the practices' stagnation and divergence may not alter in the medium- to long-term, such conclusions may suggest that the most recent curriculum revision may have an impact on physical education in the UK (Herold, 2020).

5.2. Ofsted Framework

The Ofsted framework evaluates curriculum documents based on the intent, implement, and impact criteria. To demonstrate the breadth and depth of learning, curriculum designs must make use of the three i's. There is a definite correlation between the NC policy information and how these goals are interpreted and understood through the sports that are used as examples. In line with NC principles, these materials seek to advance sports as the main vehicle for delivering and advancing physical education. Some departments may have prioritised skill development and greater physical activity over theoretical opportunities due to concerns about children's health and physical inactivity, especially after COVID-19 (Prince & Annison, 2022). The study's other key findings concern instructional methods, classroom environment as outlined in curriculum maps, and educational quality. When looking at the Ofsted implementation criteria, there is a strong connection between the KS3 NC teaching that addresses "techniques in performance" and the curriculum document notes that list the skills being taught. Since there is such a clear focus on sporting abilities and growth within varied activities, the implementation phase is made easier because the skills are taught through the sporting activity. As can be observed from the findings, the majority of the sports offered in the sample were related to the same sports listed in the NC, suggesting a clear link to ensure or promote curricular conformity. Another important finding from this study relates to teaching methods, curricular maps that describe classroom environments, and educational quality, all of which are in line with Ofsted's implementation. There is an obvious connection between the KS3 NC instruction on "techniques in performance" and the curriculum document comments mentioning the skills being taught when evaluating how curriculum information is used in the classroom. Notes on the fundamental and sophisticated abilities that are taught and cultivated through sports. They can be further separated into motor skills necessary for all sports and movement skills essential to the sport being taught (Muller, 2007). The curriculum maps simply attempt to include as many "learning opportunities" as feasible, thus a mix of knowledge and sports can either show

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depth or clear up misconceptions. Then, the focus is on how effective physical education is and how instruction can change learning. Why engage in gaming? Why sports? Why are there no other ways to teach physical education? The practicality of the document illustrates how NC education and delivery standards are consistent.

6. Evaluation

Since the curriculum materials show how information is communicated, their adaptability is essential (Ekberg, 2021). The results demonstrated a variety of assessment concerns, the majority of which mentioned sports, abilities, and life lessons that physical education may impart. The criteria for assessing athletic skills reveal progressive development points, whereas athletic skills exhibit continuous development across critical periods, illustrating the difference between an unstructured and planned curriculum. However, because there is no "one size fits all" approach, the variety of assessments affects the design of a course. Some assessments focus on assessments without levels, showing a degree of progress that focuses on school development objectives, while others adhere to teaching and learning objectives. In contrast, some curriculum materials used the Key Stage 4 certificated (GCSE) PE levels 1–9 assessment criteria, emphasising skill development as a key element of progress demonstration. It is necessary to take into account how curricula demonstrate evaluation. The GCSE PE standards are referenced in the background of sports abilities based on GCSE levels and criteria, suggesting that the curriculum design places a strong emphasis on skill development, skill acquisition, and the development of competence to engage in a particular activity. As a result, most schools may modify their evaluation criteria to change their teaching strategies if there is not a clear primary goal or agreement to adhere to the NC. A complete curriculum is made possible by streamlining cohesive assessment procedures, but the bigger picture might highlight the connection between underlying pedagogy, instruction, and learning activities.

7. Conclusion and recommendations

The report started by claiming that the PE curriculum has altered and developed over time in response to a variety of outside factors, including new PE programs, Ofsted inspection frameworks, and NC recommendations. However, this study demonstrated that curriculum designers must ensure that an underlying concept of the NC serves as a development building block. This is important since curriculum design requires the local field to establish important needs, such as the Ofsted inspection system and NC criteria. Curriculum designs are affected

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by compromises made with specific activities taught, instructional methods, and assessment forms. However, most curriculum materials adopted the NC's goals and objectives without providing much detail on how those standards would be met. There was little uniformity among the designs of the various foci, with some emphasising skill and others' overall development. Though they all draw from the NC recommendations, each curriculum design uniquely applies the information. Since it shows that a curriculum is adaptable and that departments are allowed to express and promote provisions that appeal to their target audience, the fact that these principles seem to be more impacted by evaluation methodologies than by core goals may be advantageous. There are notable compromises throughout the research, even though it does not offer a conclusive explanation of the relationship between PE curricula, NC, and the Ofsted framework. Sports-related activities that focus on holistic development and other skill competencies are instances of such compromises. According to the survey, the majority of schools focused on athletic skills, and even fewer had descriptive information on evaluation techniques. Few schools had documentation for the KS4 curriculum. Even while there is clear evidence of compromises and some connection to NC and Ofsted, more research on the fundamental principles and components of curriculum designs, as well as the rationale behind specific decisions, would be helpful.

The need for future study is therefore essential to address the following recommendations. It is recommended that the PE curriculums should include both NC guidance and the development of various physical and social skills. These skills should include confidence, self-esteem, and self-worth as I was suggested by Harris and Cale (2018). As Griggs and Fleet (2021) suggest, these skills are learnt through hands-on experiences, even if they are not explicitly stated in the curriculum. In England, schools have recently emphasised their focus on reading, numeracy, and test performance, as well as limited school funds, all of which tend to limit the subject's prestige and push much-needed relevant professional development down the pecking order- therefore this issue also needs to be addressed. As a result, departments must consider how their curriculum design can align with, at the very least, NC advice and Ofsted's standards of quality education and curriculum, allowing the education judgement to be evaluated against the inspection criteria (Ofsted, 2019). To that end, any reliance on departments as the sole source of curriculum design could be viewed as fabricated because the underlying concept may reflect PE's ability to recognise Ofsted rather than access learning opportunities to assist learning at appropriate times.

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References

Al-Saadi, H. (2014). *Demystifying ontology and epistemology in research methods*. University of Sheffield, 1(1), 1–10.

Boddy, C. (2016). The sample size for qualitative research. *Qualitative Market Research: An International Journal, 19*(4), 426-432.

