Agent-Based Social Skills Training Systems: A Comprehensive Analysis of Commercial Solutions

What commercially available training systems are out there and how do they model their agents and feedback?

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Abstract

Agent-based social skills training systems have been gaining attention for their potential to improve social skills development in various contexts. Through a rapid review methodology, data was collected from diverse sources, including company websites and research papers. This study then uses the collected data to categorize 8 commercial systems based on their agent model and feedback approaches, into two categorization tables. The findings reveal notable trends in the use of choice-based input, scenario-defined decision-making, and post-interaction feedback. Additionally, the paper discusses the limitations of these findings, highlights characteristics of commercial systems and compares them to research systems, as well as suggesting areas for future research. This study contributes to the understanding and advancement of agent-based social skills training systems, offering guidance to researchers in this field.

1 Introduction

The development of social skills is an essential aspect of human interaction and communication. Effective social skills enable individuals to establish and maintain relationships, navigate social environments, and work collaboratively in a team. Social skills training has traditionally been done through methods such as role-playing, coaching, and feedback sessions. However, these approaches can be time-consuming, expensive, and tend to steer away from real-world scenarios [3].

In recent years, artificial intelligence has made it to the spotlight and has seen remarkable growth that is expected to continue for the foreseeable future [1, 24]. As a result of this growth, there has been an emergence in the development of agent-based social skills training systems [4, 23]. These systems use virtual agents to provide a more immersive and engaging learning experience, allowing users to practice social skills in a safe and controlled environment.

Despite the growing interest in this area, there remains a lack of comprehensive information on commercially available social skills training systems and how they model their agents and provide feedback. The study carried out by Bosman, Bosse, and Formolo [3] gives a comprehensive review of many agent-based social skills training systems, however, excludes any commercially available system. Another example of this is the work undertaken by Core et al. [7] where only a single commercially available training system is included in the scope of the research.

This study aims to fill this gap by providing a holistic view of many commercially available training systems, in particular those focusing on communication training agents. Concretely, this review will identify and evaluate relevant training systems, analyzing their approaches to modeling agents and providing feedback. It is also important to note, that this paper is not a literature review, its main focus will be on company systems rather than academic prototypes.

Furthermore, previous research in this field also made significant contributions to our understanding of social skills training, such as the use of cognitive architectures like the Belief Desire Intention model[12] and the development of feedback mechanisms based on reinforcement learning[11]. However, there remain unanswered questions about the effectiveness of different approaches and the optimal design of social skills training systems. By examining and evaluating a range of commercially available training systems, this study seeks to contribute to the ongoing research efforts in this area.

Researching commercially available systems would be beneficial as it provides insights into real-world applications that are currently accessible to users. It allows for a better understanding of the techniques and features most commonly used in commercial systems. This could help create better systems in the future, that are ready to be commercialized and be widely used by any user.

As a means to facilitate the research, the main research question, *"What commercially available training systems are out there and how do they model their agents and feedback?"*, is divided into three sub-questions:

- What commercially available social skills training systems exist?
- How do these training systems model their agents, and what approaches do they use?
- What types of feedback mechanisms do these systems use to teach and provide guidance to the user?

The main contributions of this research are two-fold: (1) It will give a holistic overview of commercially available social skills training systems, an analysis of how these systems model their agents, and an evaluation of the feedback mechanisms used by these systems to help the user. (2) This study will provide further insights into the state of the art in agent-based social skills training research while identifying areas for further investigation.

The rest of the paper is organized as follows: First, the methodology used in this study is presented and then this paper's contributions to the field. Followed by, the results of the study are presented. Then, a section about responsible research is presented to reflect on the reproducibility of the research. Finally, the paper concludes with a discussion of the findings, followed by, an overall conclusion to the paper with suggestions for future work.

2 Methodology

In the chapter that follows, the methodology of this study is outlined to investigate commercially available training systems and analyze their agent modeling and feedback mechanisms. The primary purpose of this research is to provide a comprehensive overview of the existing systems and understand how they apply virtual agents to train social skills. The methodology encompasses a rapid review, leveraging online research and industry reports while adhering to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) structure guidelines [19]. It is important to note that since there is a limited time frame for this study, the paper will not follow everything included in PRISMA but will

follow the same structure and basic requirements, such as the flow diagram.

