

WHAT SHOULD EDUCATIONAL EMBODIED CONVERSATIONAL AGENTS BE LIKE? PUPILS' EXPECTATIONS AND PREFERENCES

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Abstract

Conversational Agents (CAs) like ChatGPT are increasingly used in education to support teaching, learning, and administrative tasks, especially in higher education. However, their limited ability to engage in personalized interactions due to the lack of a visual representation reduces their effectiveness in learning support. Embodied Conversational Agents (ECAs)—virtual characters that communicate using both verbal and non-verbal cues such as facial expressions and gestures—offer a promising extension. While the potential of ECAs has been explored in general educational contexts, little is known about their design and effectiveness for pupils. To address this gap, we conducted a structured workshop with 64 pupils aged 13 to 17 to explore their views and expectations on how ECAs should be designed to best support learners in this age group. The workshop focused on identifying pupils' expectations about which educational tasks are best suited for ECAs and uncovering design features that enhance user engagement and perceived educational value. Our findings offer new insights into pupils' preferences and expectations, leading to design recommendations for engaging and effective ECAs for school settings. These results lay the groundwork for designing age-appropriate ECAs and highlight the need for further research into age-related differences in user experience and interaction preferences.

Keywords: Embodied Conversational Agents (ECAs), Education, Educational ECA, Personalized Learning.

1 INTRODUCTION

Conversational Agents have already been integrated into education, supporting various activities such as teaching, learning, administration, assessment, and advisory services, being used across different educational domains and levels, with a particular emphasis on higher education [1], [2].

In educational technologies, the interfaces used by learners are crucial for enhancing engagement and improving comprehension. Building on the success of conversational agents like ChatGPT, Embodied Conversational Agents (ECAs) can further expand communication by integrating nonverbal cues, offering a more holistic interaction experience [3]. This is especially important in distance education platforms, where the lack of personal and social presence has been a significant challenge [4]. To address this and enhance social interaction and learner motivation, ECAs offer a promising solution [5].

ECAs have gained increasing attention in educational contexts, yet there are still significant gaps in the literature regarding their effectiveness and optimal design for different age groups and educational tasks [6], [7]. While some studies have explored the general role of ECAs in education, there is limited research on how these agents should be specifically designed for pupils.

To address this gap, we conducted a workshop with 64 pupils aged 13 to 17. Our aim was to explore how ECAs should be designed to best support pupils in this age group and to identify the tasks where they are most useful and effective. We focused on the features that make ECAs educationally valuable and engaging. During the workshop, we systematically collected data and asked pupils about their expectations and preferences. This helped us gain a better understanding of how ECAs can be effectively used in school settings and how they can help create more engaging and supportive learning environments.

2 METHODOLOGY

For our methodology, we adopted a qualitative approach to emphasize the authentic voices of participants, rather than the conventional quantitative approach that converts their experiences into statistical data. This approach enables researchers to observe and present a more comprehensive perspective on social reality within their investigative practices [8], [9]. Specifically, we used small

subgroups of school classes, led by a facilitator who facilitated discussions to gain deeper insights after each target question.

German pupils were invited to participate in a workshop on CAs and ECAs. The session began with a warm-up period, as recommended by experienced group researchers, during which the ground rules were outlined, and pupils were assured of confidentiality to foster a safe and open discussion environment [10]. The pupils were first given an overview of the topic before having the opportunity to either interact with an ECA application or observe a recorded interaction. This exposure was designed to ensure a clear understanding of ECAs, allowing them to provide well-informed responses to our questions. After this, they responded to a series of open-ended questions designed to capture their perceptions and expectations of ECAs, which were collected using *Mentimeter* [11]. After gathering the responses, participants engaged in an open discussion with the moderator, allowing for further exploration of ideas, while the researchers enriched the data through note-taking.

2.1 Participants

A total of 64 pupils participated in the workshop, which took place over three days, dividing them into three subgroups of varying sizes. Of these, 42 identified as female and 18 as male, while 2 participants did not disclose their gender. The participants' ages ranged from 13 to 17 years. They were enrolled in grades 8 through 11 at German secondary schools (Gymnasium).

