Master Thesis

Educational Science and Technology

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Investigating the Effect of a Conversational Agent on Students' Intrinsic Motivation during an Online Dyad Discussion among University-Level Students

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Abstract

Online education has become increasingly prominent, especially with the global COVID-19 pandemic prompting the use of online learning platforms. Conversational Agents (CAs) in the context of Computer-Supported Collaborative Learning (CSCL) have emerged as promising tools to enhance the learning process in online settings. Nonetheless, the lack of student motivation has been exacerbated especially after the pandemic. While the Self-Determination Theory (SDT) is central to the discussion of motivation, most studies have investigated the SDT in in-person environments rather than online environments. This study explores the impact of a Conversational Agent (CA), Clair, on university students' intrinsic motivation during online dyad discussions. In particular, it examines Clair's influence on students' basic psychological needs, namely autonomy, competence, and relatedness, derived from the SDT. Using a controlled experiment, students were randomly assigned to a control group (without Clair), consisting of 14 participants, and an experimental group (with Clair), consisting of 10 participants. Quantitative and qualitative analyses were conducted in which the Intrinsic Motivation Inventory (IMI) questionnaire was used to measure intrinsic motivation, and the demonstration of autonomy, competence, and relatedness was coded in chatlogs of dyad discussions. Findings indicate that the control group demonstrated higher competence and relatedness whereas the experimental group demonstrated higher autonomy. Future studies should use a larger sample size and conduct a longitudinal study to investigate the effect of Clair on learners' autonomy, competence, and relatedness over a longer period.

Keywords: Computer-Supported Collaborative Learning, Conversational Agent, Self-Determination Theory, Intrinsic Motivation

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1. Introduction

In recent years, online education has become increasingly prominent, especially with the global COVID-19 pandemic prompting the use of online learning platforms (Kansal et al., 2021). Recognizing the potential of technology to effectively support teachers and students in online environments (Adedoyin & Soykan, 2020), Computer-Supported Collaborative Learning (CSCL) stands out as an area of great academic interest to enhance collaborative learning in the classroom (Jeong et al., 2019). CSCL leverages technology to monitor, assist, and support learners in their learning process, helping them achieve their learning objectives (Fischer et al., 2013).

To foster collaborative experiences, Artificial Intelligence (AI) was employed as a tool within CSCL (Jeong et al., 2019). AI systems are intelligence machines that are capable of activities that typically require human intelligence like perception, and reasoning (Hwang et al., 2020). They are regarded as a "game-changer" as they may take the form of providing individualized learning experiences (Tegos et al., 2020). One of the leading AI systems employed in education is Conversational Agents (CAs) (Demetriadis et al., 2018). These agents communicate with students using natural language and are widely recognized for their ability to analyze ongoing discussions, facilitate real-time interventions, and provide personalized feedback to students during collaborative work (Murad et al., 2019). An example of a CA in the context of CSCL is Clair. She facilitates online discussion between dyads communicating via chat on a given topic to promote a smooth discussion flow and maintain their concentration on the task. This is achieved through Academically Productive Talk (APT), a classroom discourse framework, in which Clair intervenes as a teacher would, by posing questions to students during online dyad discussions (de Araujo et al., 2023b).

While CAs hold the potential to enhance learning outcomes (Tegos et al., 2020), the shift to online education during the pandemic posed several challenges in teaching and learning (Chiu et al., 2021). One of the significant challenges was the impact on student motivation, exacerbating existing concerns about the lack of student motivation in the classroom (Daniels et al., 2021). Given the importance of intrinsic motivation in the development and success of online learning (Hartnett, 2016), there is a need to investigate effective strategies to address student motivation (Mendoza et al., 2023).

Central to the discussion of motivation is the self-determination theory (SDT) (Ryan & Deci, 2000). The SDT describes the inherent drive of individuals to engage in activities that fulfill their three basic psychological needs, namely autonomy (i.e., feeling in control of one's actions), competence (i.e., feeling of mastery of skills), and relatedness (i.e., feeling connected and belonging with others) (Ryan & Deci, 2000). To increase intrinsic motivation, teachers relied on applying the SDT framework in their classroom practices to fulfill the three basic psychological needs of students in the classroom (Ryan & Deci, 2000). However, much of the research on the basic psychological needs of students was conducted in in-person learning environments (Mendoza et al., 2023). Hence, given the increase in the use of online learning (Kansal et al., 2021), and CAs' potential to enhance learning outcomes (Tegos et al., 2020), it is necessary to explore how CAs can be leveraged to increase students' intrinsic motivation in the context of CSCL.

This research aims to investigate the effect of a CA, Clair, on students' autonomy, competence, and relatedness during peer discussions in a CSCL environment among university students. The interventions of Clair were modeled after classroom practices of three

psychological needs highlighted in the SDT theory. An experiment was conducted to investigate the effect of Clair on intrinsic motivation to compare students' autonomy competence and relatedness in the control group (without Clair) and the experimental group (with Clair).

2. Theoretical Framework

2.1 Computer-Supported Collaborative Learning

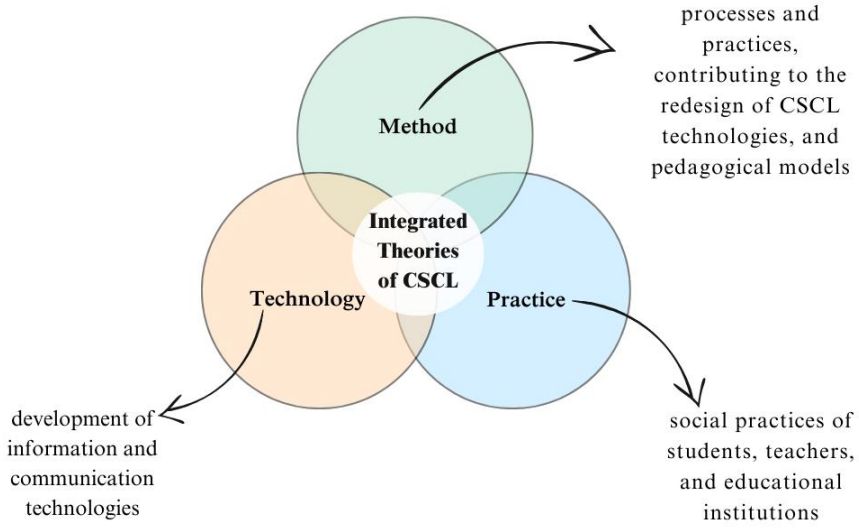
CSCL has emerged over the past two decades as a dynamic field at the intersection of technology and education. It is an approach to learning and instruction that facilitates learning processes using various technological and pedagogical strategies (Dillenbourg, 1999). According to Stahl and Hakkarainen (2021), CSCL is a pedagogical approach that envisions a form of collaborative learning enhanced by advanced computational tools and novel approaches, fostering a deeper understanding of knowledge, cognition, and collaborative learning.

