An Empathic Pedagogical Conversational Agent for Development of Computer and Research Competencies: A Research Plan

Elvis Ortega-Ochoa

Doctoral School, Universitat Oberta de Catalunya, Rambla del Poblenou 154, Barcelona, 08018, Spain

Abstract

Empathic Pedagogical Conversational Agents (PCAs) are learning tools that can favor adaptive learning in acquiring skills. Although the authors studied the effect of the learning articulated by the empathic PCAs in computer competencies, it is only focused on student perceptions. In contrast, many studies have considered the learning performance in the research competencies, but an assessment of the student perceptions and the qualitative approach is necessary. Thus, the main goal is to understand the adaptive learning articulated by an empathic PCA and its impact on the development of competencies in distributed systems and educational research in higher education. To this end, a framework is constructed to evaluate the learning outcomes of this type of learning tool (learning performance and student perceptions). The research will be a mixed method quasi-experimental. It will collect and analyze quantitative and qualitative data and integrate the information into two quasi-experiments. The main expected results are to improve the integration of empathic PCAs in the education field through the construction of evidence-based algorithms. Moreover, through the integration of Artificial Intelligence and Natural Language Processing to favor advancement in the construction of better PCAs incorporating emotional features. These results will be disseminated through a compendium of publications.

Keywords

Conversational Agents, E-learning, Emotion, Competencies, Higher Education

1. Introduction

In the Organisation for Economic Co-operation and Development countries member, the average student-teacher ratio in higher education is fifteen to one in public and seventeen in private institutions [1]. In this context, it is difficult for educational institutions to respond in a personalized way to the development competencies of each student. In particular, the development of computer and research competencies is highly valued in higher education [2, 3, 4, 5]. Information and Communication Technology (ICT) mediated learning is a mode of education that supports the solution [6]. Specifically, Pedagogical Conversational Agents (PCAs) are learning tools that can favor adaptive learning in acquiring skills [7, 8, 9]. These agents, also known as educational chatbots, can function as independent tools or be integrated into Intelligent Tutoring Systems.

In the set of PCAs, there are agents with empathic abilities; that is, they evoke an empathic reaction in the learner, which is their main difference from the others. Emotions are integral to the educational experience, influencing motivation, attention, memory, communication, problem-solving, behavior, and overall well-being. For example, Affective Pedagogical Tutor [10], TIPOO [11], Multiagent Intelligent Tutoring System [12], and so on. However, empathic PCA's impact has been scarcely evaluated in a comprehensive manner in e-learning. In this context, the research problem is posed in the literature and evidenced in practice.

Although science has advanced in the implementation and evaluation of empathic PCAs applied to different domains from a primarily quantitative approach, few studies assess their learning performance and student perceptions from the mixed approach [13, 14, 15, 16]. Furthermore, few previous studies on chatbots focus on developing computer or research skills in higher education, considering empathic abilities. Moreover, taking into account the student-teacher ratio, the tutoring of courses and projects at the Universitat Oberta de Catalunya (UOC) and the National University of Education (UNAE, by its acronym in Spanish) and other higher education institutions have problems serving many students and require better integration of ICT-mediated learning in e-learning [17, 18].

Then, this paper entitled *An Empathic Pedagogical Conversational Agent and Development of Computer and Research Competencies* is the doctoral research plan for the general question: How does the adaptive learning articulated by an empathic PCA affect the development of competencies in distributed systems and educational research in higher education? Based on the problem, the main

Proceedings of the Doctoral Consortium of the 18th European Conference on Technology Enhanced Learning, 4th September 2023, Aveiro, Portugal.

egortega@uoc.edu (E. Ortega-Ochoa)
https://elvisortega.com (E. Ortega-Ochoa)
0000-0003-4634-6288 (E. Ortega-Ochoa)

goal is to understand the adaptive learning articulated by an empathic PCA and its impact on developing computer and research competencies. To this end, a framework is constructed to evaluate the learning outcomes of this type of learning tool, specifically learning performance and student perceptions.