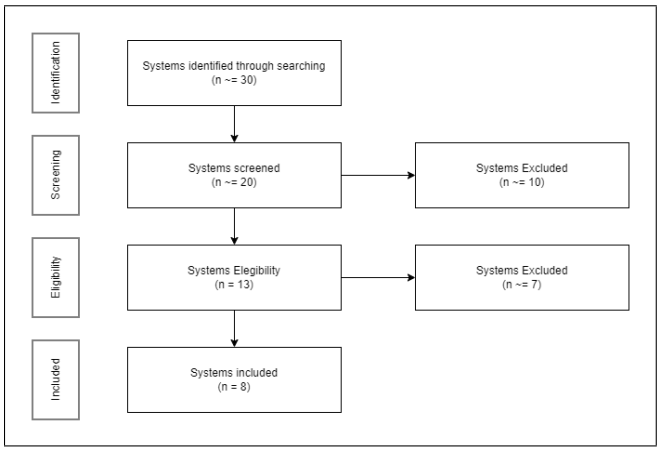


Figure 1: PRISMA flow diagram

2.1 Study Design

With the aim of this research in mind a rapid review [21] was the selected methodology for this paper. Given that this study aims to provide insights into commercially available agent-based social skills training systems within a short time frame while maintaining methodological rigor, a rapid review approach was deemed appropriate as it allows for a more time-efficient review of the literature, while still maintaining a high level of quality and rigor [14, 18].

The use of rapid review methodology also influenced the decision to adhere to the PRISMA guidelines [19]. Adhering to the PRISMA guidelines ensures comprehensive reporting and enables a clear presentation of the review's methods and findings.

2.2 Search Strategy

The sections below describe the procedures and methods used as means of investigation. More concretely, this chapter will describe the search sources and the search terms used to find relevant data.

Search Sources

To ensure a comprehensive search, multiple data sources were utilized in this research. The primary source of information was the Google Search Engine, as the research does not include academic prototypes. Furthermore, ChatGPT[1], a language model developed by OpenAI, was used to aid research and find more systems. Even if the research does not focus on academic prototypes, some academic databases were also queried, as some research papers [3, 22] mention systems that could be used in the study. Therefore, the following databases were queried: IEEE Xplore, PubMed, and Google Scholar, which are platforms where academic papers can be queried. Incorporating these diverse data sources, a thorough research of the topic was conducted to gather relevant information on these commercial systems. Finally, it is important to note that this research started in April 2023 and finished on June 2023.

[1]https://chat.openai.com

Search Terms

Search terms in this review were divided into 3 parts namely: the system (e.g., agent-based, virtual agent, virtual reality), what the systems trains (e.g., social skills, job interviews, leadership), and the purpose of the system (e.g. practice, train, training). These search terms were combined using the Boolean operators AND and OR, where between each part there is an AND and between each possible term of each part an OR. An example of a search query done in google scholar would be, "*("virtual agent" OR "conversational agent" OR "virtual reality")(social OR interview OR leadership)(training OR practice OR train)*". For further examples, the following table includes a list of the search terms used in the search engines and databases used in this study.

Term 1	**Term 2**	**Term 3**
Virtual Agent	Social	Training
Virtual Reality	Interview	Practice
Agent-based	Leadership	Train
Artificial Intelligence	Customer	Development
Conversational Agent	Interpersonal	Educational
Chatbot		Instruction
Simulation		Coaching

Table 1: Search terms

In the case of ChatGPT, the main query to find some of these systems was *"Can you give me examples of commercially available agent-based social skills training systems?"*. Followed by this, questions were asked about the systems when necessary and more examples could be requested by using the following prompt *"Could you show me more examples?"*.