CSCL is interpreted and applied differently across academic studies (Cress et al., 2021). Lehtinen et al. (1999) defined CSCL as an educational technology that facilitates student interaction through networked devices, often augmented by AI. This interaction within CSCL can be categorized into two forms: *learning through technology*, where CSCL environments serve as platforms for synchronous or asynchronous online interactions, and *learning around technology*, involving face-to-face collaboration and creation of knowledge artifacts or physical objects using digital devices such as computers or tablets (Lehtinen et al.,1999). Schatzki et al. (2001) distinguish CSCL from cooperative learning, describing the former as a joint pursuit of knowledge through evolving shared meaning and common understanding, and the latter as a process where the focus is on merely diving tasks among students within groups. Similarly, Cress & Kimmerle (2023), emphasize that CSCL extends beyond the individual learning process,

engaging in what is known as group cognition. This group cognition is a collective thinking process where new understandings emerge as members of small groups assimilate and build upon each other's knowledge during their interactions (Stahl, 2017). In contrast, Ludvigsen et al. (2021), view CSCL as a field that primarily focuses on the interconnectedness of social interaction and computational artifacts, creating a triadic structure where at least two individuals collaborate through a computational artifact. These artifacts, equipped with information-processing capabilities, are often integrated into a broader digital framework or platform, like an online science simulation (Ludvigsen et al. 2021).

Figure 1

Integrated Theories of CSCL by Stahl and Hakkarainen (2021)



As shown in Figure 1, Stahl and Hakkarainen (2021) define CSCL as an integration of three key theories: *technology* (development of information and communication technologies), *practice* (application of CSCL technologies in social practices of students, teachers, and

educational institutions), and *method* (analysis of CSCL processes and practices, contributing to the redesign of CSCL technologies, and pedagogical models). While a variety of definitions of CSCL have been suggested, this paper will use the definition suggested by Stahl and Hakkarainen (2021).

CSCL represents a continually evolving landscape, where the integration of technology, pedagogy, and innovative research methods shapes the future of collaborative learning and educational practices (Stahl & Hakkarainen, 2021). One way the field of CSCL has attracted scholars' interest is by employing conversational agents (Michos et al., 2020). The following section explains CAs and their application in CSCL.

2.2 Conversational Agent

CAs are tools that use natural language processes to interact with users, including both text-based, speech-based interactions, figures, and gestures (Gnewuch et al., 2017). They are based on the idea that individuals engage with intelligent systems using natural language, just as they would with another human (McTear et al., 2016). Gnewuch et al. (2017) categorized CAs into two main types: firstly, mode of communication, where CAs use natural language which may be in written or spoken form; and secondly, the context of use, differentiating CAs that are tailored for particular settings from those intended for more general applications.

CAs are gaining popularity as a common application of AI in several areas, particularly in education (Tegos et al., 2020; Demetriadis et al., 2018). According to Silalahi and Hutauruk (2020), online environments could take the control teachers have over their classes, impacting the collaborative process during the online learning process. CAs can provide automated support to both teachers and students by being constantly present (Tegos et al., 2016). Furthermore, CAs

have made natural language processing more accessible, enabling developers to construct human-like interfaces (Wollny et al., 2021).

In the last decade, there has been a focus on the development of conversational agents rooted in the concept of Academically Productive Talk (APT) (Stahl, 2015; Tegos et al., 2015; Tegos et al., 2016). The concept of APT, also known as Accountable Talk, has been developed as a classroom discourse framework (Michaels & O'Connor, 2015). It evolved from teachers investigating effective ways to foster academic learning and reasoned participation in classroom discussions. This approach emphasizes the importance of social interaction in the learning process (Michaels & O'Connor, 2015). According to the APT guidelines, peers should paraphrase and expand on each other's ideas (i.e., being accountable to the learning community), support the validity of their claims by explicitly referring to a pool of knowledge available to the group (i.e., being accountable to accurate knowledge), and logically connect their statements through rigorous argumentation (i.e., being accountable to rigorous thinking) (Resnick et al., 2015).

Developed by de Araujo et al. (2023b), Clair is an example of a CA grounded on the APT framework. She serves as a tool for collaborative learning, enhancing interactive reasoning to aid students in various learning environments, including online and traditional settings. Clair's primary objective is to facilitate online discussion between dyads communicating via chat on a given topic. Her role is to engage with the students to promote a smooth discussion flow and maintain their concentration on the task while encouraging effective collaboration. To promote and guide students' communication, Clair utilizes a set of "talk moves" (de Araujo et al., 2023b). These talk moves are strategic interventions (Tegos et al., 2016). An example of a talk move is

"Recapping," where Clair might step in to ask, "Can someone provide a summary of what we've covered so far?" as a way to engage students (de Araujo et al., 2023b). Table 1 demonstrates Clair's eight talk moves and utterances grounded on the APT framework.

Table 1

Talk Moves and Utterances of Clair

Talk move	Utterance
Add-on	Would you like to add something to what your partner just said?
Rephrasing	Could you put in other words what your partner just said?
Agree/Disagree	Do you agree or disagree with your partner?
Linking contributions	How does that align with what your partner just said?
Build on prior knowledge	How does this connect with what we have discussed so far?
Example	Could you give an example?
Expand reasoning	Could you elaborate on this?
Recapping	Could someone summarize what we have talked about so far?

Note. Reprinted from "Supporting Collaborative Online Science Education with a Transferable and Configurable Conversational Agent," by A. De Araujo, P. M. Papadopoulos, S. McKenney, and T. De Jong, 2023, *15th International Conference on Computer-Supported Collaborative Learning (CSCL)*, p. 2. Copyright 2023 by the International Society of the Learning Sciences.