The selection of pupils as experts is predicated on the social constructivist paradigm, which posits that individuals are active creators of their environment [12]. Consequently, pupils are not only affected by their living conditions and environment, but also actively shape them [12]. Their direct involvement in the research leads to a better understanding of their experiences and everyday lives [12], including their educational spaces. Since adolescents are still embedded in institutionalized educational processes and pose as the primary target group for the ECA, they are well qualified as experts. Their perspectives are therefore crucial for developing well-founded insights into the design of ECAs that are engaging, supportive, and relevant to their learning needs.

2.2 Questions

The open-ended questions follow a methodically structured sequence, starting with general aspects of ECA design (e.g., look, voice, and motion) and gradually moving to more specific use cases in the educational context. This block of questions begins with general uses of ECAs and then continues with a more in-depth look at how they might be integrated into everyday school life. The subsequent questions go into further detail, first looking at which school subjects could benefit most from ECAs, followed by exploring specific tasks or scenarios where their use would be beneficial. This is followed by asking about the desired personality traits of ECAs and their ideal way of interaction with pupils. The final question focused on the preferred formats for presenting ECA responses (e.g., text, audio, visual). This approach was designed to capture both the pupils' initial impressions and their deeper reflections on how ECAs could be effectively integrated into school life.

- **Q1:** What should an ECA look like?
- **Q2:** How should an ECA sound?
- **Q3:** How should an ECA move?
- **Q4:** For what purpose would you use an ECA?
- **Q5:** In what ways could an ECA support you in your daily school life?
- **Q6:** In which subjects could an ECA be particularly helpful?
- **Q7:** For which tasks would an ECA be especially useful?
- **Q8:** How should an ECA interact with you? (e.g., should it be friendly, strict, humorous, or highly knowledgeable?)
- **Q9:** Should the ECA only speak when addressed, or should it proactively engage with you?
- **Q10:** Should the ECA respond only through speech or should it also present other types of content? If so, what kind?

2.3 Data Analysis

To analyze the collected data, we employed a qualitative content analysis approach of the open responses. This analysis was conducted deductively [13], as the categories were predefined by the structured questions. The responses were analysed using a descriptive design, which means “working through the texts with a deductively formulated category system ... and registering the occurrence of those categories, in a nominal way ... or in category frequencies” [13]. In this approach, the predefined categories which were derived from the questions served as the analytical framework. The text material was systematically coded according to these categories, allowing for a structured evaluation of recurring themes and patterns. This process ensured a rule-based, transparent analysis of the open responses.

While additional new categories emerged inductively during the evaluation of the open responses, the findings were additionally compared with existing research to highlight similarities and differences. In order to gain a deeper understanding of pupils' perspectives and preferences regarding ECAs.