Bochner, A. (2018). Unfurling rigour: On continuity and change in qualitative inquiry. *Qualitative Inquiry, 24*(6), 359-368.

Breckenridge, J. & Jones, D. (2009). Demystifying Theoretical Sampling in Grounded Theory Research. *Grounded Theory Review.* 8. 113-126.

Brown, T.D. & Penney, D. (2017) Interpretation and enactment of Senior Secondary Physical Education: Pedagogic realities and the expression of Arnoldian dimensions of movement. *Physical Education and Sport Pedagogy* 22(2): 121–136.

Caena, F. (2014). Teacher competency frameworks in Europe: Policy-as-discourse and policy-as-practice. *European Journal of Education, 49* (3), 311-331.

Cooper, S. & Endacott, R. (2007). Generic qualitative research: A design for qualitative research in emergency care? *Emergency Medicine Journal, 24* (12), 816-819.

Creswell, J. (2009). *Research design: Qualitative, quantitative, and mixed methods approaches* (3rd ed.). London: Sage.

Department for Education (2013) *National curriculum - physical education key stages 3 and 4 - gov.uk*. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/239086/SECONDARY_national_curriculum_-_Physical_education.pdf (Accessed: December 9, 2022).

Dixon, K., Braye, S., & Gibbons, T. (2022). Still outsiders: The inclusion of disabled children and young people in physical education in England. *Disability & Society, 37*(10), 1549-1567.

Elliott-Mainwaring, H. (2021). Exploring using NVivo software to facilitate inductive coding for thematic narrative synthesis. *British Journal of Midwifery, 29*, 2-6.

 License: CC BY 4.0

Ekberg, J. E. (2021). Knowledge in the school subject of physical education: A Bernsteinian perspective. *Physical Education and Sport Pedagogy, 26*(5), 448–459.

Esterberg, K. G. (2002). *Qualitative methods in social research.* Boston, MA: McGraw-Hill.

Evans, J., & Penney, D. (2008). Levels on the playing field: The social construction of physical 'ability' in the physical education curriculum. *Physical Education & Sport Pedagogy, 13*(1), 31–47.

Francis, J., Johnston, M., Robertson, C., Glidewell, L., Entwistle, V., Eccles, M., & Grimshaw, J. (2010). What is an adequate sample size? Operationalising data saturation for theory-based interview studies. *Psychology & Health, 25*(10), 1229-1245.

Gert J. J. Biesta (2018*) The Rediscovery of Teachin*g, London: Routledge.

Glaser, B., & Strauss, A. (1967). *The Discovery of Grounded Theory: Strategies for Qualitative Research. Mill Valley*, CA: Sociology Press.

Griggs, G., & Fleet, M. (2021). Most people hate physical education and most drop out of physical activity: In search of credible curriculum alternatives. *Education Sciences, 11*(11).

Harris, J. and Cale, N. (2013). Physical education teachers educate students' knowledge, perceptions, and experiences of promoting healthy, active lifestyles in secondary schools. *Physical Education and Sport Pedagogy, 19*(5), 466-480.

Haycock, D., & Smith, A. (2010). Inclusive physical education? A study of the management of national curriculum physical education and unplanned outcomes in England. *British Journal of Sociology of Education, 31*(3), 291–305.

Herold, F. A. (2020). 'There is new wording, but there is no real change in what we deliver': Implementing the new National Curriculum for Physical Education in England. *European Physical Education Review, 26*(4), 920–937.

Johnson, D. W., Maruyama, G., Johnson, R., Nelson, D., & Skon, L. (1981). Effects of cooperative, competitive, and individualistic goal structures on achievement: *A meta-analysis. Psychological Bulletin,* 89(1), 47–62. https://doi.org/10.1037/0033-2909.89.1.47

Kiger, M. E., & Varpio, L. (2020). Thematic analysis of qualitative data: AMEE Guide No. 131. *Medical Teacher, 42*(8), 846–854.

Light, R. (2012). *Game sense: Pedagogy for performance, participation, and enjoyment.* London & New York: Routledge.

McPhail, G. (2015). Music on the move: Methodological applications of Bernstein's concepts in a secondary school music context. *British Journal of Sociology of Education, 37*(8), 1147-1166.

Miles, M.B., Huberman, A.M., & Saldana, J. (2013) *Qualitative Data Analysis: A Methods Sourcebook.* London: Sage.

Millar, Sarah-Kate & Chow, Jia Yi & Gleeson, Mo & Cleaver, Michelle. (2021). Teachers' Perceptions of Applying Contemporary Skill Acquisition Approaches in High School Physical

Education. *Frontiers in Sports and Active Living*. 3. 775423. https://doi.org/10.3389/fspor.2021.775423

Mikuska, E. (2021) Nursery workers' narratives: what makes a 'good' nursery worker? Unpublished Thesis. London: London Metropolitan University https://eprints.chi.ac.uk/id/eprint/5916/

Nowell, L. S., Norris, J. M., White, D. E., & Moules, N. J. (2017). Thematic analysis. *International Journal of Qualitative Methods, 16*(1) https://doi.org/10.1177/1609406917733847

Ofsted (2019) Guidance: Education inspection framework (EIF). London: Department for Education.

Ofsted (2023) *Research and analysis. Levelling the playing field: the physical education subject report.* London: Department for Education

O'Leary, N. (2019). Teacher socialisation in physical education: New perspectives. *Sport, Education and Society, 24*(6), 668-671.

Oh, J., & Graber, K. C. (2019). Physical education teacher education leaders' perceptions on a national curriculum in Physical Education. *Research Quarterly for Exercise and Sport, 90*(3), 362–376.

Oslin, J. L., Mitchell, S. A. & Gryphon, L. L. (2013). Teaching sports concepts and skills: A tactical approach for ages 7 to 18 (The Coding Manual for Qualitative Researchers (3rd edition)3rd ed.). *Human Kinetics*.

Penney, D. (2013). Points of tension and possibility: Boundaries in and of physical education. *Sport, Education and Society, 18*(1), 6-20.