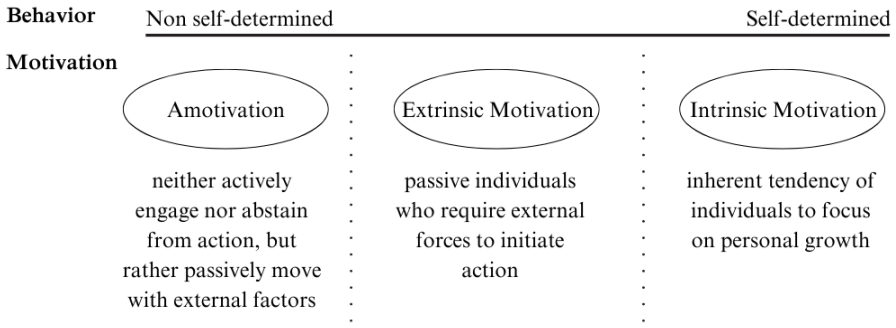
2.3 Self-Determination Theory

The SDT is a macro theory of human motivation (Ryan & Deci, 2000). It highlights the inherent tendency of individuals to focus on personal growth, emphasizing their intrinsic motivation for learning (Ryan & Deci, 2017). While intrinsic motivation is the core of this theory, SDT recognized other types of motivation placed in the self-determination continuum, namely amotivation, extrinsic motivation, and intrinsic motivation (Ryan & Deci, 2000). As illustrated in

Figure 2, amotivation, described as a non-self-determined behavior, is positioned on the left side of the continuum. Individuals exhibiting amotivation neither actively engage nor abstain from action but rather respond passively to external factors (Ryan & Deci, 2000). Moving towards the center of the continuum, extrinsic motivation is presented. This type of motivation depicts individuals as passive beings who require external forces to initiate action (Ryan & Deci, 2000). Situated on the right side of the continuum is intrinsic motivation, identified as a self-determined behavior. This type of motivation describes individuals as inherently active organisms with the ability to regulate their actions (Ryan & Deci, 2000).

Figure 2

Types of Motivation in the Self-Determination Continuum by Ryan and Deci (2000)



In addition to explaining types of motivation, the SDT investigates the transition from a non-self-determined behavior to a self-determined behavior (Ryan & Deci, 2000). This transition is further explained in one of the SDT's micro-theories: the Basic Psychological Needs Theory (BPNT). The BPNT states that individuals with any motivation type could be driven to be intrinsically motivation by the fulfilment of the three psychological needs: autonomy (i.e., feeling

in control of one's actions), competence (i.e., feeling of mastery of skills), and relatedness (i.e., feeling connected and belonging with others) (Ryan & Deci, 2000).

The extensive capacity of the SDT to explain human motivation inspired an abundance of research in various areas such as education sports, and healthcare (Ryan & Deci, 2019). In educational settings, the SDT was applied as a framework to foster the intrinsic motivation of students in the classroom. According to Ryan & Deci (2020), when classroom environments cater to the basic needs of students for autonomy, competence, and relatedness, students with any motivation type are more likely to be intrinsically motivated to learn. Numerous studies suggest a positive relationship between intrinsic motivation and the fulfillment of basic psychological needs (Pulyaeva & Nevryuev, 2020; Walker et al., 2020). In the context of education, Jang et al. (2009) investigated the impact of satisfying basic psychological needs on the learning experiences of Korean students in middle school. The findings revealed that when students' basic psychological needs were met, they reported a more satisfying learning experience and demonstrated higher academic achievement. These results position the SDT as a valuable framework for teachers to address the intrinsic motivation of students through the fulfillment of basic needs in classroom practices (Niemiec & Ryan, 2009). The following section conceptualizes the three basic psychological needs, autonomy, competence, and relatedness, and provides examples of their application in classroom practices and in giving praise to form the basis for the modification of Clair grounded on the SDT in the present study.

2.1.1 Autonomy

Autonomy refers to a sense of choice in one's actions (Ryan & Deci, 2000). The SDT suggests that when people perceive their activities as self-endorsed and aligned with their values

and interests, their intrinsic motivation tends to increase (Ryan & Deci, 2000). Deci & Vansteenkiste (2004) point out that autonomy does not imply a desire to be independent; rather, it involves acting by one's own will and choice. The need for autonomy is therefore with the "self", which is the active center of integration, initiation, and spontaneous interaction within the social context (Guay, 2021).

In the context of education, autonomy support involves identifying, nurturing, and developing students' internal motivating resources, including interests, preferences, objectives, and psychological needs (Assor et al., 2002; Reeve & Jang, 2006). There are several factors that help teachers promote student autonomy in the classroom. Firstly, teachers could promote autonomy by encouraging students' own choices (Lietaert et al., 2015). This is achieved when teachers empower students to set their own learning goals, select learning activities and resources, as well as provide consistent support for their choices within the classroom environment (Olivier et al., 2021). When students make a selection and show preference, they will experience a sense of being the driving force behind their actions, ensuring their behavior resonates with their interests and values (Deci et al., 2013). Moreover, teachers could fulfill the need for autonomy by reducing the pressure of performance evaluation and their controlled behavior in the classroom while simultaneously increasing students' sense of agency and decision-making in their learning activities (Niemiec & Ryan, 2009). For instance, teachers provide explanations when choices are limited, and avoid the use of controlling and demanding language (De Naeghel et al., 2016). Another critical factor in supporting students' autonomy is the role of teachers in giving a rationale explaining the relevance and value of a learning activity (Niemiec & Ryan, 2009). Reeve et al. (2002) found that providing (as opposed to not providing) a rationale that supports autonomy and explaining the value of a learning activity helps in

students' internalization process, which is then linked to an increased effort from students in their learning.

To summarize, the need for student autonomy could be fulfilled by offering choices, enabling them to make decisions, avoiding the use of demanding language, and providing a rationale for learning activities. Consequently, students are more likely to make decisions that are aligned with their personal goals, interests, and abilities, helping them feel more intrinsically motivated during the learning process (Xia et al, 2022).

2.1.2 Competence

Competence involves the need to feel effective and capable in one's actions (Ryan & Deci, 2000). It is the experience of being confident in one's ability during the learning process (Ryan & Deci, 2002). The SDT suggests that individuals demonstrate competence when they perceive themselves as capable learners, and recognize their progress in learning (Ryan & Deci, 2017).

In classroom practices, competence is understood as the desire to interact effectively with one's environment (Guay, 2021). Several factors contribute to fulfilling the need for competence effectively in classroom settings. Teachers could introduce activities that challenge students, allowing them to feel a sense of accomplishment when a task is completed (Niemiec & Ryan, 2009). The focus of introducing a challenging task is on fostering an experience of perceiving one's self as competent. Therefore, the tasks need to be slightly more challenging than the current capability level of the learner (Guay, 2021; Guay et al., 2003). Moreover, students are more likely to invest in tasks they believe they understand and could perform (Niemiec & Ryan, 2009). Thus, teachers could fulfill the need for competence by offering precise and detailed instructions for learning and defining the scope of learning tasks (Chiu, 2021; Olivier et al.,

2021). Furthermore, teachers could provide constructive feedback to promote the sense of accomplishment of students in a learning activity (Niemiec & Ryan, 2009). It is important to note that the focus of feedback should be less on evaluation (i.e., grading) and more on the ability to achieve the desired outcome of a given task (Niemiec & Ryan, 2009).