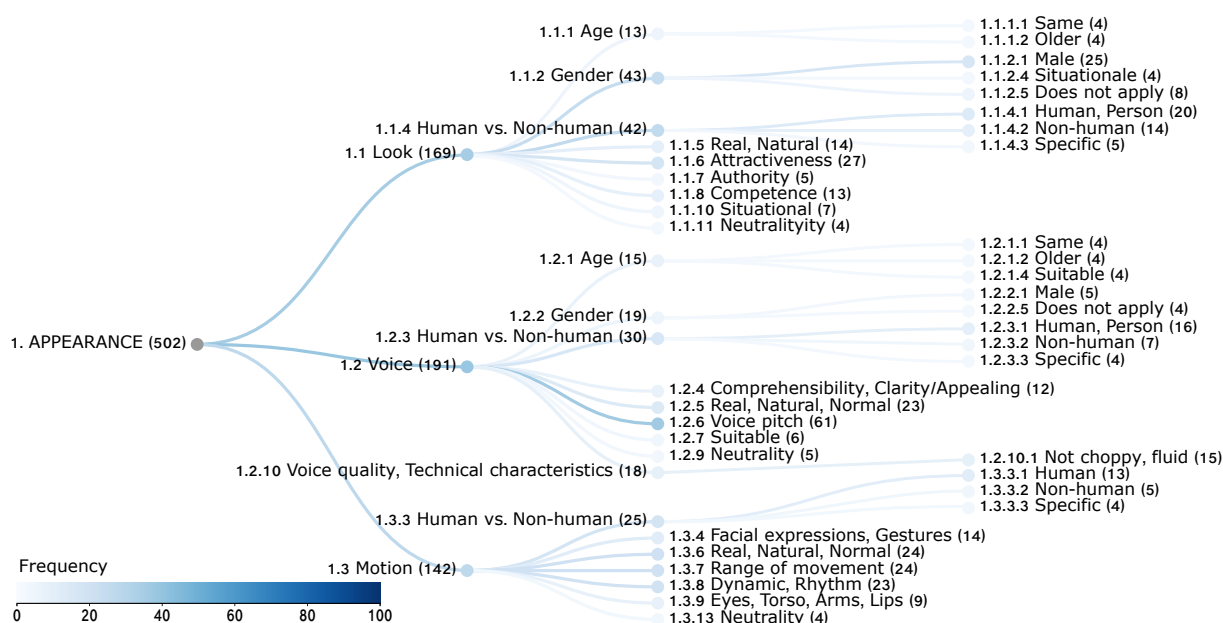


Figure 1. Shows the reduced subcategory APPEARANCE of the category system. The frequencies are shown in brackets and highlighted by a color scale.

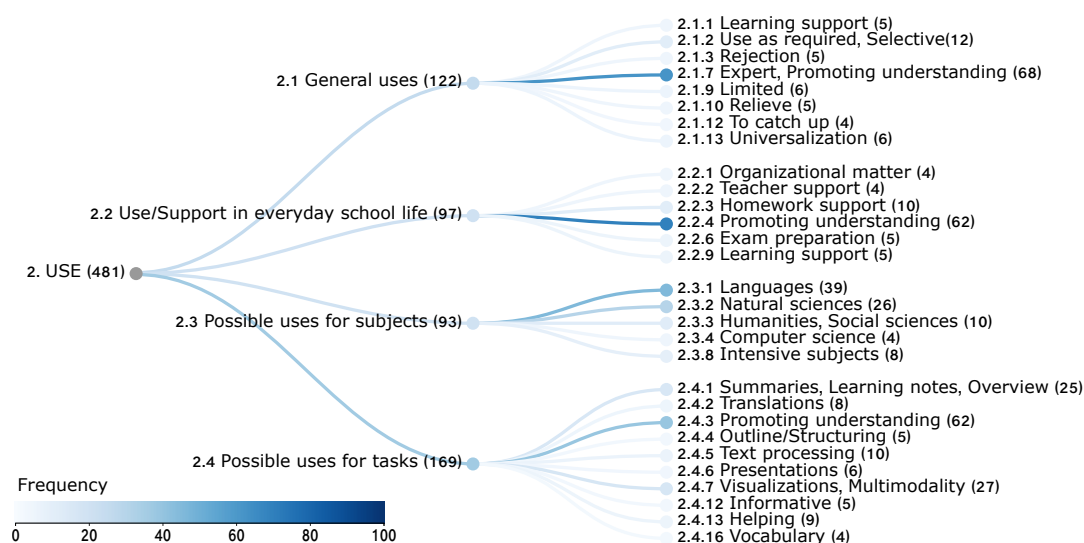


Figure 2. Displays the reduced subcategory USE of the category system. This figure uses the same color scale as the Appearance figure.

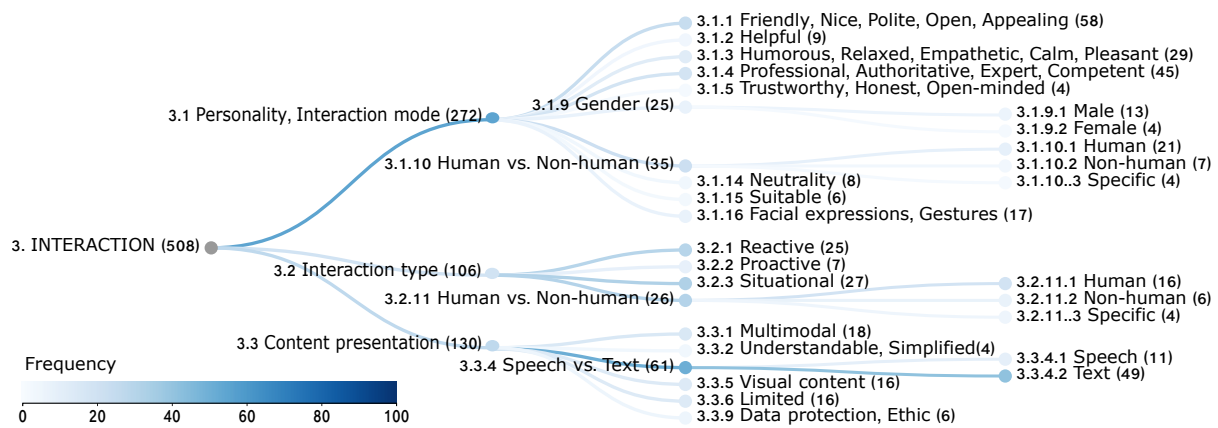


Figure 3. Provides an illustration of the reduced subcategory INTERACTION of the category system. The same color scale is also used here to highlight the frequencies.