2.3 Inclusion Criteria

The following criteria were used to determine the eligibility of the studies:

- Agent-Based: The systems must employ virtual agents or virtual coaches to simulate a scenario which the user can interact directly with.
- Social Skills Training: The systems must be designed to train and improve social skills. This includes but is not limited to job interviews, leadership, and interpersonal relationships.
- Commercially Available: Only commercially available systems will be considered. In this study, commercially available systems are defined as systems that are not research focused and end up being used in real-world situations.

By applying these criteria, the study aims to ensure that the selected systems align with the research focus. This approach will enable a comprehensive examination of systems that are specifically designed to enhance social skills through the use of agents.

2.4 Exclusion Criteria

Systems that did not meet the inclusion criteria were immediately excluded from the analysis. Additionally, any systems that did not have enough publicly available information to be categorized were also excluded from this research. This exclusion criterion ensures that the analysis is more focused and that no system cannot be categorized.

2.5 Data collection

The data collection process consisted of multiple steps. Firstly, a comprehensive search was conducted using Google to identify new training systems and academic databases to find references to systems mentioned in research papers. An example of the search terms used during this process can be found in Table 1.

Next, a filtering process was implemented to identify systems that matched the inclusion criteria (mentioned in the previous section).

For the selected systems, data was gathered by exploring the corresponding companies' websites for product descriptions, analyzing videos demonstrating the system in use, as well as any available promotional material. These videos were gathered from the companies' websites and YouTube[2] (querying by the company name). Additionally, whenever there was a lack of online data and there was a contact form available, information was sought through those forms, to gather as much relevant data as possible.

Once all the data was collected, it was organized into a categorization table [3], providing a more structured analysis of the underlying agent model and feedback mechanisms. The categorization table provided a standardized format for comparing and contrasting the different systems based on key attributes and features.

2.6 Categorization

The paper incorporates the use of two categorization tables to address the research questions presented in this study. Both tables mention a range of systems that were analyzed, which in turn answers the first sub-research question. In the following section, two separate categorization tables, one for agent models and the other for agent feedback, are introduced to address the second and third sub-research questions, respectively. It is important to note that, the categorization tables were derived based on a work-in-progress paper that defined the categorizations for different components within social skills training systems, see Table 6.

Agent Model Categorization

As previously mentioned, in this section the agent model categorization table is introduced and explained. This table, which focuses on agent model categorization, plays a crucial role in understanding the underlying design and structure of the researched systems. By categorizing the agents' models used in these systems, valuable insights can be gained regarding the varying approaches, strategies, and techniques employed by these commercial systems.

[2]https://www.youtube.com/

System	Type Training	Input Type	Agent Model Structure	Decision Making	Changeable Emotions/Cognition	Learner Model	Use of Learner Model

Table 2: Template Categorization Table for Agent Model

Input Type: The input type refers to the type of input the system accepts. Possible categories are:

- *Choice-Based*: The system accepts input in the form of multiple-choice questions.
- *Open-Ended*: The system accepts input in the form of free text.

Agent Model Structure: The agent model structure refers to how the agent is structured internally. Possible categories are:

- *No change of states*: The agent does not change states based on the user's input.
- *Changes of states are fixed*: The agent changes states based on the user's input, but the state transitions are fixed.
- *Limited state changes*: The agent changes states based on the user's input, but the states are limited.
- *Representation of changes in states*: The agent changes states based on the user's input, but state transitions are influenced by multiple dimensions.

Decision Making: The decision-making process refers to how the agent decides on the next action to take.

- *Teacher Actor*: The agent decision-making is controlled by a teacher actor.
- *Direct Input to Output*: The agent's decision-making maps inputs to outputs.
- *Scenario is defined*: The agent has a defined scenario and makes decisions based on the events that have happened during that scenario.

Changeable Emotions/Cognition: Whether the agent can change its emotions and/or cognition based on the user's input.

- *Yes*: The agent can change its emotions/cognition based on the user's input.
- *No*: The agent cannot change its emotions/cognition based on the user's input.

Learner Model: Whether the agent perceives and models the learner.

- *Yes*: The agent models the learner.
- *No*: The agent does not model the learner.

Use of Learner Model: Where is the learner model used.