To summarize, the need for competence could be fulfilled by offering practical tools, providing feedback focused on students' success and achievement, as well as presenting challenging tasks to promote a sense of accomplishment. When competence is fulfilled, students tend to experience a sense of mastery and, thus are more likely to feel confident in actively participating in learning activities (Xia et al, 2022).

2.1.3 Relatedness

Relatedness highlights the need for individuals to form meaningful connections (Ryan & Deci, 2000). It addresses the significance of interpersonal relationships and the importance of experiencing a sense of belongingness to a wider community (Martela & Riekki, 2018). According to the SDT, such feelings of connectedness and belongingness are crucial in boosting individuals' intrinsic motivation to learn (Niemiec & Ryan, 2009).

Teachers play a crucial role in fulfilling students' need for relatedness within the classroom. The need for relatedness could be addressed by establishing and nurturing the teacher-student bond and connections among the students themselves (Chiu, 2021; Niemiec & Ryan, 2009). Such strong connections are essential for creating a socially supportive learning environment (Chiu, 2021). To establish and nurture these connections, teachers have to demonstrate genuine care, respect, and appreciation for their students (Niemiec & Ryan, 2009). Teachers also have to provide emotional support, through understanding, assistance, and acceptance to further

strengthen the teacher-student and student-student relationships (Vollet et al., 2017). Strong relationships in educational settings make students feel secure, welcomed, supported, and connected to their school, and subjects, thus significantly increasing their engagement in the learning process (Olivier et al., 2021; Ryan & Deci, 2017). Another way teachers could foster relatedness in the classroom is by creating and maintaining a positive learning atmosphere. For example, teachers could encourage collaboration between students to work towards common goals (Reeve et al., 2004).

To summarize, fulfilling the need for relatedness involves fostering strong relationships between teachers and students, as well as among students themselves, expressing genuine care and appreciation, and creating a positive learning environment. This contributes to students feeling connected to a broader community, thereby boosting their engagement in the learning process (Olivier et al., 2021; Ryan & Deci, 2017).

2.1.4 Application of SDT in Giving Praise

It is widely believed that giving praise is a strong and apparent approach to increasing an individual's motivation (Benson-Goldberg & Erickson, 2021). The act of valuing and acknowledging the successes, skills advancement, or abilities of the learners could increase their motivation (Soenens & Vansteenkiste, 2020). Nevertheless, certain forms of praise could yield undesirable outcomes (Henderlong & Lepper, 2002). The SDT could offer insights into the processes of praise in which the effectiveness of motivating strategies is connected to the three psychological needs for autonomy, competence, and relatedness (Ryan & Deci, 2017). According to the SDT, informational praise, focusing on strengths and areas for improvement, helps individuals navigate challenges and boosts intrinsic motivation (Ryan & Deci, 2017). For

instance, using inviting language like “I suggest” or “You could” (Reeve & Halusic, 2009). In contrast, evaluative praise, focusing on assessing and grading, could be perceived as controlling and diminish autonomy, thereby reducing intrinsic motivation (Ryan & Deci, 2017; Niemiec & Ryan, 2009) An example of evaluative praise is using forceful language, such as “have to”, “must” (Soenens & Vansteenkiste, 2020).

In the context of education, Reeve and Halusic (2009) discuss how K-12 teachers could apply the SDT to support the three psychological needs of students by giving praise. To fulfill the need for autonomy, teachers should offer praise for recognizing students' choices and decision-making, highlighting their independence and progress in learning. For the need for competence, praise should be directed towards mastery of the subject, celebrating students' achievements. Lastly, to address the need for relatedness, teachers could praise the collaborative efforts and positive peer interactions of the students to reinforce the value of connectedness.

2.4 Research Model and Questions

This research aims to investigate the effect of Clair on students’ intrinsic motivation during online peer discussions. Therefore, the following research questions are posed:

RQ1: Does Clair affect university students’ autonomy during online peer discussions?

RQ2: Does Clair affect university students’ competence during online peer discussions?

RQ3: Does Clair affect university students’ relatedness during online peer discussions?

3. Method

3.1 Materials

The presented study builds upon the work of Adelson et al. (2023a) on Clair. She serves as a chat tool within the Go-Lab environment, a digital platform designed for creating online learning experiences, such as virtual labs, multimedia content, and e-learning tools. Clair employs a set of interventions in the chat tool on the Go-Lab environment during the online dyad discussion. The interventions of Clair in this study are grounded on the SDT. Specifically, the interventions were modified based on the classroom practices of the SDT to satisfy students' three psychological needs, namely autonomy, competence, and relatedness. As shown in Table 2, Clair was modified to use a set of three interventions, each consisting of: a) talk move: a tool that triggers students' communication; and b) follow-up: praise for students' contribution. To avoid redundancy, two variations of follow-up were included in the design. Figure 3 demonstrates examples of Clair's interventions.

Table 2

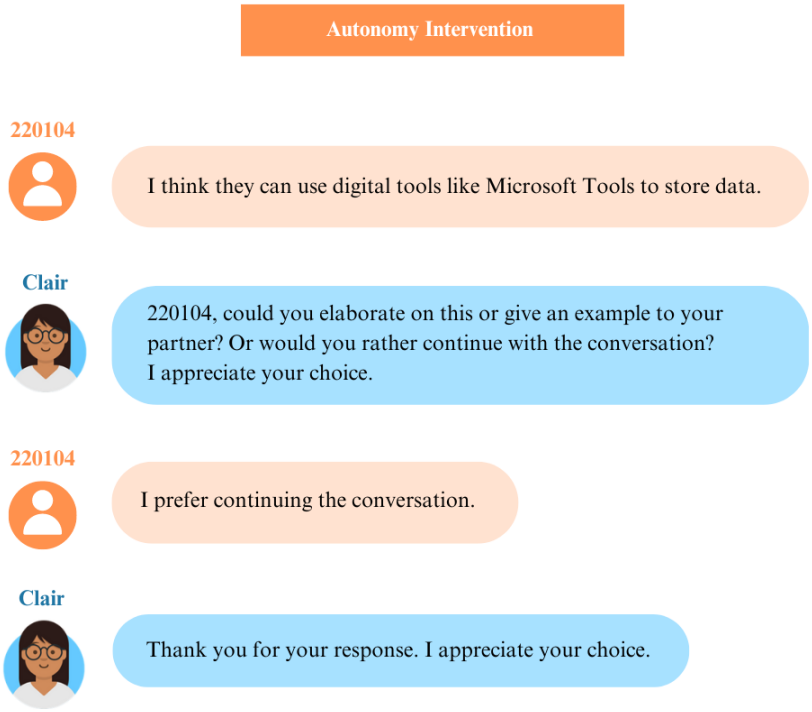
Interventions of Clair Grounded on the SDT theory

Intervention	Talk Move Example	Follow-up Example
Autonomy	Could you elaborate on this or give an example to your partner? Or would you rather continue with the conversation?	Variation 1: Thank you for your response. I appreciate your choice. Variation 2: Thank you for steering the conversation. Your response is greatly valued.