1.1. Justification

The results are of interest in the literature and practice. On the one hand, when it comes to the PCAs in e-learning, the current trends require more research on the assessment of learning performance and perceptions about learning promoted by empathic PCAs [13, 19]. Scientific research suggests the assessment of learning performance and student perceptions in a general and particular way on applying PCAs in different domains [13, 14, 15, 16], whose design and development are focused on achieving student-teacher interaction, that is, incorporating sufficient empathic abilities. On the other hand, the assessment is also of interest in the practice given that it will allow responding to the need to promote adaptive learning. There is a need to strengthen the online teaching and learning process in higher education institutions' courses and projects [20]. Specifically, there is a need to reinforce computer and research skills in higher education [2, 3, 4, 5]. For that, the study considers competencies in distributed systems of the Computer Engineering Degree at UOC and educational research of the Basic Education Degree at UNAE.

The following sections will present the literature review, research questions and goal, method, and potential ethical issues. Finally, the research contribution to the problem solution in the Technology Enhanced Learning (TEL) domain will also be described.

2. Literature Review

Empathic PCAs are educational chatbots that can facilitate the development of skills. An empathic agent is "a synthetic character that evokes an empathic reaction in the user" (p. 310) [21]. For instance, the [10] and [11] agents focused on computer competencies, and [12] agents focused on research competencies. Recent studies have evidenced the need to configure chatbots that incorporate empathic abilities to mitigate frustrations and conversation breaks [10]. Emotions play a crucial role in education by affecting students' motivation, attention, memory, communication, problem-solving, and overall well-being. Furthermore, research has suggested quantitative and mixed assessments of their results. On the other hand, computer and research skills are a complex and broad set of competencies highly valued in higher education [2, 3, 4, 5]. The goal of developing these competencies in students through an online environment has promoted researchers to propose and assess learning tools such as empathic PCAs [10, 11, 12], as well as has favored scientists to work on establishing a reliable way to assess these competencies [5, 22].

2.1. Empathic Pedagogical Conversational Agents

This section reports on the implementation and evaluation stage of 13 empathic PCAs, constituting the existing literature and relevant topics for this research plan. For more information on the Systematic Literature Review protocol, the systematic review registration number is osf.io/jnf3x.

To begin, previous studies have predominantly favored the experiment as the research design for implementing empathic PCA, with a quantitative approach being the norm. However, four of these studies opted for a mixed methods design to comprehensively assess the effectiveness of this learning tool [13, 14, 15, 16]. This approach allows for a more comprehensive evaluation, particularly in the later stages of the intervention, as all reports include a posttest. It is worth noting that only seven of these studies incorporated a pretest, rendering comparisons with students' initial states impossible in the other studies. Instead of a pretest, four studies utilized a control group as an alternative resource.

Secondly, the authors consider two variables when assessing the effectiveness of empathic PCA in learning. The first variable, learning performance (1), encompasses content, procedures, or attitudes [13, 12, 23, 19]. The preferred data collection method for this variable is the test, with the specific content dependent on the domain and objectives related to empathic PCA. A strictly quantitative approach has been consistently employed for evaluation. The second variable, student perceptions (2), is multidimensional, with most reports evaluating the affective bond dimension. Other dimensions, such as interaction enjoyment (e.g., [15, 16]) and confidence perception (e.g., [24, 14]), are also considered. Questionnaires, surveys, and interviews serve as the primary instruments, encompassing quantitative and open-ended questions. These findings align with prior research, such as the work by [25] on Intelligent Virtual Agents, where instrument reuse is rare, and exploring new dimensions remains a prevailing trend in empathic PCA evaluation.

Thirdly, the types of feedback employed play a significant role in achieving positive outcomes in learning performance and student perceptions [15, 16] and appear to exhibit a positive correlation [13, 19]. For enhanced learning performance, cognitive and empathic feedback, hints, and bimodal feedback, are deemed essential [12, 23, 19]. Additionally, analyzing and commending student progress has shown a positive impact [23]. On

the other hand, to foster positive student perceptions, cognitive and affective feedback, scaffold design, chatbot book talk and social affective cues, coherent facial expressions, specific characteristics of Embodied Conversational Agents, support for students with significant levels of anxiety, or popular culture topics empathic are required [10, 11, 24, 14, 19, 26, 27, 28]. Notably, student-specific factors, such as gender [26], can influence these outcomes. In summary, most feedback types share common attributes, with variations in their impact on the two evaluated variables. Figure 1 illustrates the resulting framework for assessing the learning outcomes of empathic PCA.