3 RESULTS

In this paper, the deductive content analysis presents only fine-grained sub-categories with a frequency greater than three to keep the description of the results compact. In this context, Figure 1, Figure 2, and Figure 3 provide a supporting visualization of the reduced category system. The complete category system, visualization and other materials are provided under the following link: https://osf.io/7d94p/?view_only=8047484fd26b400a81a533a1a305f742

3.1 Q1: What Should an ECA Look Like?

The results indicate that there are several key aspects in an ECA's look (1.1): With regard to age (1.1.1), on the one hand an ECA should have the same age (1.1.1.1), on the other hand an ECA should have a slightly higher age (1.1.1.2). In terms of gender (1.1.2), the association of male (1.1.2.1) ECAs with competence dominates, but at the same time gender is often classified as irrelevant (1.1.2.5) or context-dependent (1.1.2.4). The human vs. non-human appearance (1.1.4) divides preferences: While many call for a realistic, human avatar (1.1.4.1) with natural expressions (1.1.5), others advocate abstract forms (1.1.4.2), with the suggestion not to appear too mechanical (1.1.4.4).

Attractiveness (1.1.6) was also mentioned with words like friendliness and appealing, while authority (1.1.7) should be conveyed more subtly, for example through a professional appearance. Competence (1.1.8) is reflected in professional expertise. Some pupils stated for situational look adjustment (1.1.10), where the appearance should be adjusted depending on the subject. Neutral appearance was also (1.1.11) mentioned.

The results show that the pupils' preferences regarding the look of ECAs are very diverse. For example, while some pupils expressed a desire for ECAs to have more human-like features, others preferred a less anthropomorphic look. This divergence is in line with existing research that similarly shows different preferences in user expectations [14]. In addition, pupils emphasized the importance of adapting ECAs to factors such as age, gender and situational context. A plausible explanation for this variance is that user expectations are inherently characterized by individual differences, a hypothesis supported by previous studies [14], [15]. These findings emphasize that a one-size-fits-all approach to ECA appearance is insufficient. To meet pupils' expectations, it is likely necessary to implement adaptive ECAs—or at least configurable features—that allow personalization of the agent's look.

3.2 Q2: How Should an ECA Sound?

To design the voice (1.2) of an ECA, several aspects should be taken into account in order to meet pupils' preferences and expectations: In terms of age (1.2.1), the voice should sound as if it is of the same age (1.2.1.1) or slightly older (1.2.1.2) than the pupils. The pupils also state that the voice should match (1.2.1.4) to the look of the ECA. Some mentioned situational flexibility (1.2.1.5) in the use of the voice, e.g., different voices for different subject areas. Pupils' preferences to gender (1.2.2) are: Some pupils prefer male (1.2.2.1) voices, but at the same time gender can be considered secondary, because the most common statement is that it does not matter (1.2.2.5).

The human vs. non-human (1.2.3) voice quality debate divides opinion: The majority favour a natural human voice (1.2.3.1), valuing realism and emotional authenticity. At the same time, some pupils explicitly prefer robotic or technical sounds such as those used by smart assistants like Siri (1.2.3.2). Specific (1.2.3.3) comparisons to video game characters are mentioned too.

Other key aspects are comprehensibility and clarity (1.2.4): a clearly articulated, fluent way of speaking without breaks is prioritized. The voice should also sound natural, real and normal (1.2.5). The pitch of the voice plays a key role (1.2.6): friendliness, politeness and a calm, trustworthy tone are mentioned frequently.

Technically, a high voice quality is expected (1.2.10): choppy or unfluent speech is rejected, while smart device voices such as Siri or Alexa are rated ambivalently—some users accept them, others explicitly demand deviation from them (“not that typical Alexa voice”).

The results indicate that the voice design of an ECA must be closely aligned with the requirements of the situation and the characteristics of the students to ensure effective interaction and perception. In particular, it was found to be: appropriateness for the target audience (e.g., adaptation to age, gender), clarity (including articulation precision and contextual speech matching), emotion expression (sensitive tonal reproduction) and technical sophistication (including natural-sounding synthesis and minimal artifacts). These criteria are consistent with previous research on speech-based interfaces [16], [17], [18], [19].