Penney, D., Brooker, R., Hay, P., & Gillespie, L. (2009). Curriculum, pedagogy, and assessment: Three message systems of schooling and dimensions of quality physical education. *Sport, Education and Society, 14*(4), 421–442.

Power, T., Jackson, D., Carter, B., & Weaver, R. (2014). Misunderstood as mothers: Women's stories of being hospitalised for illness in the postpartum period. *Journal of Advanced Nursing, 71*(2), 370-380.

Prince, H. E., & Annison, E. (2022). The impact of menstruation on participation in adventurous activities. *Sport, Education and Society, 1–13*.

Renshaw, I., & Chow, J. Y. (2019). A constraint-led approach to sports physical education pedagogy. *Physical Education and Sport Pedagogy, 24*, 103–116.

Roberts, K., Dowell, A., & Nie, J. B. (2019). Attempting rigour and replicability in the thematic analysis of qualitative research data: A case study of codebook development. *BMC Medical Research Methodology, 19*(1).

Rudd, J. R., Pesce, C., Strafford, B. W., & Davids, K. (2020). Physical literacy: A journey of individual enrichment: An ecological dynamics rationale for enhancing performance and physical activity in all. *Frontiers in Psychology, 11*.

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Saldana, J. (2015) *The Coding Manual for Qualitative Researchers.* London: The World of Books

Saunders, B., Sim, J., Kingstone, T., Baker, S., Waterfield, J., Bartlam, B., Burroughs, H., & Jinks, C. (2018). Saturation in qualitative research: Exploring its conceptualisation and operationalization. *Quality & Quantity, 52*(4), 1893–1907.

Shay, S. (2013). Conceptualising curriculum differentiation in higher education: A sociology of knowledge point of view. *British Journal of Sociology of Education, 34*(4), 563-582.

Siedentop, D. (1994). *Sport education: Quality physical education through positive sports experiences.* Champaign, IL: Human Kinetics.

Simmons, J., & MacLean, J. (2016). Physical education teachers' perceptions of factors that inhibit and facilitate the enactment of curriculum change in a high-stakes exam climate. *Sport, Education and Society, 23*(2), 186-202.

Singh, P. (2002). Pedagogical knowledge: Bernstein's theory of the pedagogic device. *British Journal of Sociology of Education, 23*(4), 571-582.

Skjott Linneberg, M., & Korsgaard, S. (2019). Coding qualitative data: A synthesis guiding the novice. *Qualitative Research Journal, 19*(3), 259–270.

Smith, B., & Sparkes, A. (2013). Qualitative research methods in sport, exercise and health: From process to product. *International Journal of Sport Policy and Politics, 5*(3), 405-421.

Sparkes, A., & Smith, B. (2014). *Qualitative research methods in sport, exercise and health: From process to product.* London, England: Routledge.

Vaismoradi, M., Turunen, H., & Bondas, T. (2013). Content analysis and thematic analysis: Implications for conducting a qualitative descriptive study. *Nursing & Health Sciences, 15*(3), 398-405.

Wilkinson, S. D., & Penney, D. (2023). A national survey of gendered grouping practices in secondary school physical education in England. Physical Education and Sport Pedagogy, 1–16.

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Processing sensor data from the NAO robot

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Abstract: *The paper presents the processing of sensor data from the NAO humanoid robot, with a focus on the use of Python and the NAOqi API to capture and analyze visual data. The robot is equipped with advanced sensors, such as accelerometers, gyroscopes, touch sensors, and a camera, which enable complex interactions in the human environment. The solution allows for live video streaming to be captured and displayed using OpenCV, while the user can intuitively control the process. In addition, the paper discusses the diverse application areas of the NAO robot, such as education, research, entertainment, and healthcare, all of which offer innovative solutions to meet different usage needs. The interactive capabilities of the NAO robot allow students to easily learn the basics of programming and artificial intelligence, while researchers can use it to develop new algorithms in the field of machine learning and AI. The paper emphasizes the importance of technological integration, which makes robotics play an increasingly important role in everyday life. The study opens new perspectives in the field of data processing and application possibilities of robots, contributing to the development of future autonomous systems.*

Keywords: *NAO robot ; sensor data processing; NAOqi API; Python; OpenCV; humanoid robot; interactive education; machine learning; autonomous systems;*

Introduction

The development of humanoid robots has reached significant milestones in the last decades and they have become versatile devices that offer innovative solutions in many fields. One of the best known and most popular of these robots is Nao, developed by SoftBank Robotics. The Nao robot was originally designed for research purposes, but over time it has become increasingly popular in education and entertainment. Its versatility is due to its programmability, numerous sensors and humanoid design, which allows it to perform complex interactions in a human environment (Softbank Robotics, 2008).

One of the greatest advantages of the Nao robot is that it is both easy to use and highly advanced. It is used in education, for example, to teach programming, participate in robotics projects and support interactive learning activities (Nagy, Karl & Molnár, 2024). The popularity of this type of robot highlights the rapid pace at which robotics is becoming part of everyday life, while

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creating new opportunities for engineering and computer science research. The teaching of topics supported by robots and unmanned (UAV) robotic systems (Szabolcsi, Molnár, & Wührl, 2024) can be implemented in a modern, interactive way, which greatly supports the informal learning dimension (Molnár, 2013) and the process of learning through group work (Molnár, .2014). This also contributes significantly to the development of students' digital competences (Holik et. al., 2023).

A key element in the operation of robots is the use of sensors, which are essential for collecting and processing environmental information. Sensors enable robots to sense the world around them, collect data on movement, touch or visual stimuli and make decisions based on this information. The Nao robot, for example, is equipped with sensors such as accelerometers, gyroscopes, touch sensors and cameras that provide a variety of data for the device's operation and interaction with the environment.

Technological advances are increasingly integrating the processing of sensor data into cloud-based services. Cloud services allow the data collected by robots to be centrally stored, analysed and made easily accessible for further processing. This is particularly important in modern robotic systems, where efficient data management and storage are essential for advanced functionality.