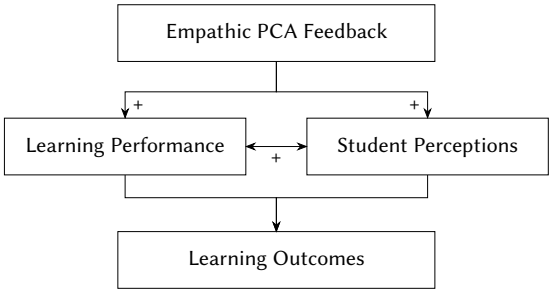

Figure 1: Framework to Evaluate the Learning Outcomes of Empathic Pedagogical Conversational Agents

2.2. Competencies Development

This section focuses on reports related to computer and research competencies.

Although the authors studied the effect of the learning articulated by the empathic PCA in computer competencies, it is only focused on student perceptions. First, in the quasi-experiment of [10], they concluded that, in the web design domain, the use of specific types of affective and cognitive feedback has a positive effect on the affective state. However, studies are needed to validate the effectiveness of such cognitive and affective PCA abilities. Second, [11] found that affective dialogue, based on encouragement phrases, positively impacts the motivation of students, female students, and engineering students. The authors concluded that affective feedback significantly impacts motivation, particularly in these cases. Nevertheless, like the previous study, there are no results on the impact of such empathic learning tools on learning performance. Thus, considering the framework (Figure 1), the assessment of the cognitive and affective feedback on the learning performance of computer competencies is necessary. Because of the need for a solid framework to evaluate the set of competencies, this study is based on the contributions of [5], who conceptualize user competence in three factors: conceptualization of competence, measurement methods, and knowledge domains.

At the same time, ICT-mediated strategies favor the development of research competencies. In this sense, defining their evaluation is essential, for both learning tools and domains. [12] discussed the impact of Multi-agent Intelligent Tutoring System feedback on student learning performance in the research methods domain. The authors found that the agents' cognitive support positively impacts students with low rejecty sensibility in confusion regulation. On the other hand, agents' empathic support positively impacts students with high rejecty sensibility in confusion regulation. In contrast to the studies on computer competencies, this study considers the learning performance, but an assessment of the student perceptions and the qualitative approach is necessary. Likewise, because of the need to have a solid framework to develop and evaluate the set of competencies, this study is based on the contributions of [3], who conceptualize the competencies in eight scientific activities: problem identification, questioning, hypothesis generation, instrument construction and redesign, evidence generation, evidence evaluation, drawing conclusions, and communicating and examining.

3. Research Questions and Goal

The research question is: How does the adaptive learning articulated by an empathic PCA affect the development of competencies in distributed systems and educational research in higher education? Sub-questions (SQ) [29]:

- What is the acquisition level of competencies in distributed systems and educational research of adaptive learning articulated by empathic PCA? (SQ1)
- What are the student perceptions of adaptive learning articulated by empathic PCA in developing competencies in distributed systems and educational research? (SQ2)
- Is there a relationship between empathic PCA feedback with acquired competencies in distributed systems and/or student perceptions developing educational research competencies? (SQ3)
- Are there significant differences in acquired computer and research competencies between the pretest and posttest, and between the control and experimental groups? (SQ4)

The main goal is to understand the adaptive learning articulated by an empathic PCA and its impact on developing computer and research competencies. Professors will know whether there is a relationship between the three variables (empathic PCA feedback, learning performance, and student perceptions) and whether there

are differences in learning performance. These issues are relevant to understanding how PCA works in e-learning.