In addition to these factors and the suggestions made by pupils—such as using different voices for different subjects and varying preferences for voice quality—we believe that adaptive flexibility between human naturalness and technical clarity is necessary to promote positive pupils’ perception and preference.

3.3 Q3: How Should an ECA Move?

The movement (1.3) of an ECA should be based on several aspects in order to be perceived appropriate by the pupils. A central aspect is the human vs. non-human (1.3.3): The majority prefer human-like (1.3.3.1) movements. At the same time, however, there are also pupils that deliberately favour a non-human (1.3.3.2) aesthetic, for example to identify the ECAs as machines. Some refer to movements same as video games avatars (1.3.3.3).

Facial expressions and gestures (1.3.4) play an essential role: natural, but not exaggerated gestures and subtle facial expressions are desirable. Realism is highly emphasized (1.3.6): expressions such as fluid, unforced movements that are not choppy are included. The range of movement (1.3.7), like not too fast or too slow, should be balanced. Dynamics and rhythm (1.3.8) should be fluid and calm to signal naturalness. Further motion details concern physical aspects such as natural eye blinking, torso movements or arm gestures (1.3.9). Neutral movements to neutral facial expression (1.3.13) are also mentioned as an option.

In summary, an ECA should act in a natural and fluid way, with expressive but not overloaded facial expressions and gestures. The movement must balance between human realism and technical clarity, always appearing synchronized and authentic in order to promote intuitive interaction and to be perceived as appropriate by the pupils.

3.4 Q4: For What Purpose Would You Use an ECA?

The results show a broad spectrum of general uses (2.1), which can be divided into several even more detailed subcategories. Most mentioned a clear focus on promoting supporting and expert (2.1.7) roles. Here, the ECA was primarily mentioned as an assistant to clarifying questions, explaining complex topics, consolidating technical terms or providing support in subjects such as mathematics and physics.

Another key aspect is selective and needs-based use (2.1.2), where the ECA is to be used in cases of boredom, lack of ideas or specific problems. At the same time, some expressed negative attitudes (2.1.3) (“Not at all”), which could indicate limited use intentions. In the area of learning support (2.1.1), the ECA was seen as a motivating assistant for preparing for class tests or general learning. Others mention the need to catch up (2.1.12), for example with after-school tutoring. Some voices favor a universal use (2.1.13) (“everywhere”).

In summary, the open responses reflect a clear priority: the ECA is primarily perceived as a digital expert for knowledge transfer and problem solving, supplemented by situational, creative and relieving functions. At the same time, the dissenting voices show that the scope of use depend heavily on individual needs.

3.5 Q5: In What Ways Could an ECA Support You in Your Daily School Life?

The use in everyday school life is wide-ranging (2.2). Most of the comments are about promoting understanding (2.2.4). The ECA would act as a digital assistant to clarify open questions and explain complex topics. The ECA could also help with homework (2.2.3), for example by generating solutions or providing assistance with tasks for which an atlas or other resources would otherwise be lacking.

Organizational support would include clarifying timetables (2.2.1), room changes or the presence of teachers. At the same time, the ECA could relieve teachers (2.2.2) by taking on routine tasks such as corrections or acting as a knowledge resource. Pupils see potential in exam preparation (2.2.6), for example through targeted quizzes before class tests. In addition, the learning support (2.2.9) was also mentioned, the ECA could act as a motivated learning assistant.

Overall, the ECA is primarily perceived as a flexible assistant for questions and homework that could simplify everyday school life with answers and clear explanations. The strong emphasis on promoting understanding underlines the desire for intuitive, adaptable learning support.

3.6 Q6: In Which Subjects Could an ECA be Particularly Helpful?

The results show that an ECA could be helpful in various subjects (2.3). Language subjects were mentioned most frequently (2.3.1), particularly for learning vocabulary, translating texts and consolidating languages such as German, English, French and Latin. In the natural sciences (2.3.2) such as mathematics, physics, chemistry and biology, an ECA could provide support and explaining complex concepts.