- *Feedback*: The learner model is used to provide feedback.
- *Teaching Strategy*: The learner model is used to adapt the teaching strategy.
- *Agent's Decision Making*: The learner model is used to adapt the agent's decision-making.

Agent Feedback Categorization

The agent feedback categorization table is introduced and explained in the following section. By categorizing and analyzing the types, timing, and strategies used in providing feedback, a better understanding of how these systems help in social skills development can be obtained.

System	Type Training	When	Content	Covers	Teaching Strategies	Pedagogical Agent	Pedagogical Agent Role(s)

Table 3: Empty Categorization Table for Agent Feedback

When: When the feedback is provided.

- *After*: The feedback is provided after the interaction with the agent.
- *During*: The feedback is provided during the interaction with the agent.

Content: The content of the feedback.

- *Reflection of performance*: The feedback reflects the user's performance.
- *The agent's mind*: The feedback contains references to the agent's internal references.

Covers: The number of sessions the feedback covers.

- *Single Session*: The feedback covers a single session.
- *Multiple Sessions*: The feedback covers multiple sessions.

Teaching Strategies: Strategies used to teach the user.

- *Cognitivism*: Building a learner's cognitive process regarding training.
- *Constructivism*: Building a learner's knowledge based on exploring modeled scenarios.
- *Behaviorism*: Building a learner's knowledge based on repetitive tasks and memorization with positive reinforcement.
- *Social Cognitive Theory*: Building a learner's knowledge based on learning from others.

Pedagogical Agent: Virtual trainer guiding or reflecting on learner's interaction.

- *No agent*: There is no pedagogical agent.
- *Textual*: Pedagogical agent is textual.
- *Embodiment*: Pedagogical agent has a visual avatar.

3 Results

The next section presents the results of the study, which focused on examining and evaluating commercially available agent-based social skills training systems. The first subsection will focus on displaying the categorization tables which are the main takeaway of this research. However, since similarities, were found in most of the systems, the second section will do a quick analysis of the categorization tables.

3.1 Categorization

The results are displayed in two categorization tables that provide an overview of the analysis done to the systems included in this study, at the agent model level and the feedback system level.

System	Type Training	Input Type	Agent Model Structure	Decision Making	Changeable Emotions/Cognition	Learner Model	Use of Learner Model
Elite [10]	Leadership	Choice based	Changes of states are fixed	Direct input to output	No/No	No	-
Elite Lite [9,10]	Leadership	Choice based	Changes of states are fixed	Direct input to output	No/No	No	-
Dialogue Trainer [6]	General Social Skills	Choice based	Limited States	Scenario is defined	Yes/No	No	-
Simmersion [25]	Job Interview & Coaching	Choice based	Representation of changes in state	Scenario is defined	Yes/Yes	Yes	Feedback
Kognito [15]	Clinical	Choice based	Representation of changes in state	Scenario is defined	Yes/No	Yes	Feedback
Mursion [13]	Customer Service	Open-ended	No Change of states	The teacher actor	-	No	-
Virtual Speech [20]	Performance Reviews	Open-ended	Representation of changes in state	Scenario is defined	-	Yes	Feedback
Cognii [5]	Communication skills	Open-ended	Representation of changes in state	Scenario is defined	No/No	No	-

Table 4: Agent Model Categorization Table

Table 4 addresses the second sub-research question of this study. By systematically examining the agent models employed in the different analyzed systems, this table provides valuable insights into the agent behaviors and characteristics of commercial systems. Through this categorization, a deeper understanding of the approaches in agent modeling is gained, shedding light on the mechanisms used by these systems. Such analysis facilitates the identification of commonalities, differences, and potential areas for improvement in the agent models used.