The aim of this paper is to describe in detail how the sensor data of the Nao robot can be retrieved using Python and then transmitted to a cloud environment. The analysis focuses not only on data management, but also on how the integration of robots and cloud technology can become a cornerstone of innovation. The application of this type of technology can open up new perspectives not only in research, but also in education and industry (E. Nagy, 2020).

1. Introducing the Nao robot and the NAOqi API

1.1. Features of the Nao robot

The Nao robot is a humanoid robot developed by SoftBank Robotics. Its design follows the humanoid form: two arms, two legs, head and torso, which together can simulate human movements and behaviour. The robot is about 58 cm high and weighs 5 kg, making it easy to carry but capable of stable movement.

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Hardware features of the Nao robot include advanced sensors and complex motion mechanics. The robot features:

- accelerometers and gyroscopes needed to maintain balance.
- Camera that enables face recognition and visual object detection.
- Touch sensors on the head, arms and legs that can be used to receive interaction commands.
- Microphones and speakers that enable the robot to recognise and generate speech.
- LEDs that provide visual feedback.

The integration of these sensors and devices makes the Nao robot suitable for complex tasks such as use in education or research environments.

1.2. The NAOqi software platform

The Nao robot is supported by the NAOqi API, which is the official development framework for the robot. NAOqi provides communication between the hardware and software components of the robot and allows the robot to be programmed in different languages, such as Python or C++.

Main functions:

- Motion control: the API allows the robot's movements to be precisely programmed. NAOqi supports the simulation of walking, arm and head movements, as well as balance maintenance.
- Sensor data management: the NAOqi API provides access to data collected by the robot's sensors, such as accelerometer or camera data.
- Communication: the API makes it easy to program speech recognition, text reading and interaction with human users.
- Application development: NAOqi allows the creation of custom applications that can be tailored to different tasks.

1.3. Development opportunities and the role of Python

One of the biggest advantages of the NAOqi API is its support for Python, one of the most widely used and easiest to learn programming languages. With Python, developers can easily

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write scripts for the robot, such as motion commands, sensor data readouts or even more complex algorithms to analyse data.

The combination of Python and the NAOqi API allows developers to:

- Access the robot's sensors.
- Program user interactions such as speech recognition or visual analysis.
- Store data and integrate it with external systems such as cloud services.

Example 1: Motion programming

The code snippet below shows an example of how a robot can be programmed to raise its arm:

```
from naoqi import ALProxy
motion = ALProxy("ALMotion", "<robot_ip>", 9559)
motion.setAngles("RShoulderPitch", -1.0, 0.2) # Raise right arm
```

Example 2: Speech generation

The following example shows how to make the robot speak:

```
from naoqi import ALProxy
tts = ALProxy("ALTextToSpeech", "<robot_ip>", 9559)
tts.say("Hello! I am Nao, your friendly robot!")
```

Example 3: Using a camera

The following Python code can be used to capture frames from the camera:

```
from naoqi import ALProxy
video = ALProxy("ALVideoDevice", "<robot_ip>", 9559)
client_name = video.subscribe("camera", 2, 11, 5) # Camera settings
frame = video.getImageRemote(client_name) # Get frame
video.unsubscribe(client_name)
```

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1.4. Areas of application of the Nao robot

The versatility of the Nao robot means it can be used in many different fields, particularly in education, research and entertainment. The advanced sensors and accessible programming capabilities allow Nao to be used in a variety of interactive and educational applications, as well as in artificial intelligence and robotics research. Below, I will describe in more detail some of the commonly known applications and practical case studies of the use of the Nao robot in different fields. These types of case studies are documented in a number of research and projects, particularly in the field of educational robotics and STEM education (Bano, S., Atif, K. & Mehdi, S.A, 2024).

1.4.1 Education

The Nao robot plays a prominent role in education by helping students understand programming, robotics, artificial intelligence and other technology topics. The robot can interact with students, helping them to stay motivated while learning new skills (Fig.1).

Example case study - Teaching programming to children

In a school project, the Nao robot can be used to help students learn the basics of programming. Students program the robot in Python to perform simple tasks such as walking, holding out their hand or telling a simple story. The robot makes programming engaging for students because they are able to see the robot move and respond to commands in real time. The teacher can use the Nao robot to easily illustrate different elements of programming, such as loops and conditions, while the students have fun learning. This is supported by Eduporium's two e-books that help educators to effectively integrate the NAO robot into the curriculum, with a focus on STEM and special education (Eduporium, 2025).

As another example, the NAO robot Higher Education Pack offered by RobotLAB is specifically designed for higher education institutions and allows students to learn programming and robotics hands-on (RobotLab, 2025).

At the same time, several studies point out that the proper training of teachers is key not only in the transfer of technological knowledge, but also in the way they interpret and accept technological tools in a social and cultural context. Lack of training can encourage teachers to use the robot as a mere entertainment tool, which can reduce learning effectiveness and teacher confidence (Gardenghi C. & Gherardi L, 2024).

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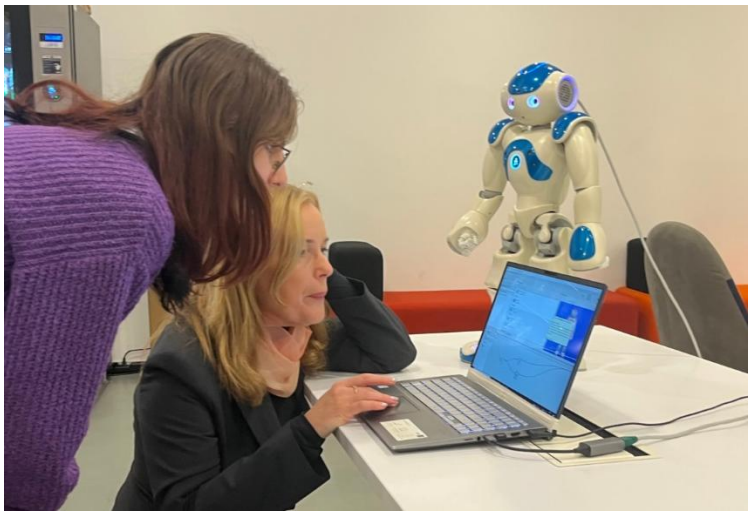

Figure 1. NAO are used in classrooms to teach robotics. Photo: Own Editing

1.4.2 Robotic research

Nao robots are an excellent tool for robotics research, especially in the fields of artificial intelligence (AI), machine learning and social interaction. Robots are able to continuously learn and adapt to their environment, providing researchers with the opportunity to develop new algorithms that facilitate communication, cooperation and intelligence between robots.