4. Method

The research will be a mixed method quasi-experimental (convergent core design) because it will use predefined groups. It will collect and analyze quantitative and qualitative data and integrate the information into two quasi-experiments [30]. The research will collect a qualitative component during the Randomized Controlled Trial ([31]). The purpose is to understand and depict processes experienced by the experimental groups. Specifically, the parallel database variant will be used. That is, two parallel data strands will be collected and analyzed independently and only joined in interpretation (see Figure 2). The data source for the quantitative approach will be the level of computer and research proficiency (learning performance), for which the test will be used, and student perceptions of adaptive learning articulated by PCA in a generalized manner, for which the survey will be used. The survey will allow data collection on perceptions, which will be generalized to the population, but individual experiences will not be analyzed in depth [32]. The data source for the qualitative approach will also be the perceptions. In this case, these will be in a particular way for which reflective practice will be used [33]. Reflective practice will be a safe space for participants to express their feelings, perspectives, and biases regarding the experience; notwithstanding, its purpose may be limited in the hypothetical case that students' external circumstances reduce the depth of their responses [34].

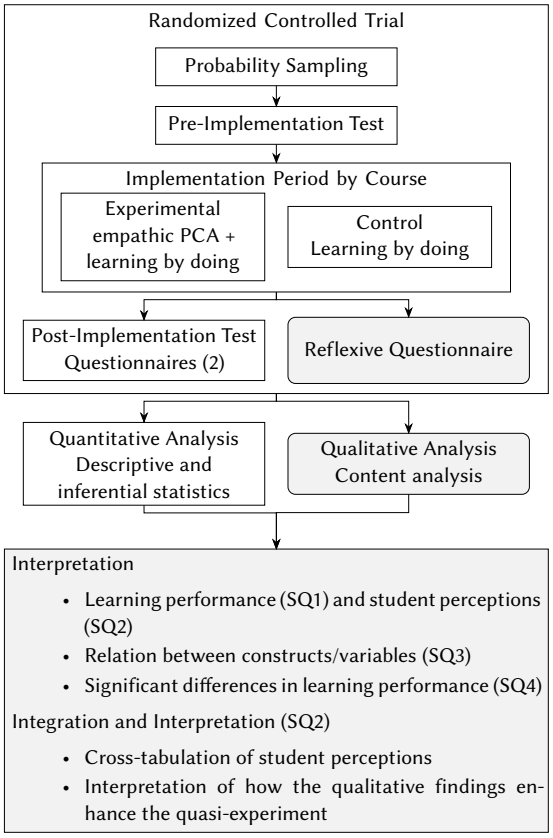

Figure 2: Diagram of the Mixed Methods Quasi-Experimental Research

4.1. Data Collection Techniques and Instruments

The instruments' constructs are identified in Figure 1. In the quantitative approach, the tests are according to the competencies stipulated in the syllabus and the questionnaire is organized into sections (constructs) [32]. The questionnaire consists of two parts, both with 7-item Likert-type closed-ended response options. The first part is on student perceptions, which has twenty questions: interaction enjoyment (5), confidence perception (9), and affective bond (6). The second part is on learning outcomes and consists of one question. Regarding the reflective questionnaire, the free-association reflective questionnaire has three reflection themes corresponding to the constructs mentioned above. The content of the questionnaires is appropriate because it encompasses the three perception constructs that a user may have with TEL [35, 36]. First, student perceptions regarding interaction enjoyment encompass ease of access and use. Second, confidence perception of the content encompasses the veracity of the information in the empathic PCA interventions. Third, student perceptions of affective bonding encompass the ability of the agent to establish an empathic connection.

4.2. Procedure

The two approaches (quantitative and qualitative) will follow the same guidelines. A plan will be designed considering the course syllabus for the implementation period. Communication with the participants will be through the noticeboard and email, which will be sent by the researcher. The first message will be the doctoral research summary. The following messages will be the pedagogical guidelines of the implementation plan. The instruments' administration will be electronic. The test will be applied at the start and end, and the questionnaires will be applied at the end of the implementation (see Figure 2). The instruments will be virtualized on the Qualtrics platform. The test and questionnaires will be pilot-tested before final administration. The researcher will oversee data collection at the institutions, UOC and

UNAE.