Intervention	Talk Move Example	Follow-up Example
Competence	How does this connect with what we have discussed so far?	Variation 1: Thank you for your contribution, hopefully, this will help your partner understand your point of view. Variation 2: Thank you for your response. Remember, each time you contribute in this way, you're improving your understanding and your communication skills. Keep it up!
Relatedness	How does your understanding match or differ from your partner's? What else would you like to add?	Variation 1: Thank you for your contribution, sharing your understanding is what helps us learn from each other. Variation 2: Your contribution is valued, sharing enriches our learning.

Figure 3

Three Examples of Clair's Interventions



Competence Intervention

330105

The company's goal is to set a new system, so they need to conduct research first.

Clair

3330105, how does this connect with what we have discussed so far?

330105

Well, discussing how the company can make a digital transformation and that research is an important step

Clair

Thank you for your contribution, hopefully, this will help your partner understand your point of view.

Relatedness Intervention

440106

In my opinion, the company is successful because it pays attention to its customers.

Clair

440106, how do your ideas match or differ from your partner's? What else would you like to add?

440106

My ideas match with my partner as we both agree that the company puts its customers first.

Clair

Your contribution is valued, sharing enriches our learning.

3.2 Research Design

A controlled experiment research design was conducted at Gulf University, a private university in the Kingdom of Bahrain, to explore the effect of the conversational agent, Clair, on the three basic psychological needs, autonomy, competence, and relatedness. Within this design, the control group did not have Clair whereas the experimental group had Clair. Considering that this is a newly introduced version of Clair, a pilot study was conducted to identify and fix any potential technical issues.

3.3 Participants and Domain

In total, all 63 first-year bachelor students enrolled in the Digital Skills in Business course at Gulf University were invited to participate in the study. Out of 63 participants, 45 participants were present during the lecture on the experiment day. A form was shared with the 45 participants to record their active consent to participate in the study (Appendix A), of which all gave their consent and participated in the activity. Participants whose dialogues did not meet the following criteria were excluded from the analysis: a) participants must have one active peer in the chat; b) dyads must have spent a minimum of 50 minutes on the task; and c) dyads must have exchanged a minimum of 10 messages. After applying the criteria to the 45 participants, the final research sample consisted of 24 participants, of which 14 participants were in the control group (6 male, 8 female), and 10 participants were in the experiment group (5 male, 5 female).

The participants follow the Digital Skills Business course as a mandatory course in the Advertising and Digital Marketing Bachelor Program. This Digital Skills Business course aims to provide students with a conceptual framework for understanding computer systems, foster an understanding of the role technology plays in various aspects of businesses, and instill critical

analysis skills to assess digital transformation cases in business. Its primary focus is on using basic digital skills to analyze business cases. To achieve the course objectives, various teaching methods are employed including lectures, classroom discussions, Moodle as a Learning Management System, and hands-on lab work. Students are assessed using formative assessment via short quizzes, and a final written exam. Given that discussions and lab activities are part of teaching and learning methods in this specific course, the use of Clair was considered well-suited to the course objectives and instructional approaches.

3.4 Instrumentation

This section describes three main instruments used in the current study: a) Clair; b) Intrinsic Motivation Inventory; and c) Basic Psychological Needs Working Definitions

3.4.1 Clair

Clair was used as the CA to facilitate online dyad discussions. The configuration of Clair was implemented in two stages. The first stage of configuration involved identifying a set of topic-specific keywords, which were extracted from the syllabus for the given module, as specified by the teacher of the course. The second stage involved setting up rules based on Clair's dialogue variables pre-defined in the work of de Araujo et al. (2023b). While Clair has a set of 12 dialogue variables that act as sensors for messages (de Araujo et al, 2023b; de Araujo et al., 2024), this study focuses on the Topic Accumulation (TACC) dialogue variable. This variable allows Clair to intervene based on the ratio of the two discussants' accumulated topic similarities with the pre-defined topic keywords. For example, if the speaker's TACC is low, then autonomy is active. In this scenario, the speaker's message uses keywords far less frequently than their peer. This condition would trigger, for example, "Could you elaborate on

this or give an example to your partner? Or would you rather continue with the conversation?" Table 3 provides an overview of the triggering mechanism of Clair.

Table 3

The Triggering Mechanism of Clair

Variable	Dialogue Variable	Role	Utterance
Autonomy	TACC low	Speaker	Could you elaborate on this or give an example to your partner? Or would you rather continue with the conversation?
Competence	TACC high	Speaker	How does this connect with what we have discussed so far?
		Discussant	Could you rephrase what your partner has said?
Relatedness	TACC low	Discussant	How does your understanding match or differ from your partner's? What else would you like to add?

3.4.2 Intrinsic Motivation Inventory

The Intrinsic Motivation Inventory (IMI) instrument was adapted to measure autonomy, competence, and relatedness in this study. The IMI was developed to measure participants' intrinsic motivation towards a certain task (Centre of Self-Determination Theory, n.d.). The original instrument consists of 45 items and seven subscales. Given the specific focus of this study, only three subscales were used, namely perceived autonomy, perceived competence, and perceived relatedness. Furthermore, considering the redundancy of certain items and their overlap, a shorter version was used. Therefore, the adapted instrument had a total of 9 items. Each item was measured on a 7-point Likert scale, where participants were asked to rate the extent of their agreement from not at all true (1) to very true (7). Sample items included: "I had some choices while doing the activity with my peer." (perceived autonomy), "I was satisfied with my performance in this activity." (perceived competence), and "I felt that my opinion mattered while interacting with my peer."

In addition, the participants were asked three open-ended questions to investigate how they perceived their sense of autonomy, competence, and relatedness. For example, to gain insights into autonomy, participants were asked about the perceived level of control they had over their decisions and actions during the activity: "How did you perceive your ability to make choices during the activity?" Similarly, to understand their perceived mastery of the activity, they will be asked: "How did you perceive your level of competence in solving the case study?". Finally, to understand how the participants perceived their connectedness and acceptance by their peers, the following question will be asked: "How did you perceive the importance of your opinion during the activity?"