Example case study - Using the Nao robot in visual attention and therapeutic behaviour research

In a study, researchers from the University of Parma have investigated the use of the NAO humanoid robot in memory training for elderly people with mild cognitive impairment. The aim of the study was to explore the impact of robot-led exercises on the cognitive performance and behaviour of the participants. The NAO robot was programmed to perform memory exercises that were familiar during therapy sessions, while the researchers used special software to analyse the participants' reactions, in particular the direction of their gaze and the frequency of their smiles towards the robot and the therapist.

The results of the study showed that participants made significant improvements in prose memory and verbal fluency after the robot-led training sessions. In addition, the studies showed that patients paid increased visual attention to the robot, which was a motivating factor for their participation in the tasks. The presence of the robot not only reinforced positive therapeutic behaviours, but also helped to reduce unwanted behaviours. The results of the study suggest that the NAO robot can be effectively integrated into memory training programmes and may be

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a useful tool in the treatment of cognitive decline in older adults. The interactive and motivating environment provided by the robot can significantly contribute to the success of the therapeutic process (Pino, O.; Palestra, G.; Trevino, Rosalinda & De Carolis, B., 2019).

1.4.3 Entertainment industry

The Nao robot can be used not only for educational and research purposes, but is also being given a prominent role in entertainment applications. It offers interactive and entertaining experiences that have been presented at various events and exhibitions. The robot can give simple presentations, dance or tell stories.

Case study - Interactive demonstration in an exhibition

Nao robots are also presented at various international exhibitions, where visitors can interact with the robot. The robot answers questions, dances to music and performs entertaining sketches. The aim of these events is usually to raise awareness of the development of robotics and to showcase future applications of robots. Visitors enjoy the direct interaction, and many make videos that are shared on social media, so the robot also acts as an entertainment and educational tool. The NAO robot has been presented at several events at Óbuda University. For example, at the annual Educatio exhibition, visitors to the university's stand can take part in interactive demonstrations where the NAO robot dances and performs various tasks. In addition, the NAO robot is also used at university open days and in secondary schools, where participants can learn about the robot's capabilities and applications (Óbudai Egyetem, 2024).

The Nao robot was developed by SoftBank Robotics and has become known worldwide, particularly in the fields of education and research. The robot's interactive capabilities, such as speech, dance and facial recognition, allow users to communicate directly with it (Aldebaran, 2025).

1.4.4 Care for the elderly

Some research and applications have also used the Nao robot in elderly care. It can help elderly people to perform routine daily tasks, provide reminders and communicate with them interactively. Robots can perform tasks such as providing medical reminders or even help provide companionship to those who are lonely.

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Example case study - Home for the elderly

In a nursing home, the Nao robot was used to help residents with their daily routines. The robot reminded them to take their medication, chatted with them and was able to entertain them with simple games and stories. Residents responded positively to the robot's interactive capabilities and many felt that the robot kept them company. The home's management saw this as a big step in incorporating technology into everyday care (B. H Abery & R. Ticha, 2025).

1.5. Technological features of the Nao robot

The Nao robot is a highly advanced humanoid robot used for a variety of research, educational and entertainment purposes around the world. Its compact size and lightweight design make it one of the most suitable tools for use in educational institutions. The Nao robot is approximately 58 cm high and weighs 4 kg, which allows it to operate in small spaces while providing sufficient stability for various interactions and movements. The robot has a number of built-in sensors that play an essential role in interacting with its environment. These include accelerometers, gyroscopes, infrared rangefinders, and an advanced camera, all of which contribute to Nao's ability to sense and react to its environment.

The operation and control of the Nao robot is provided by the NAOqi Software Development Kit (SDK), which allows the robot to be controlled by supporting a wide range of programming languages. The SDK gives users full access to the robot's various capabilities, including motion, speech and sensor data. The Python programming language is particularly popular for working with the NAOqi SDK, as its simplified syntax and wide range of applications make it easy to control the robot and process data. Using the Python API, users can query the robot's sensors and automate robot behaviour such as movement, sounds and responses.

The Nao robot is equipped with various sensors that form the basis of its interaction. The accelerometer and gyroscope allow the robot to sense its motion and stability, which are essential for navigation in dynamic environments. In addition, the robot's range-finding sensors help Nao to detect approaching obstacles and other objects, thus avoiding potential collisions. The robot can retrieve and process this data using Python, which gives developers the ability to create different applications that take into account the robot's environment and movements. Managing sensor data is crucial to increasing the robot's interactive capabilities, as accurate

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data collection is essential to developing successful applications, whether for educational, research or entertainment purposes.

The Nao robot is therefore not just a simple humanoid robot, but a highly advanced technological tool that is an integral part of modern robotics research and applications. The combination of various sensors and the NAOqi SDK allows robots to react intelligently and dynamically to their environment and can be used in a wide range of applications.

2. Processing and storage of sensor data

In this chapter, we will describe in detail how to retrieve and prepare the sensor data of the Nao robot, and how to process and store the data in different formats so that it can be easily used later. The solution is also demonstrated through a practical example of saving to image and video files.

2.1. Retrieving and preparing sensor data

The Nao robot contains a number of sensors that provide data about the robot's environment and status. These sensors generate different types of data, such as accelerometers, gyroscopes, rangefinders, infrared sensors, touch sensors, cameras, etc.

The camera as a sensor in robotics

One of the most important questions in modern robotics is how different sensors can help machines to accurately and efficiently sense their environment. Sensors play a key role in this process by enabling robots to react to external stimuli. Most people traditionally think of sensors as devices that provide specific measurements, such as temperature, distance or pressure. In this context, the question arises: can a camera be considered a sensor?