In the humanities and social sciences (2.3.3) such as history, geography or social sciences, an ECA would be useful for explaining historical contexts or social topics. The potential uses in computer science are mentioned more specifically (2.3.2), for example programming support or identifying syntax errors. Intensive subjects were also mentioned (2.3.8), e.g., subjects with a high learning effort, many technical terms, complex tasks or extensive writing requirements.

Overall, the findings show that ECA should offers advantages where repetitive learning, the need for explanation or the mastery of extensive content are the main focus.

3.7 Q7: For Which Tasks Would an ECA be Especially Useful?

An ECA would be helpful in the following tasks (2.4): summaries, learning notes and overviews that are a key aspect of tasks (2.4.1). The ECA can assist in creation of summaries, texts or learning materials. In the aspect of translations (2.4.2), the ECA could translate texts into foreign languages such as Latin or generally help with language teaching.

Promoting understanding was mentioned most frequently (2.4.3). The ECA could serve as an interactive assistant to answer questions on unclear topics. For outlining and structuring (2.4.4), the ECA could help to organize content, e.g., when preparing presentations or structuring learning material. In text processing (2.4.5), the ECA would be useful for correcting errors, analysing texts or writing texts.

In presentations (2.4.6), the ECA could support the creation and preparation of content. Visualization and multimodality play a major role (2.4.7): diagrams, images, videos or statistics could be used to vividly convey abstract topics. Other aspects of tasks include informative functions (2.4.12), e.g., by collecting up-to-date information. Practical assistance (2.4.13) such as homework support, tutoring or teacher support would also be conceivable. More specific tasks such as vocabulary (2.4.16) learning round off the task's usage.

In summary, ECA would be valuable for consolidating knowledge, ensuring individual understanding, the multimodal preparation of content and the organizational structuring of learning processes. The high relevance of promoting understanding and visualization underscores the expected pupils need for an adaptive, multimodal and interactive learning assistant that go beyond pure text mediation.

3.8 Q8: How Should an ECA Interact With You? (e.g., Should It be Friendly, Strict, Humorous, or Highly Knowledgeable?)

The results show that pupils have expectations of a kind of personality from an ECA when interacting with them (3.1). First and foremost, the ECA should appear nice, polite and appealing in order to create a basis for interaction (3.1.1). At the same time, a professionally competent and authoritative character

is desired (3.1.4), who explains complex topics in an understandable way, provides support with questions and acts as a reliable source of knowledge.

Another aspect is the natural and realistic design of the agent. Many respondents attach importance to a human appearance (3.1.10.1), natural voice and realistic facial expressions, such as synchronized mouth movements. Nevertheless, there are also comments that prefer a clear distinction from the human-like (3.1.10.2, 3.1.10.3) interaction—for example in the style of voice assistants such as Siri or Alexa, to ensure a mechanical but functional interaction. Some interaction modes should be kind of adaptable to the situation: some pupils want a relaxed, humorous or empathetic tone (3.1.3), while others prioritize a calm and composure ECA behaviour. Appropriate gestures and facial expressions (3.1.16) are also expected—not too exaggerated, but expressive enough to convey authenticity.

There are different preferences with regard to gender, but these were mentioned with varying frequency (3.1.9): Most students prefer the male gender (3.1.9.1). However, a few also prefer the female gender (3.1.9.2). Less common, but still relevant, are aspects such as neutrality (e.g., in facial expressions and emotions) (3.1.14) and trustworthiness (3.1.5).

Pupils' preferences to gender (1.2.2) are: Some pupils prefer male (1.2.2.1) voices, but at the same gender can be considered secondary, because the most common statement is that it does not matter (1.2.2.5).

In summary, an ECA should be empathetic and competent at the same time, technically reliable and naturally oriented towards the expectation of the pupils in terms of tone of personality and behaviour - be it in school support, everyday questions or informative dialogues.

3.9 Q9: Should the ECA Only Speak When Addressed, or Should It Proactively Engage with You?

The results of the interaction types (3.2) indicate a multi-layered picture that shows both clear preferences and context-dependent nuances. Reactive (3.2.1) interaction is the clearest focus. The pupils prefer that the ECA primarily response to their requests—for example, ECA should only response when asked. The reasons for this could be to maintain the flow of conversation (“don't interrupt”) and to avoid interruptions.