3.4.3 Basic Psychological Needs Working Definitions

A qualitative analysis was conducted to further investigate the effect of Clair on autonomy, competence, and relatedness due to the deviation of the data collection process from its intended purpose. Analysis of the IMI questionnaire revealed a pattern of superficial responses. For example, eight participants in the control group scored seven on every item. Therefore, a decision was made to conduct a qualitative analysis to gain a better understanding of the data.

Inspired by the work of Sharoff & Vogel (2008), an instrument was designed to measure the demonstration of autonomy competence and relatedness in the chatlogs of dyad discussions. To measure the demonstration of autonomy, two measures were followed: a) selection: when participants choose a set of options offered by Clair; and b) regulation: when participants facilitate the discussion flow by posing questions to their peers. To measure the demonstration of competence, three measures were followed: a) analysis: when participants investigate the situation and its context further; b) elaboration: when participants expand on the argument by providing details or examples; and c) synthesis: when participants combine their perspectives with their peers. To measure the demonstration of relatedness, three measures were followed: a) inquiry: when participants seek their peers' opinion; b) opinion: when participants state their personal beliefs or thoughts about a particular matter; and c) when participants thank their peers for their contribution to the discussion. Table 4 provides a summary of the instrument used in the present study.

Table 4

Measure and Description of Qualitative Analysis Instrument for Each Variable

Variable	Measure	Description
Autonomy	Selection	Choosing from a set of options offered
	Regulation	Facilitating the discussion flow by posing questions
Competence	Analysis	Investigating the situation and its context further
	Elaboration	Expanding on the argument by providing details or examples
	Synthesis	Combining one's perspectives with those of peers
Relatedness	Inquiry	Seeking peers opinion
	Opinion	Stating personal beliefs or thoughts about a particular matter
	Appreciation	Thanking peers for their contribution to the discussion

3.5 Procedure

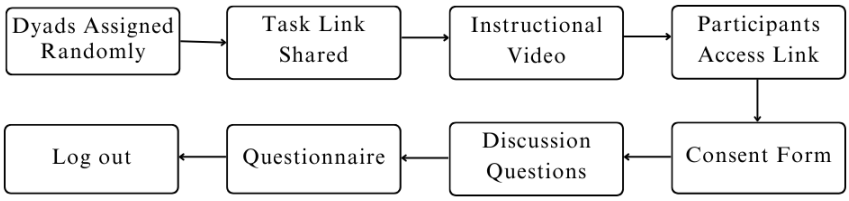
Participants were randomly paired up in advance using their student IDs. To execute the main task, the course teacher received the necessary instructions to guide the students through it. This was done by sharing two separate links to the same activity of the Go-Lab environment: a link for day one, the control group (without Clair), and a link for day two, the experimental group (with Clair). The teacher uploaded the link on Moodle and the access was locked until the task started on the lecture day. Students could only access the link after watching a 3-minute instructional video. Given the importance of understanding how to navigate the environment properly to complete the task, the instructional video was recorded in the participants' native language, Arabic. The main task was originally planned to be supervised on-site. However, due to unexpected circumstances, the task had to be monitored remotely. To provide guidance

remotely, the researcher was in contact with the teacher during the data collection process through the instant messaging application, WhatsApp.

After that, the participants logged in Go-Lab environment with their student IDs. The first page included a consent form, stating the aim and a short description of the study along with the researcher's contact information (Appendix A). This was followed by the main task of the case study scenario and the four discussion questions (Appendix B). Participants had 60 minutes to complete the task in which 15 minutes were allocated on each of the four discussion questions, after which they had to move to the next discussion question. When the 60 minutes were over, the participants had to fill out the questionnaire (Appendix C). Figure 4 is a summary of the procedure undertaken in the study.

Figure 4

Summary of the Procedure



3.6 Data Analysis

Quantitative and Qualitative analyses were conducted. For the quantitative analysis, the responses from the questionnaire were extracted as a .csv file from Go-Lab environment and then imported into the R programme for analysis. A reliability test was conducted for the IMI instrument by measuring Cronbach's Alpha for all subscales ($\alpha = .90$ or higher). Descriptive

statistics were measured for all variables (mean and standard deviation). After that, a t-test was performed to compare the control group and the experiment group across each variable. As for the qualitative analysis, the chatlogs were exported from Go-Lab as a .csv file and imported to ATLAS.ti. Clair's talk moves were counted and coded under autonomy (ATM), competence (CMP), and relatedness (RLT). In the control group, Clair's potential interventions, where Clair would have intervened as if she was present were coded. Additionally, responsiveness was measured by coding and categorizing it into three codes, namely Responded (RES), Somehow Responded (SMH), and Ignored (IGN). Responses in which participants demonstrated autonomy, competence, or relatedness, were respectively coded "ATM_1", "CMP_1" and "RLT_1" in the control and the experimental group. In addition, responses with demonstrated autonomy, competence, or relatedness had a sub-code to indicate the type of measure derived from the working definition. Table 5 demonstrates the coding book for the interventions and their sub-categories.

Table 5

Code Book for The Three Variables and their Measures

Variable	Code	Measure	Code
Autonomy	ATM_1	Regulation	RGL
		Selection	SLC
Competence	CMP_1	Analysis	ANS
		Elaboration	ELB
		Synthesis	SYN
Relatedness	RLT_1	Inquiry	INQ
		Opinion	OPN
		Appreciation	APR

4. Results

4.1 Reliability Analysis

The reliability coefficients of the intrinsic motivation subscales are listed in Table 6. Cronbach's alpha was high (α = .90 or higher) for all subscales. Despite the high reliability, a pattern of superficial responses was identified upon close inspection of the data. For example, within the control group, eight participants scored seven in all of the items. Therefore, a decision was made to disregard the data generated from the questionnaire.

Table 6

Reliability Analysis of Intrinsic Motivation Subscales

Variable	Control group	Experimental Group
	Cronbach's Alpha	Cronbach's Alpha
Autonomy	0.99	0.94
Competence	0.97	0.99
Relatedness	0.99	0.90

4.2 Descriptive Statistics

4.2.1 Number of Clair's Interventions in the Control and Experimental Group

In the control group, Clair had 16 potential interventions of which six were autonomy interventions, (37%), two were competence interventions (12%), and eight were relatedness interventions (50%). In the experimental group, Clair intervened 16 times in the experimental group of which six were autonomy interventions (37%), three were competence interventions (19%), and seven were relatedness interventions (44%). Table 7 summarizes Clair's potential interventions in both groups.