Sensors are defined as any device that detects physical signals and converts them into an electronic data format. A camera fits this definition as it captures and transmits visual data in digital form. Modern cameras use light-sensitive sensors, usually CMOS or CCD technology, to convert incoming light into pixels. This feature makes the camera particularly important in robotics, as it allows machines to process and react to visual information.

For the NAO humanoid robot, the camera acts as a key sensor. It not only captures visual data, but also provides a means of interpreting the environment. For example, the camera can help

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the NAO recognise faces, track moving objects or even identify objects using artificial intelligence algorithms. These capabilities allow the robot to interact with its environment in a way that would not be possible with a traditional sensor, such as a temperature or range finder.

Nevertheless, the camera is different from sensors in the classical sense. While a temperature sensor returns a specific numerical value, a camera captures a complete image that requires further processing. To process the image information, advanced algorithms and computing power are needed to draw useful conclusions from the data. This differentiates the camera from other sensors, but does not reduce its importance in the field of sensing.

The greatest benefits are achieved when the camera is combined with other sensors. For example, when used in combination with an ultrasonic rangefinder, it can provide more accurate spatial sensing. The visual information can then complement the data measured by other sensors, giving the robot a more complex and accurate picture of its environment.

2.2. How the NAO Robot Camera Works and OpenCV-based Image Processing

A key element of modern robotic systems is visual perception and its efficient processing. The NAO humanoid robot's built-in camera provides the ability to perceive the environment, which can be used in a wide range of applications such as interactive education, object recognition and navigation. This paper presents a Python-based solution that can capture and display a real-time video stream using OpenCV and the NAOqi API.

Structure of the system

The first step of the implementation is to import the necessary libraries. The OpenCV (cv2) is responsible for image processing and video display, while the numpy library provides efficient data conversion and storage. From the NAO robot API, the ALProxy class is used to connect to the robot's camera.

To establish the connection, we first need to specify the IP address of the NAO robot and the corresponding port. This allows the program to access the camera via the ALVideoDevice service. The resolution, colour mode and frame rate settings determine the quality and format of the image data received. The current implementation uses a resolution of 640×480 pixels in RGB colour mode and a frame rate of 20 frames per second.

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Real-time frame processing

The program processes frames from the NAO robot's camera in a continuous cycle. Using the getImageRemote function, the current image seen by the robot is retrieved and the binary data is converted into a numpy array. The transformed data is converted to a three-dimensional matrix, which is converted to the appropriate format using OpenCV and set to RGB colour order.

Once the program receives valid image data, the live video stream is displayed in a separate window via the OpenCV imshow function. At the same time, the frames are also saved in an AVI video file, which allows the data to be played back and analysed later. Using the XVID compression format, the video recorder handles the frames efficiently and ensures the right quality.

User interaction and safe shutdown

For the user, the program offers a simple and intuitive control: pressing the 'q' key stops the video stream and the program releases resources accordingly. The implementation also includes an exception handling mechanism to ensure that the flow will complete properly in case of any interruption (e.g. a user shutdown or an unexpected error). Camera access is revoked, the video file is closed and all OpenCV windows are closed.

2.3. Interpreting the code

The following Python code captures and displays a live video stream from the NAO robot's camera using OpenCV. It also saves the data to an .avi video file. Let's take a closer look at what it does!

1. **Importing libraries**

import cv2 cv2 (OpenCV) – Used for image processing and visualization.

import numpy as np numpy – Converts the NAO camera data to a numpy array for easier handling.

from naoqi import ALProxy naoqi.ALProxy – The NAO robot API that allows you to connect to the camera and retrieve images.

import sys – Although sys is not used here, it is usually used to handle command line arguments.

2. **Configuring the NAO robot camera**

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NAO_IP = "169.254.20.238" Sets the IP address and port of the NAO robot to communicate with it.

NAO_PORT = 9559

camera_proxy = ALProxy("ALVideoDevice", NAO_IP, NAO_PORT) Creates a proxy object for the NAO camera service using ALProxy.

3. Camera settings

resolution = 2 # 640x480 The camera records in 640×480 resolution.

color_space = 11 # RGB color mode NAO renders the image in RGB color space.

fps = 20 # Frame rate The video runs at 20 frames per second.

4. Video stream access

video_client = camera_proxy.subscribe("Camera", resolution, color_space, fps)

Accesses the NAO camera through the ALVideoDevice service and receives live frames in a video_client object.

5. Video save settings

fourcc = cv2.VideoWriter_fourcc('XVID')* Uses XVID codec to compress the video.

video_filename = 'nao_camera_video_02.avi'

The recorded video is saved as nao_camera_video_02.avi.

video_writer = None The video writer object is initially None and is only created if there is a valid frame.

try:

while True:

result = camera_proxy.getImageRemote(video_client)

Continuously requests images from the robot's camera.

6. If the image is successfully read

if result:

width = result[0] Stores the width of the image.

height = result[1] Stores the height of the image.

image_data = result[6] Stores a list of the raw binary data of the image.

7. Image transformation and OpenCV display

if len(image_data) > 0:

image = np.frombuffer(image_data, dtype=np.uint8)

Converts the data to a numpy array.

image = image.reshape((height, width, 3))

Formats the array into an RGB image of the appropriate size.

image = cv2.cvtColor(image, cv2.COLOR_BGR2RGB)

Converts the default BGR format of OpenCV to RGB, because that is how NAO returns it.

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8. Save video to file

if video_writer is None:

video_writer = cv2.VideoWriter(video_filename, fourcc, fps, (width, height))

video_writer.write(image) If the video writer object has not been created yet, initialize it. It writes each frame to the video file.

9. Display image in OpenCV window

cv2.imshow("Nao Camera Feed", image) OpenCV displays the camera image in a window.

if cv2.waitKey(1) & 0xFF == ord('q'):break If the user presses the “q” key, the program exits.