4.3. Data Analysis Techniques

Descriptive and inferential statistics will be the data analysis techniques for the quantitative approach and content analysis for the qualitative approach. On the one hand, descriptive statistics will allow the systematic presentation of the student's data, and inferential statistics will allow an estimation of the population parameters and perform statistical analyses to answer the research questions [37]. Specifically, (1) to assess the correlation between the variables of learning performance, and student perceptions, Spearman's rank correlation coefficient will be used, and (2) to compare the results of the pretest and posttest for both the control and experimental groups, a mixed-design analysis of variance will be used. The software to be used for these analyses will be SPSS [38], version 27.0. On the other hand, content analysis [39] will reduce the volume of words and phrases in a matrix format [40]. Based on the student perceptions variable of Figure 1, the codes will be constructed. That is, the codes will be elaborated following deductive coding. The units of analysis will be each student's responses. In this sense, the analytic scheme will be developed before the analysis. The coding themes task will follow the strategy of [40]. The software that will facilitate this analysis will be NVivo [41], version 12. The integrated results will be performed on a joint display.

4.4. Sample

The population will be students of two courses: Distributed Systems, first semester 2023/2024, and Educational Research: Theoretical and Epistemological Bases, second semester 2023/2024. In each course, the researcher will select an identical sample for the two approaches using one-stage cluster probability sampling, given that the units of analysis are grouped into courses. A general rule is that if the number of courses equals 3 or less, the sample will be equal to the population. Otherwise, the sample size will be calculated using Equation 1, applying a confidence level of 95 % and an estimated error of 5 %. The Distributed Systems course is expected to have three courses as a population, approximately 253 students. The Educational Research Project course is expected to have two courses as a population, approximately 60 students. One time the size sample is obtained, the researcher will choose the number of courses that are closest to the students' size sample using Simple Random Sampling; half of the courses will be assigned to the control and the other half to the experimental group.

$$n_h = \frac{N_h * Z^2_{a/2} * \pi(1-\pi)}{(N-1) * e^2 + Z^2_{a/2} * \pi(1-\pi)} \quad (1)$$

4.5. Mixed Methods Validity

The Mixed Method Research (MMR) validity is based on each approach and strategy specific to this method. The strategies for the quantitative approach are construct validity granted by the positive consequences of previous research, and reliability granted by piloting the initial version to construct definitive versions [42]. The strategies for the qualitative approach are communicating the results to the participants, reporting divergent results, and examining the results with professors [43, 44]. The strategies for MMR are addressing the internal and external threats identified in the literature review, providing a justification for qualitative data collection and its use, and considering unobtrusive data collection [30].

5. Potential Ethical Issues

The research has an ethical and moral commitment. The rules are in the research ethics protocol. Those responsible for the educational process and selected students will be informed of the objectives and phases and how to access their results. The evidence will be the communication emails and the informed consent; the latter will guarantee data confidentiality. Personal data will only be necessary for monitoring student participation during the quasi-experiment. Once data collection is complete, personal data will be separated from the data set to ensure privacy. Each student will be coded by cases during data analysis. The personal data will be stored on the researcher's computer. The data from the coded cases will be stored in Mendeley Data, for open access. On the other hand, only the researcher can match the coded cases with the personal information, which will be private. Therefore, ethical criteria will always be maintained to certify free and responsible collaboration, especially in data treatment.

6. Ph.D. Project's Contribution

The novelty of the research is that it is framed in one of the key technologies and practices. Specifically, this study is linked to the UOC's Responsive Teaching and Learning Processes and Outcomes in Online Education research line, in Education and ICT (e-learning). According to [6], technology, especially Artificial Intelligence (AI) and Natural Learning Processing (NLP), applied to learning tools in practice, can enhance student learning experiences. In this regard, this study provides a valuable contribution in two critical areas through assessing the adaptive learning articulated by the PCA. First, the positive or negative study results will improve the integration of virtual agents in education by constructing evidence-based algorithms. Second, integrating AI and

NLP will allow advancement in the construction of better conversational agents, such as ChatGPT [45], but in this case, also incorporating education and emotional features. Therefore, the project contributes to scientific progress because it crosses several disciplines, resulting in the design of learning experiences.