Proactive (3.2.2) behaviour is less frequently desired. However, some pupils see situations in which an active approach could be useful, for example when conversations are faltering or when a relevant information should be provided. Situational (3.2.3) interaction combines both aspects: The ECA should decide whether reactivity or proactivity is appropriate depending on the context. For example, the ECA could ask questions independently during learning or provide support in the event of ambiguities in texts. Other aspects that were mentioned are human-like (3.2.11.1) agents that should act like teachers and, in contrast, clear machine attributes (3.2.11.2/3) such as Siri are preferred.

While reactive behaviour is clearly prioritized, the results shows that the ECA must be able to make decisions adapted to the situation. An ideal agent combines restraint in everyday questions with targeted proactivity in learning or problem situations, as well as human traits and a variable design that adapts to the user context. Ultimately, this reflects the desire for a balanced, intuitive companion that offers support without being intrusive.

3.10 Q10: Should the ECA Respond Only Through Speech or Should It Also Present Other Types of Content? If so, What Kind?

The results for content presentation (3.3) show a clear preference: The most pupils advocate that the ECA should respond with multimodal (3.3.1) capability by including visual and text-based content such as images, videos, diagrams, statistics or presentations. Visual contents (3.3.5) are considered as useful if they promote understanding, for example through step-by-step explanations or simplified illustrations.

The speech vs. text (3.3.4) debate reveals a clear weighting: while speech (3.3.4.1) functions should be used for realistic lip-synchronization, translations or dialogue-based interaction, text generation (3.3.4.2) dominates with a focus on practical applications such as creating summaries, learning notes, outlines or text corrections.

At the same time, there are restrictions (3.3.6) in that the ECA only shows content when explicitly requested and does not provide personal or ethical assessments. Ethical and data protection (3.3.9) aspects also play a role: pupils demand transparency and warnings about copyright problems with generated images or videos. Personal data or morally sensitive topics should be excluded.

To summarize, an ECA should be flexible and context-sensitive multimodal—primarily speech-based, but supplemented by visual and textual elements that increase understanding and efficiency. Ethical boundaries, user preferences and situational relevance are keys to avoiding excessive demands or misuse.

4 CONCLUSIONS

This paper explored the design and use of embodied conversational agents (ECAs) in educational settings for pupils aged between 13 and 17 years to address gaps in the literature regarding age-specific preferences and effectiveness. In a workshop with 64 participants, valuable qualitative insights were gained to guide the development and design of ECAs tailored to pupils' expectations and preferences.

Design preferences: Pupils stated different preferences for the look, voice, and motion of the ECA. Some preferred human-like features (e.g., realistic facial expressions, age-appropriate avatars), while others preferred abstract or non-human designs to emphasize the agent's role as an assistant. Voices were also expected to strike a balance between clarity, naturalness, and emotional authenticity, as well as situational adaptability (e.g., different voices for different subjects). Movements and gestures were considered essential for engagement. They need to be fluid and subtle to avoid exaggerated or mechanical interactions. These findings highlight the need for customizable or adaptive ECAs to meet individual preferences and contextual requirements.

Educational roles and tasks: Pupils valued ECAs as useful assistants for knowledge consolidation, problem solving, and organizational support. Subjects that require repetitive practice (e.g., languages, math) or complex conceptual understanding (e.g., science) were highlighted as ideal fields. Tasks such as summarizing content, translating texts, visualizing abstract concepts, and assisting with exam preparation were prioritized, reflecting the need for multimodal interaction (e.g., combining speech, text, and diagrams). ECAs were also seen as potential aids to reduce teacher workload by automating routine tasks.

Interaction and personality: Pupils emphasized a preference for reactive interactions, where ECAs respond to explicit prompts to avoid disruption. However, situational proactivity (e.g., offering cues to important and valuable information) was seen as beneficial. Personality traits such as friendliness, competence, and humor were valued, although the agent's voice and behavior should be consistent with the educational goals (e.g., professionally competent and authoritative character who explains complex topics in an understandable way). Ethical concerns and data protection were emphasized, including transparency in data use and avoiding copyright violations.

Relevance for design and future research: The results underline the importance of a user-centered design of ECAs in education. Developers should prioritize adaptability and allow ECAs to adjust their appearance, interaction style, and content offering to user preferences and situational needs. Future research should investigate the long-term impact of ECAs on learning outcomes, ethical guidelines for AI in education, and the balance between human-like empathy and functional efficiency [2], [6].

By integrating these insights, ECAs can evolve into versatile, engaging tools that enhance the educational experience while meeting pupils' expectations and preferences.

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