Table 7

Clair's Potential Interventions in the Control and Interventions in the Experimental Group

Variable	Control group	Experimental Group
	Frequency	Frequency
Autonomy	6 (37%)	6 (37%)
Competence	3 (19%)	2 (12%)
Relatedness	7 (44%)	8 (50%)
Total	16 (100%)	16 (100%)

4.2.2 Responsiveness to the Interventions of Clair in the Experimental Group

Notably, 11 out of 16 interventions of Clair were ignored during the discussion (69%) of which four were autonomy interventions, one was competence intervention, and six were relatedness interventions. Only two interventions of Clair were somehow responded to (12%) all of which were competence interventions. Lastly, only three interventions were completely answered (19%) of which two were autonomy interventions and one was relatedness interventions. Table 8 summarizes responsiveness to Clair's Interventions.

Table 8

Responsiveness to Clair's Interventions in the Experimental Group (N = 16)

Intervention	Responded	Somehow Responded	Ignored
Autonomy	2	0	4
Competence	0	2	1

Intervention	Responded	Somehow Responded	Ignored
Relatedness	1	0	6
Total	3 (19%)	2 (12%)	11 (69%)

4.2.3 The Effect of the Interventions of Clair on the Basic Psychological Needs

The descriptive statistics for the three variables, autonomy, competence, and relatedness are listed in Table 9. Findings indicated that the control group had a higher mean score than the experiment group for all subscales. The competence subscale had the greatest mean in the control group (M = 6.01) whereas the subscale relatedness had the lowest mean in the experiment group (M = 4.29). There was no significant difference in autonomy for the control group (M = 5.94, SD = 1.65) and the experimental group (M = 4.47, SD = 2.46), $t(13) = 1.65$, $p = .122$. Similarly, there was no significant difference in competence for the control group (M = 6.01, SD = 1.62) and the experimental group (M = 4.36, SD = 2.71), $t(13) = 1.62$, $p = .132$. Results indicated a non-significant trend in relatedness for the control group (M = 5.94, SD = 1.65) and the experimental group (M = 4.29, SD = 2.68), $t(13) = 1.88$, $p = .081$.

Table 9

Descriptive Statistics of the Three Variables from the Control Group and Experimental Group

	Control group		Experimental Group			
	M	*SD*	*M*	*SD*	*t*(13)	*p*
Autonomy	5.94	1.65	4.47	2.46	1.65	.122
Competence	6.01	1.62	4.36	2.71	1.62	.132
Relatedness	5.94	1.65	4.29	2.68	1.88	.081

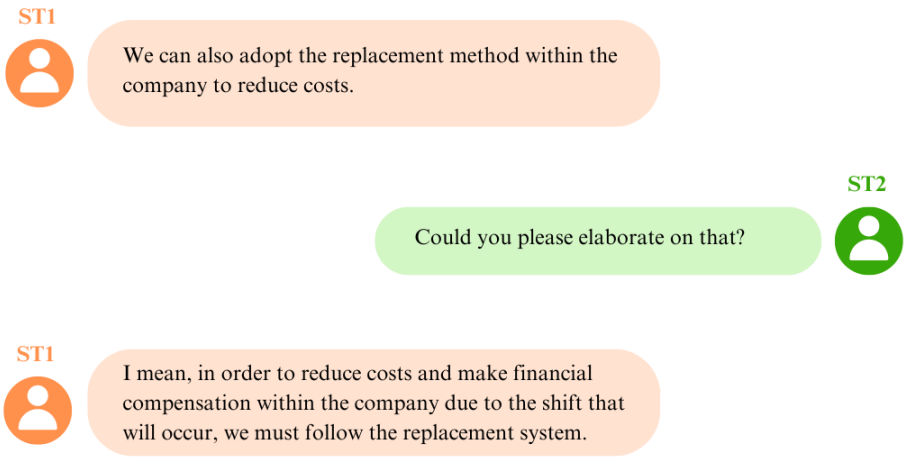
$p < .05$

4.4 Qualitative Analysis

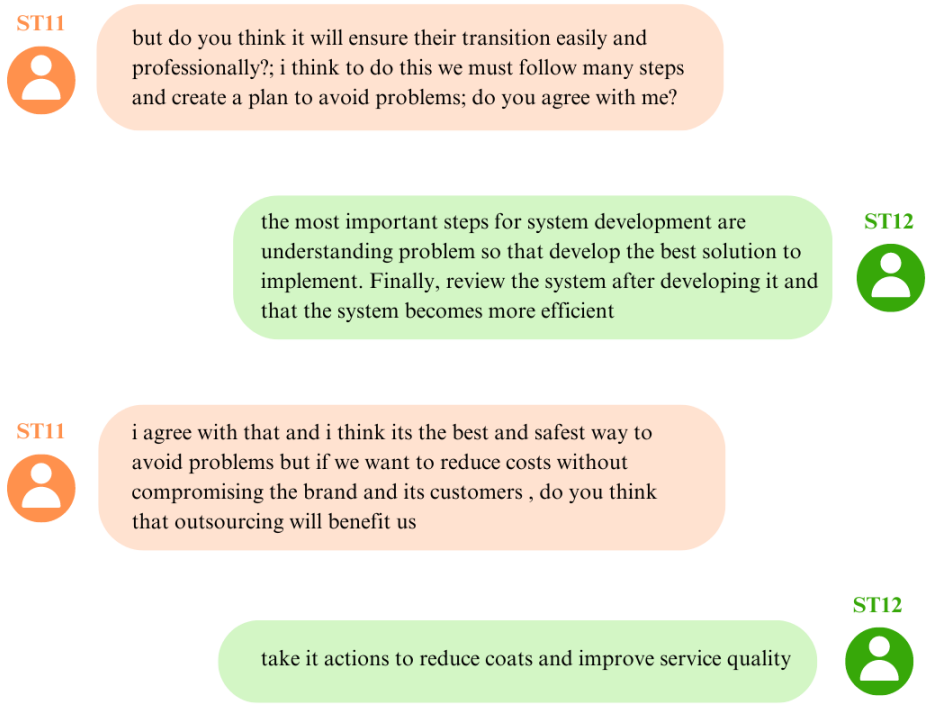
Drawing on the chatlogs of student discussions, this section compares the demonstration of autonomy, competence, and relatedness between the control group and the experimental group.