System	Type Training	When	Content	Covers	Teaching Strategies	Pedagogical Agent	Pedagogical Agent Role(s)
Elite [10]	Leadership	After	Reflection of performance	Single session	Cognitivism	-	-
Elite Lite [9,10]	Leadership	During & After	Reflection of performance	Single session	Cognitivism	Textual Agent	Learning & Feedback
Dialogue Trainer [6]	General Social Skills	During	Reflection of performance	Single session	Cognitivism	-	-
Simmersion [25]	Job Interview & Coaching	During & After	Reflection of performance	Single session	Cognitivism	Embodiment	Learning & Feedback
Kognito [15]	Clinical	During & After	Reflection of performance	Single Session	Cognitivism	Embodiment	Learning
Mursion [13]	Customer Service	After	Reflection of performance	Single Session	Cognitivism	-	-
Virtual Speech [20]	Performance Reviews	After	Reflection of performance	Single session	Cognitivism	-	-
Cognii [5]	Communication skills	During & After	Reflection of performance	Single Session	Cognitivism & Behaviourism	-	-

Table 5: Agent Feedback Categorization Table

Table 5 focuses on answering the third sub-research question of this study. This analysis gives more insights into the strategies used by commercial systems to guide and support learners' skill development. By understanding the range of feedback approaches, this table contributes to improving the design of agent-based systems in providing valuable feedback.

3.2 Analysis

As previously stated, this section next section will provide a quick analysis of some similar similarities found in these systems. Furthermore, this will discuss possible reasons why these patterns seem to emerge from the data collected.

Input Type

In Table 4, it can be observed that 5 out of 8 of the systems employ choice-based input as opposed to open-ended input. A possible explanation for this is that since there is a limited amount of options that the user can select from, this offers a more structured interaction to the user while maintaining focus during the interaction. This approach may be beneficial for individuals who are new to social skills training or prefer a more structured learning environment.

Agent Model Structure

Regarding agent model structure, there does not seem to be a consensus over the analyzed systems. According to Table 4, 4 out of 8 systems seem to use *representation of changes in state*, this design choice may be attributed to the need for a more nuanced and adaptive interaction between the agent and the user, allowing for a broader range of responses and behaviors. However, this approach may be more difficult to implement and require more resources than the other approaches, and that could be the reason for 3 out of 8 systems use *limited states*.

Decision Making

In Table 4, 5 out of 8 of the included systems utilized a scenario-based approach for decision-making, rather than matching inputs with predefined outputs. Scenario-based approaches present the users with specific social situations or contexts and prompt them to make decisions or select appropriate responses. By presenting varied scenarios, these systems aim to simulate real-life interactions and provide users with opportunities to practice in contextually relevant situations. These results may be due to, scenario-based approaches allowing for a more immersive and realistic learning experience, enabling users to develop their communication skills more effectively.

Changeable Emotions/Cognition

The inclusion of changeable emotions in agent-based social skills training systems varied among the analyzed systems. While some systems incorporated changeable emotions to enhance the realism and engagement of user interactions, others did not explicitly incorporate this feature, potentially prioritizing different aspects of agent behavior or pedagogical approaches. The decision to include emotions could be because these could improve the efficiency of learning by providing a more realistic environment [17]. On the other hand, the decision to exclude emotions could be because implementing emotions is more technically challenging.

Learner Model

According to Table 4, 3 out of 8 of the systems included a learner model, to provide personalized feedback. The reason for this choice could be that according to, Back and Dietrich [2] and El Mawas et al. [8] personalization is one of the most important features of e-learning. However, this is a feature that is technically more challenging to implement, potentially being the reason why the other 5 systems decided to exclude the learner model.

Feedback Frequency

According to Table 5, about 7 out of 8 of the researched systems provide feedback after the interaction, while only 5 mentioned feedback during the interaction. These results could suggest that most systems try to keep the interaction as realistic as possible by not introducing any disturbances, and therefore leave the feedback to the end of the interaction.

Feedback Content

In Table 5, it stands out that all of the systems only include the learner's performance in the feedback, while keeping it limited to a single session. This could suggest, that by only including this information the feedback becomes easier to read and understand while providing the necessary information for the learner to improve.

Teaching Strategies

According to Table 5, all of the included systems use cognitivism as a teaching strategy. This could be linked to the fact that all of these systems decided to go for a reflection of performance feedback, which is considered to be cognitivism.

