Chapter 15

Essential Features and Critical Issues With Educational Chatbots:
Toward Personalized Learning via Digital Agents

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ABSTRACT

Conversational agents, also known as chatbots, are automated systems for engaging in two-way dialogue with human users. These systems have existed in one form or another for at least 60 years but have recently demonstrated significant potential with advances in machine learning and artificial intelligence technologies. The use of conversational agents or chatbots for education can potentially reduce costs and supplement teacher instruction in transformative ways for formal learning. This chapter examines the design and status of chatbots and conversational agents for educational purposes. Common design functions and goals of educational chatbots are described, along with current practical applications of chatbots for educational purposes. Finally, this chapter considers issues about pedagogical commitments, ethics, and equity to suggest future work in the field.

INTRODUCTION

Instant messaging and text-based chat apps, such as Facebook Messenger, iMessage, SMS, WhatsApp, and Kik, have become increasingly popular in the previous decade. Although text-based communications technologies not new, their presence on the billions of mobile devices globally have facilitated their everyday use (Pew Research Center, 2018). This surge of mobile communications apps has encouraged renewed attention by researchers in education toward the use of automated text-based communications

for interacting with people. One such automated communications technology is the development of automated **conversational agents**, also known as **chatbots**.

Because of their focus on sustaining one-on-one, two-way conversation, chatbot technologies have the potential to directly meet the interactive educational needs of learners. Both interactive dialogue and personalized one-on-one tutoring are well-known interactive educational approaches that promote effective learning (Daniels, 2016; Mercer, 2002). Thus, improvements in automated conversational technologies have appeal to educators in meeting practical needs within in both formal and informal learning contexts, which also include corporate training, adult skill development, and professional development. Although this nascent technology has yet to provide mainstream results for educational applications, chatbots to date have demonstrated a significant promise toward addressing ongoing calls for personalized learning and differentiated instruction in both formal and informal learning environments.

This chapter examines three critical functions of educational chatbots that are necessary for these systems to achieve educational objectives in a principled way: (1) conversational functionality, (2) educational goals, and (3) pedagogical roles. This examination includes chatbot applications in formal educational settings (e.g., K-12, higher education) and informal ongoing-learning settings (e.g., professional development, corporate training, video games). If designed in a principled and realistically conversational way, chatbots and similar technologies demonstrate substantial promise to support learning in many contexts for both children and adults alike.

BACKGROUND

Definitions

Although these terms are both used in the educational research literature, **chatbots** and **conversational agents** typically refer to the same type of software when concerned with educational applications. Both are most frequently defined as software that enables a human user to have a two-way conversation in authentic, natural language with an automated "virtual being" (Gong, 2008). These systems intend for the "virtual being" to provide a human-like interface to users instead of a static computer or "button" interface and can adaptively act on input received from the user (Woo, 2008).

Other less-common terms have also been used to describe chatbot-type technologies, such as chat app, chatterbot, digital agent, embodied agent, or virtual assistant. These terms are often interchangeably used without distinction in the educational and computer science literature. Although each of these terms may feature specific additional design qualities that are beyond the scope of this chapter, each of these terms also often fundamentally features the key function of chatbot-type software to enable human users to use natural language to engage in conversation with software systems. As such, these terms are also important for practitioners and researchers to be mindful of as they perform work in the educational chatbot field, despite representing variations of similar technologies.

Overview of Educational Chatbots

Conversational software that attempts to mimic human conversation with machines has existed since the early 1960s (Shah, Warwick, Vallverdú, & Wu, 2016; Thompson, 2007; Wallace, 2009). However, early automated conversational applications that were developed up to the 2000s were largely limited

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