10. Exception Handling (Program Stopping)

except KeyboardInterrupt:

print("Program is stopped") If the user presses CTRL + C, the program stops with a message.

11. Freeing Resources

finally: camera_proxy.unsubscribe(video_client)

Unsubscribes from the NAO camera.

if video_writer is not None: Stops and frees the video writer resources.

video_writer.release()

cv2.destroyAllWindows() Closes the OpenCV windows.

So this script allows you to stream live images from the NAO robot's camera and display them using OpenCV. It also saves the captured video in AVI format. The program provides intuitive control: the user can exit by pressing the 'q' key, while the system takes care of releasing resources as needed. In the event of an unexpected interruption of the run (e.g. CTRL + C), the script ensures that the camera is shut down and all open windows are closed properly.

3. Future development and application opportunities

This solution provides an efficient and versatile way to process and capture NAO robot visual data in real-time, which is of particular importance in both robotics and computer vision. By integrating OpenCV with the NAOqi API, it is possible to interactively analyze the live video stream from the robot's camera, opening up a wide range of applications, including real-time object tracking, gesture recognition, face recognition, and the development of human-robot interaction.

Visual processing is a key component of autonomous systems, enabling robots to dynamically adapt to their environment and respond to environmental stimuli. The development of such systems is particularly important in education, where the NAO robot can be used to teach

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students about artificial intelligence and computer vision, and in research, where the robot may be able to perform complex data processing tasks. From the perspective of autonomous systems development, such technologies enable robots to make more autonomous decisions, for example, when navigating in an obstacle-ridden environment.

Further development opportunities cover a broad spectrum. One possible direction is the integration of image recognition algorithms that would enable the robot to identify and categorize different objects in its environment. Another important area of development is the deployment of object tracking systems that would allow the robot to track, for example, a moving person or a specific object with its camera. With the development of artificial intelligence, the incorporation of machine learning models could be feasible, allowing deeper analysis and prediction when processing visual data.

The potential of the NAO robot extends beyond research and education. As artificial intelligence and computer vision technologies advance, the robot can be used to develop algorithmic thinking, create interactive learning environments, and teach programming. In healthcare, NAO could contribute to therapeutic programs for children with autism spectrum disorder, engaging them in interactive activities that enhance social and communication skills. It could also support elderly care by providing companionship, reminding individuals to take medication, and guiding them through physical exercises. Additionally, integrating motion analysis and guided exercise routines could assist rehabilitation programs, offering personalized and interactive rehabilitation exercises.

The robot's applications in entertainment and consumer technology are also expanding. It has been used in museums, exhibitions, and events for engaging demonstrations, storytelling, and educational entertainment. Future development may integrate NAO with IoT devices, enabling it to assist with home automation, voice-controlled tasks, and personalized digital assistance. With AI-driven behavior adaptation, NAO could function as a social companion, responding to user preferences and adapting its interactions accordingly.

As artificial intelligence, machine learning, and robotics technologies continue to evolve, NAO's capabilities will expand, making it even more versatile and autonomous. Enhanced machine learning integration will allow the robot to refine its behavior based on real-world interactions, while cloud-based AI processing could offload computationally intensive tasks, improving efficiency and scalability. Additionally, its integration into professional

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environments could enable NAO to assist employees with repetitive tasks, conduct interactive presentations, or act as an AI-powered research assistant.

The NAO robot is not merely an educational or research tool but a continuously evolving platform that integrates cutting-edge AI and robotics innovations. As these technologies progress, NAO's role in education, healthcare, entertainment, and assistive services will expand, making it an indispensable tool for learning, research, and daily human interaction. The ongoing development of AI-driven robotics ensures that humanoid robots like NAO will play an increasingly significant role in shaping the future of human-robot collaboration and intelligent autonomous systems.

4. Summary

This paper provides a comprehensive analysis of the processing of sensor data and the utilization of the camera in the humanoid robot NAO using OpenCV. The NAO robot is equipped with a variety of advanced sensors, including accelerometers, gyroscopes, touch sensors, and a high-resolution camera, enabling real-time visual data collection and processing. The paper explains the process of accessing the robot’s camera in Python via the NAOqi API and presents a program capable of capturing and displaying a live video stream. By leveraging OpenCV and numpy libraries, the image data is transformed and saved in an AVI file format, ensuring efficient data management. The implemented program also offers an intuitive interface for real-time video viewing, incorporating a simple keyboard shortcut for termination (pressing 'q'). Additionally, robust exception handling mechanisms are integrated to ensure the proper disconnection of the camera and the closure of the video file, enhancing system stability and reliability.

Beyond technical implementation, the study explores the broad spectrum of applications for the NAO robot. In educational settings, the robot serves as an interactive tool for teaching programming, robotics, and artificial intelligence through engaging, hands-on learning experiences. Its ability to execute predefined movements and respond to commands enhances student engagement and fosters a deeper understanding of computational thinking. In research, NAO plays a crucial role in the advancement of AI and machine learning, particularly in the exploration of social interactions, human-robot collaboration, and autonomous decision-making processes. The robot is also instrumental in therapeutic applications, such as cognitive

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training and emotional support for individuals with autism spectrum disorder, contributing to improved social and communication skills.

In addition to education and research, NAO has significant potential in the entertainment industry, where it is utilized in interactive presentations, exhibitions, and public events. The robot's ability to perform complex gestures, speak, and even dance makes it an attractive feature in various public engagement initiatives. Furthermore, in healthcare and social care settings, NAO has been deployed to assist the elderly and individuals with special needs by providing companionship, aiding in memory exercises, and facilitating social interactions. As artificial intelligence and robotics technologies continue to evolve, NAO's role in these domains is expected to expand, further enhancing its versatility and impact.

The document underscores the ongoing advancements in artificial intelligence and robotics, positioning the NAO robot as a pivotal tool in the convergence of technology and human-centered applications. With continuous development, NAO is expected to play an increasingly influential role in education, research, healthcare, and entertainment, driving innovation and expanding the frontiers of intelligent autonomous systems. These technological innovations not only highlight the growing significance of humanoid robots in various industries but also pave the way for future breakthroughs in interactive and autonomous robotics.