Pedagogical Agent

We can observe in Table 4, that 3 out of 8 of the systems use a pedagogical agent. By looking at the systems that adhered to the use of pedagogical agents, it can be seen that this feature is mostly used as a helper to the overall system. Therefore, the other 5 systems that did not adhere to the use of pedagogical agents could be that they deemed that this would be unnecessary.

4 Discussion

In contrast to previous research on social skills training systems, the current study revealed a notable distinction in the input mechanisms utilized. While research systems predominantly employed free input [3], commercially available systems predominantly adopted a more restricted choice-based input approach. This difference suggests that commercial systems may be influenced by factors that differ from research systems, such as ease of use, user preference and maintaining focus on the topic being addressed.

Turning the focus to feedback mechanisms, there was an evident disagreement between research systems and commercial systems. Research systems showcased a diverse range of feedback tools, ranging from emotion changes to the model of the agent [12]. Although commercial systems also used various feedback tools, there was a primary focus on the performance review at the end of the session. This distinction suggests an emphasis on self-assessment and reflection in commercial systems, aiming to promote user autonomy and self-guided learning experiences. In addition to this, the emphasis on post-interaction feedback in commercial systems may also be attributed to the practical considerations of scalability and user accessibility.

One similarity identified across both research and commercial systems is the common use of scenario-defined decision-making. In this approach, the agent is presented with social scenarios and makes decisions based on the given context and the ongoing conversation rather than mapping inputs to outputs directly. Both types of systems prioritize scenario-based decisions, this could be because both systems intend to simulate a real-world scenario as much as possible. Furthermore, since these are training systems, this feature could help to improve the learner's decision-making as it makes the conversations less predictable.

However, it is essential to recognize that comparing research systems to commercially available systems entails certain limitations. Commercial systems are designed to cater to a broader user base, emphasizing usability, scalability, and practicality. In contrast, research systems often prioritize experimental control and customization, allowing for a greater diversity of input and feedback options. These distinctions could arise from the inherent goals and constraints associated with each system type.

5 Limitations

The study has several limitations that should be acknowledged. Firstly, it is important to note that while this study aimed to gather a comprehensive set of systems, the commercial plane is ever-changing. The domain of systems used in this study is based on the availability of information at the time of data collection. Hence, it is possible that some systems may not have been included or may have undergone changes since the completion of this study (June, 2023).

Secondly, the research is constrained by the availability of publicly accessible information. Companies may not disclose the complete details of their products, limiting the analysis. Consequently, there might be certain information gaps within the provided data.

Lastly, due to the limited sample size of 8 systems analyzed in this study, generalization of the findings may be challenging. Therefore, caution should be exercised when extrapolating the results to the broader population of systems in this domain.

Despite these limitations, this study provides valuable insights into the characteristics, input mechanisms, feedback systems, and learner models of commercially available systems. The findings contribute to the existing knowledge and understanding of agent-based social skills training and lay the foundation for future research and development in this field.

6 Responsible Research

In conducting this research, we have carefully considered some of the potential ethical considerations related to data collection and analysis. Regarding the data collected, the study focused on commercially available agent-based social skills training systems, and all data was collected using publicly available information from company websites, research papers, and other online sources. As a result, no personal or sensitive data was collected or accessed during the completion of this study.

Turning now to the results of the study, ethical considerations were also considered when discussing those findings. While the categorization tables provide an overview of the underlying agent model and their feedback systems, efforts have been made to present the information in a fair and unbiased manner. In addition to this, it is important to note that the interpretation of the gathered data was conducted without any potential conflict of interest or external influence. Finally, to ensure the unbiased presentation of the results, the study also included double coding, where the same data was labeled by a different person to improve the reliability of the data and prevent any bias, the Cohen's kappa coefficients for the dimensions of both tables all ranged between 0.63-1[3] which falls between a substantial and a perfect agreement for each dimension [16].

Another significant aspect of responsible research is reproducibility, which this study hopes to achieve by providing an extensive description of the data collection and categorization processes. The overall procedure used to discover and analyze the commercially available agent-based social skills training systems has been clearly outlined in the methodology section. Moreover, the categorization tables provide a comprehensive overview of the criteria and categorization utilized in this study, enabling the replication or extension of the analysis in a consistent manner.