Acknowledgments

With the support of a doctoral grant from the Universitat Oberta de Catalunya (UOC). Moreover, this research plan was created with the support of the Ph.D. supervisors, Thanasis Daradoumis and Marta Arguedas.

References

[1] Organisation for Economic Co-operation and Development, Education at a Glance 2022: OECD Indicators, OECD Publishing, 2022. doi:10.1787/3197152b-en.

[2] K. Engelmann, B. J. Neuhaus, F. Fischer, Fostering scientific reasoning in education - meta-analytic evidence from intervention studies, Educational Research and Evaluation 22 (2016) 333–349. doi:10.1080/13803611.2016.1240089.

[3] F. Fischer, I. Kollar, S. Ufer, B. Sodian, H. Hussmann, R. Pekrun, B. Neuhaus, B. Dorner, S. Pankofer, M. Fischer, J. W. Strijbos, M. Heene, J. Eberle, Scientific Reasoning and Argumentation: Advancing an Interdisciplinary Research Agenda in Education, Educational Research and Evaluation 2 (2014) 28–45. doi:10.14786/flr.v2i2.96.

[4] U. E. Gattiker, Computer Skills Acquisition: A Review and Future Directions for Research, Journal of Management 18 (1996) 547–574. doi:10.1177/014920639201800030.

[5] B. L. Marcolin, D. R. Compeau, M. C. Munro, S. L. Huff, An analysis of children' interaction with an AI chatbot and its impact on their interest in reading, Information Systems Research 11 (2000) 37–60. doi:10.1287/isre.11.1.37.11782.

[6] K. Pelletier, M. McCormack, J. Reeves, J. Robert, N. Arbino, M. Al-Freih, C. Dickson-Deane, C. Guevara, L. Koster, M. Sánchez-Mendiola, L. Skallerup, , J. Stine, EDUCAUSE Horizon Report, Teaching and Learning Edition, EDUCAUSE, 2022.

[7] M. A. Kuhail, N. Alturki, S. Alramlawi, K. Alhejori, Interacting with educational chatbots: A systematic review, Education and Information Technologies 28 (2022) 973–1018. doi:10.1007/s10639-022-11177-3.

[8] C. W. Okonkwo, A. Ade-Ibijola, Chatbots applications in education: A systematic review, Computers and Education: Artificial Intelligence 2 (2021) 100033. doi:10.1016/j.caeai.2021.100033.

[9] W. Huang, K. F. Hew, L. K. Fryer, Chatbots for language learning—Are they really useful? A systematic review of chatbot-supported language learning, Journal of Computer Assisted Learning 38 (2021) 237–257. doi:10.1111/jcal.12610.

[10] M. Arguedas, T. Daradoumis, Analysing the role of a pedagogical agent in psychological and cognitive preparatory activities, Journal of Computer Assisted Learning 37 (2021) 1167–1180. doi:10.1111/jcal.12556.

[11] S. Jimenez, R. Juárez-Ramírez, V. H. Castillo, A. Ramírez-Noriega, Integrating affective learning into intelligent tutoring systems, Universal Access in the Information Society 17 (2018) 679–692. doi:10.1007/s10209-017-0524-1.

[12] Z. Long, D. Luo, H. Gao, X. Hu, The Effects of Rejection Sensitivity on Confusion Regulation during Learning in Multiagent Intelligent Tutoring System Environments, in: A. M. Sinatra, J. A. DeFalco (Eds.), Approaches and Challenges in Team Tutoring Workshop. 20th Artificial Intelligence in Education Conference (AIED 2019), Chicago, United States, 2019, pp. 77–86. URL: https://ceur-ws.org/Vol-2501/paper9.pdf.