References

Aldebaran (2025). Nao Support https://aldebaran.com/support/nao-6/ [2025.02.04]

Bano, S., Atif, K. & Mehdi, S.A. (2024). Systematic review: Potential effectiveness of educational robotics for 21st century skills development in young learners. *Educ Inf Technol* 29, 11135–11153. https://doi.org/10.1007/s10639-023-12233-2

B. H Abery & R. Ticha (2025). Enhancing Physical Activity Among Older Adults Using Nao, a Socially Assistive Robot at College of Education and Human Development, University of Minnesota, Institute on Community Integration, University of Minnesota https://ici.umn.edu/projects/2Oo1qdvWT_e5Xbv9wvTVfg?utm_source [2025.02.04]

Eduporiom (2025). Two eBooks for Teaching with SoftBank Robotics' NAO Robot https://www.eduporium.com/blog/two-new-ebooks-for-educators-interested-in-teaching-robotics-with-nao [2025.02.04]

E. Nagy (2020). Robots in education and training processes, TRAINING AND PRACTICE 18: 3-4 pp. 176-186., 11 p. DOI: 10.17165/TP.2020.3-4.18

 License: CC BY 4.0

E. Nagy, É. Karl & Gy. Molnár (2024). Exploring the Role of Human-Robot Interactions, within the Context of the Effectiveness of a NAO Robot ACTA POLYTECHNICA HUNGARICA 21: 3 pp. 177-190. , 14 p. DOI:10.12700/APH.21.3.2024.3.12

E. Nagy & I. Holik (2023). Educational robots in higher education -findings from an international survey, *2023 IEEE 17th International Symposium on Applied Computational Intelligence and Informatics (SACI)*, Timisoara, Romania, pp.15-20, DOI: 10.1109/SACI58269.2023.10158668.

I. Holik, T. Kersánszki, Gy. Molnár, I. Dániel Sanda (2023). Teachers' Digital Skills and Methodological Characteristics of Online Education, INTERNATIONAL JOURNAL OF ENGINEERING PEDAGOGY 13: 4 pp. 50-65.

Gy. Molnár (2013). Formal and informal network-based learning environments and the role of their learning potential, In: J. Ollé (ed.) V. Education-Informatics Conference: proceedings, Budapest, Hungary: ELTE PPK Institute of Educational Sciences pp. 196-201.

Gy. Molnár (2014). Experiences of pedagogical renewal in professional teacher education - new ICT-based tools and concepts in teacher education, In: J. Ollé (ed.) VI Conference on Education and Informatics, Budapest, Hungary: ELTE PPK Institute of Educational Sciences pp. 434-452.

Gardenghi C. & Gherardi L. (2024). "Teaching With the Nao Robot: Teacher - Users' Attitudes" *Italian Journal of Sociology of Education*, 16(1), 71-86. DOI: 10.14658/PUPJ-IJSE-2024-1-4

Óbudai Egyetem (2025). Robotok találkozása a műszaki pályaorientáció jegyében https://uni-obuda.hu/2024/12/14/robotok-talalkozasa-a-muszaki-palyaorientacio-jegyeben/ [2025.01.17]

Pino, O.; Palestra, G.; Trevino, Rosalinda & De Carolis, B. (2019). The Humanoid Robot NAO as Trainer in a Memory Program for Elderly People with Mild Cognitive Impairment In: INTERNATIONAL JOURNAL OF SOCIAL ROBOTICS. ISSN 1875-4805., pp. 1-13. [1007/s12369-019-00533-y]

RobotLab (2025). NAO robot Higher Education Pack Robots as a teaching-aid tool https://www.robotlab.com/higher-ed-robots [2025.02.04]

R. Szabolcsi, Gy. Molnár, T. Wührl (2024). Conceptual Design of a UAV-UGV Autonomous Collaborative Robot System, In: Óbuda University (ed.) 2024 IEEE 7th International Conference and Workshop Óbuda on Electrical and Power Engineering (CANDO-EPE): Proceedings, Budapest, Hungary, IEEE Hungary Section pp. 207-211.

Softbank Robotics (2008). Robots Nao https://robotsguide.com/robots/nao [2025.02.04]

Brief Professional Biography

Enikő Nagy is an associate professor, computer science engineer, English-computer science teacher, currently teaching at Óbuda University. She leads computer science courses in Hungarian and English, ranging from advanced spreadsheets to database development, from business informatics to educational robotics. She completed her higher education at the Dunaújváros College Faculty of the University of

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Miskolc and the Faculty of Informatics of the Eötvös Loránd University. She completed her doctoral studies at the "Education and Society" Doctoral School of Educational Sciences of the University of Pécs, obtaining the PhD degree. Her professional and research interests focus on robotics applied to education (robot programming and the role of robots in education), as well as databases and corporate information systems (Oracle, SQL, ERP). The subjects she teaches cover both applied and development IT disciplines, including business and economic IT, database systems, SQL, tourism software knowledge, digital pedagogy, web programming and educational robotics. Her IT activities extend not only to education, but also to participation in development projects. In these, she deals with the planning and coordination of IT development processes, as well as development support and documentation tasks. In addition, she is also involved in the implementation of new business opportunities. For nearly two decades, she has been conducting research activities. Her main research areas include the application of IT in various disciplines (education), as well as the role and application of social robots in economic and educational environments. She is a member of the "Multimedia in Education" section of the John von Neumann Computer Science Society, the secretary of the Didactics Subcommittee at Pedagogical Scientific Committee of the Hungarian Academy of Sciences. She has been hold the position of executive chairman of the Robotics Section of the Hungarian Pedagogical Society. Her announced PhD, MSc and BSc research topics:

• Efficiency testing of educational robots, promoting their suitability, technical and infrastructural integration in educational environments.

• Development of educational applications supported by robots.

• Aspects of databases and database systems.

• Informatics in education and pedagogical work.

Enikő Nagy uses education to help understand and embrace informatics, related aspects and its modern challenges, both in theory and practice, to create innovative learning environments.

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