In conclusion, this research adheres to ethical principles by using publicly available data, ensuring privacy and confidentiality, and providing reproducible methods. By addressing ethical considerations and discussing the reproducibility of the study, we aim to contribute to the responsible conduct of research.

7 Conclusions and Future Work

Thus far this study has aimed to explore commercially available agent-based social skills training systems by analyzing, their internal agent model and feedback mechanisms. The research question sought to identify the types of systems available and examine how they approach social skills training.

Through the use of a rapid review methodology and analysis of available information, several key findings emerged in the data collected. Of these findings, it was observed that commercially available systems tend to prefer choice-based input, highlighting a difference from the open-ended input approach preferred by research-focused systems. Moreover, these systems tend to skew in the direction of performance reflection when it comes to feedback mechanisms, contrasting with the research systems that tend to have more diverse feedback mechanisms. These findings shed light on the unique characteristics and design choices present in commercially available systems, which have to cater to the specific needs of users. The study highlights the importance of understanding the context and limitations of these systems, given their commercial nature.

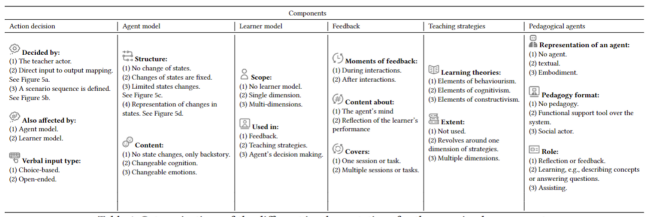
While this research provides valuable insights into the current landscape of agent-based social skills training systems, it also raises important questions and opportunities for further investigation. Future research could explore the effec-

[3] https://doi.org/10.5281/zenodo.8079777

tiveness of these differences, for example, how effective is choice-based compared to free input text. Additionally, further research could be done to find better types of feedback, if there are any, to possibly increase the variety of feedback systems in commercial systems, as this is the main source of learning for the users.

In conclusion, this study contributes to the existing knowledge by providing an overview of commercially available agent-based social skills training systems. It complements previous research, such as the one performed by Bosman, Bosse, and Formolo [3], that focused on non-commercial systems. It highlights the unique approaches and characteristics of these systems, setting them apart from their research-oriented counterparts. Finally, findings offer insights for researchers in the field, possibly guiding future advancements and shaping the direction of research in agent-based social skills training systems.

A Original Categorization Table



Components					
Action decision	Agent model	Learner model	Feedback	Teaching strategies	Pedagogical agents
Decided by: (1) The teacher actor. (2) Direct input to output mapping. See Figure 5a. (3) A scenario sequence is defined. See Figure 5b. **Also affected by:** (1) Agent model. (2) Learner model. **Verbal input type:** (1) Choice-based. (2) Open-ended.	**Structure:** (1) No change of states. (2) Changes of states are fixed. (3) Limited states changes. See Figure 5c. (4) Representation of changes in states. See Figure 5d. **Content:** (1) No state changes, only backstory. (2) Changeable cognition. (3) Changeable emotions.	**Scope:** (1) No learner model. (2) Single dimension. (3) Multi-dimensions. **Used in:** (1) Feedback. (2) Teaching strategies. (3) Agent's decision making.	**Moments of feedback:** (1) During interactions. (2) After interactions. **Content about:** (1) The agent's mind (2) Reflection of the learner's performance **Covers:** (1) One session or task. (2) Multiple sessions or tasks.	**Learning theories:** (1) Elements of behaviourism. (2) Elements of cognitivism. (3) Elements of constructivism. **Extent:** (1) Not used. (2) Revolves around one dimension of strategies. (3) Multiple dimensions.	**Representation of an agent:** (1) No agent. (2) textual. (3) Embodiment. **Pedagogy format:** (1) No pedagogy. (2) Functional support tool over the system. (3) Social actor. **Role:** (1) Reflection or feedback. (2) Learning, e.g., describing concepts or answering questions. (3) Assisting.

Table 4: Categorizations of the different implementations for the examined components

Table 6: Original Categorization Table

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