[13] J. A. Kumar, Educational chatbots for project-based learning: investigating learning outcomes for a team-based design course, International Journal of Educational Technology in Higher Education 18 (2021) 1–28. doi:10.1186/s41239-021-00302-w.

[14] C. C. Liu, M. G. Liao, C. H. Chang, H. M. Lin, An analysis of children' interaction with an AI chatbot and its impact on their interest in reading, Computers & Education 189 (2022) 1–16. doi:10.1016/j.compedu.2022.104576.

[15] K. A. Santos, E. Ong, R. Resurreccion, Therapist Vibe: Children's Expressions of their Emotions through Storytelling with a Chatbot, in: E. Rubegni, A. Vasalou (Eds.), IDC '20: Proceedings of the Interaction Design and Children Conference, London, United Kingdom, 2020, pp. 483–494. doi:10.1145/3392063.3394405.

[16] T. Wambsganss, F. Weber, M. Söllner, Designing an Adaptive Empathy Learning Tool, in: T. X. Bui (Ed.), Proceedings of the 54th Hawaii International Conference on System Sciences, Hawaii, United States, 2021, pp. 54–63. doi:10.24251/HICSS.2021.007.

[17] A. C. Graesser, H. Li, C. Forsyth, Learning by Communicating in Natural Language With Conversational Agents, Current Directions in Psychological Science 23 (2014) 374–380. doi:10.1177/0963721414540680.

[18] D. Pérez-Marín, Review of the Practical Applications of Pedagogic Conversational Agents to Be Used in School and University Classrooms, Digital

2021 1 (2021) 18–33. doi:10.3390/digital1010002.

[19] A. Oker, F. Pecune, C. Declercq, Virtual tutor and pupil interaction: A study of empathic feedback as extrinsic motivation for learning, Education and Information Technologies 25 (2020) 3643–3658. doi:10.1007/s10639-020-10123-5.

[20] E. G. Ortega-Ochoa, A Pedagogical Conversational Agent for Tutoring in the Development of Educational Research Projects, in: D. Guralnick, M. E. Auer, A. Poce (Eds.), Innovative Approaches to Technology-Enhanced Learning for the Workplace and Higher Education: Proceedings of 'The Learning Ideas Conference' 2022, New York, United States, 2023, pp. 544–556. doi:10.1007/978-3-031-21569-8_51.

[21] L. Hall, S. Woods, The Importance of Similarity in Empathic Interaction, in: C. Ghaoui (Ed.), Encyclopedia of Human Computer Interaction, Idea Group Reference, 2006, pp. 303–310. doi:10.4018/978-1-59140-562-7.

[22] A. Opitz, M. Heene, F. Fischer, Measuring scientific reasoning - a review of test instruments, Educational Research and Evaluation 23 (2017) 78–101. doi:10.1080/13803611.2017.1338586.

[23] A. Munshi, R. Rajendran, J. Ocumpaugh, G. Biswas, R. S. Baker, L. Paquette, Modeling Learners' Cognitive and Affective States to Scaffold SRL in Open-Ended Learning Environments, in: T. Mitrovic, J. Zhang (Eds.), UMAP '18: Proceedings of the 26th Conference on User Modeling, Adaptation and Personalization, Singapore, Singapore, 2018, pp. 131–138. doi:10.1145/3209219.3209241.

[24] E. Ayedoun, Y. Hayashi, K. Seta, Toward Personalized Scaffolding and Fading of Motivational Support in L2 Learner-Dialogue Agent Interactions: An Exploratory Study, IEEE Transactions on Learning Technologies 13 (2020) 604–616. doi:10.1109/TLT.2020.2989776.

[25] S. Fitrianie, M. Bruijnes, D. Richards, A. Abdulrahman, W.-P. Brinkman, What are We Measuring Anyway? - A Literature Survey of Questionnaires Used in Studies Reported in the Intelligent Virtual Agent Conferences, in: C. Pelachaud, J.-C. Martin (Eds.), IVA '19: Proceedings of the 19th ACM International Conference on Intelligent Virtual Agents, Paris, France, 2019, pp. 159–161. doi:10.1145/3308532.3329421.

[26] M. R. Scholten, S. M. Kelders, J. E. W. C. V. Gemert-Pijnen, An Empirical Study of a Pedagogical Agent as an Adjunct to an eHealth Self-Management Intervention: What Modalities Does It Need to Successfully Support and Motivate Users?, Frontiers in Psychology 10 (2019) 1–14. doi:10.3389/fpsyg.2019.01063.

[27] T. Terzidou, T. Tsiatsos, H. Apostolidis, Architecture and interaction protocol for pedagogical-empathic agents in 3D virtual learning environments, Multimedia Tools and Applications 77 (2018) 27661–27684. doi:10.1007/s11042-018-5942-4.

[28] E. H.-K. Wu, C.-H. Lin, Y.-Y. Ou, C.-Z. Liu, W.-K. Wang, C.-Y. Chao, Advantages and Constraints of a Hybrid Model K-12 E-Learning Assistant Chatbot, IEEE Access 8 (2020) 77788–77801. doi:10.1109/ACCESS.2020.2988252.

[29] V. L. Plano-Clark, M. Babbie, Research Questions in Mixed Methods Research, in: A. Tashakkori, C. Teddlie (Eds.), SAGE Handbook of Mixed Methods in Social & Behavioral Research, SAGE Publications, Inc., 2010, pp. 275–304. doi:10.4135/9781506335193.

[30] J. W. Creswell, V. L. Plano-Clark, Designing and conducting mixed methods research, 3 ed., SAGE Publications, Inc., 2018.

[31] D. W. Grissmer, A Guide to Incorporating Multiple Methods in Randomized Control Trials to Assess Intervention Effects, 2 ed., American Psychological Association, 2016.

[32] D. De Vaus, Surveys in Social Research, 6 ed., Routledge, 2013. doi:10.4324/9780203519196.

[33] M. Alvesson, K. Sköldberg, Reflexive Methodology: New Vistas for Qualitative Research, 3 ed., SAGE Publications, Inc., 2017.

[34] F. D. Billups, Qualitative Data Collection Tools: Design, Development, and Applications, SAGE Publications, Inc., 2021. doi:10.4135/9781071878699.

[35] S. Lee, J. Choi, Enhancing user experience with conversational agent for movie recommendation: Effects of self-disclosure and reciprocity, International Journal of Human-Computer Studies 103 (2017) 95–105. doi:10.1016/j.ijhcs.2017.02.005.

[36] S. Mendez, K. Johanson, V. M. Conley, K. Gosha, N. A. Mack, C. Haynes, R. A. Gerhardt, An analysis of children' interaction with an AI chatbot and its impact on their interest in reading, International Journal of Doctoral Studies 15 (2020) 373–392. doi:10.28945/4579.

[37] R. Bruhl, Understanding Statistical Analysis and Modeling, SAGE Publications, Inc., 2018. doi:10.4135/9781071878866.

[38] International Business Machines Corporation, IBM SPSS Statistics, 2020. [Computer Software].

[39] K. Krippendorff, Content Analysis, 4 ed., SAGE Publications, Inc., 2019. doi:10.4135/9781071878781.

[40] M. B. Miles, A. M. Huberman, J. Saldana, Qualitative Data Analysis: A Methods Sourcebook, 3 ed., SAGE Publications, Inc., 2014.

[41] QSR International, NVivo, 2018. [Computer Software].

[42] American Educational Research Association, American Psychological Association, National Council on Measurement in Education, The Standards for

Educational and Psychological Testing, American Educational Research Association, 2014.
[43] J. W. Creswell, C. N. Poth, Qualitative Inquiry and Research Design: Choosing Among Five Approaches, 4 ed., SAGE Publications, Inc., 2017.
[44] J. W. Creswell, D. L. Miller, Determining Validity in Qualitative Inquiry, Theory Into Practice 39 (2000) 124–130. doi:10.1207/s15430421tip3903_2.
[45] OpenAI, ChatGPT: Optimizing Language Models for Dialogue, 2022, November 30. URL: https://openai.com/blog/chatgpt.