4.4.1 Autonomy

Control group. Two out of seven dyads demonstrated autonomy at least one time through regulation by facilitating the conversation in the control group. In one dyad, one participant adopted a facilitator role that closely resembled Clair's interventions. This proactive approach prompted peers to delve deeper into the subject matter, fostering a more dynamic exchange and enriching the overall depth of the conversation. For example, during the interaction between ST2 and their peer; ST2's request for elaboration encouraged ST1 to provide a more nuanced explanation of their viewpoint:

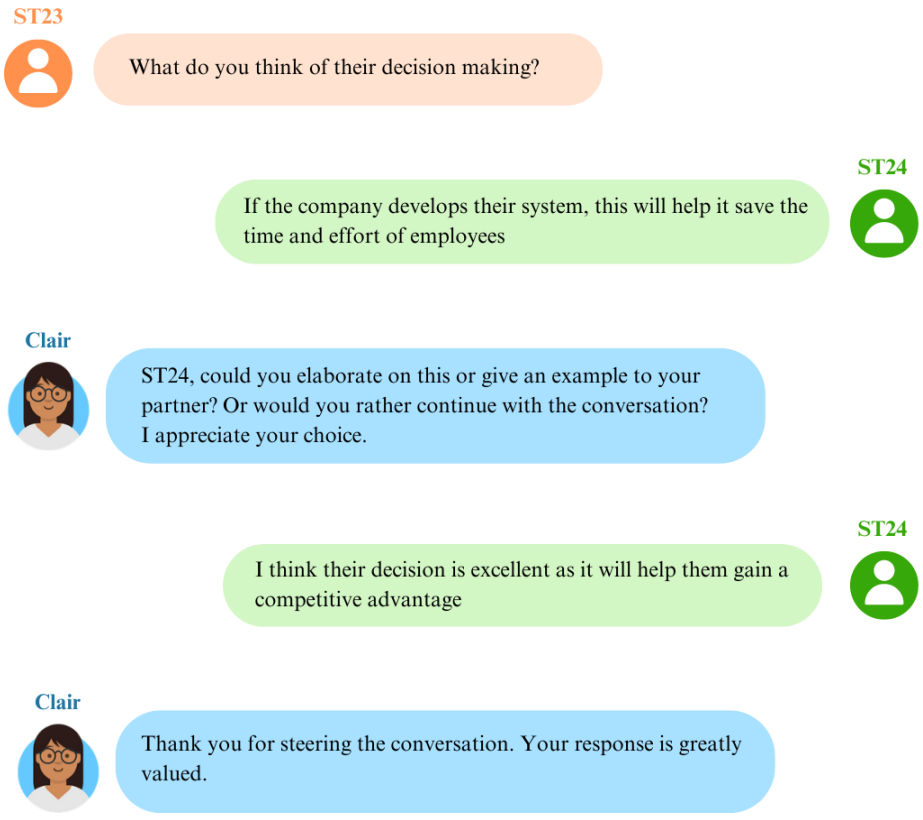


Conversely, this facilitative approach was differently perceived in another dyad. Despite the participant's efforts to take a facilitative role, their initiative was met with minimal engagement from their peer, leading to a one-sided conversation that lacked depth. These interactions were characterized by a mere listing of answers, devoid of the rich, reciprocal exchange of ideas that could elevate a discussion from simple question-and-answer to a meaningful dialogue. For instance, participant ST11 took the facilitator role by posing questions. However, instead of engaging in a collaborative discussion, participant ST12 focused solely on expressing their viewpoint missing the opportunity to explore each other's ideas and enrich their mutual understanding:



In dyads where participants did not take the facilitator role, brief responses were provided. Rather than fostering a meaningful exchange of ideas, these discussions remained at a surface level, by merely listing short answers.

Experimental group. Participants demonstrated autonomy eight times across different dyads in the experimental group. To start with, participants demonstrated autonomy five times through regulation by taking the initiative to pose questions to their peers, at a similar time as Clair's interventions. In all instances, they favored addressing questions posed by their peers rather than responding to Clair's interventions. For example, ST23 and Clair both directed a question to ST24. However, ST24 chose to respond to the question posed by their peer rather than the one from Clair:



Furthermore, there were three instances where participants demonstrated autonomy through selection by choosing their preferred method of responding to Clair's interventions. In one dyad, a participant responded to Clair's intervention by providing an example, thus enhancing the dialogue. In another dyad, a participant responded to Clair by indicating their preference to continue the conversation and elaborate on their arguments. For instance, participant ST17 explicitly stated their preference to proceed with the conversation following Clair's intervention, thereby addressing the discussion topics and offering examples. ST17 then overlooked Clair's subsequent interventions throughout the discussion, opting instead to further elaborate on their original arguments:

Table 10 summarizes the responses in autonomy in both the control and the experimental groups.

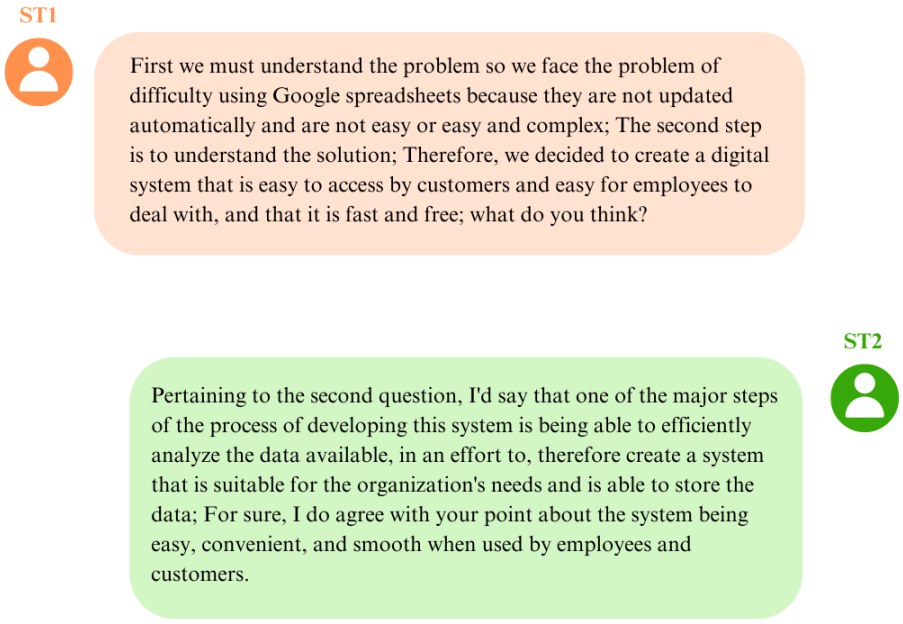
Table 10

Frequency of Autonomy and Its Sub-codes in the Control and Experimental Groups

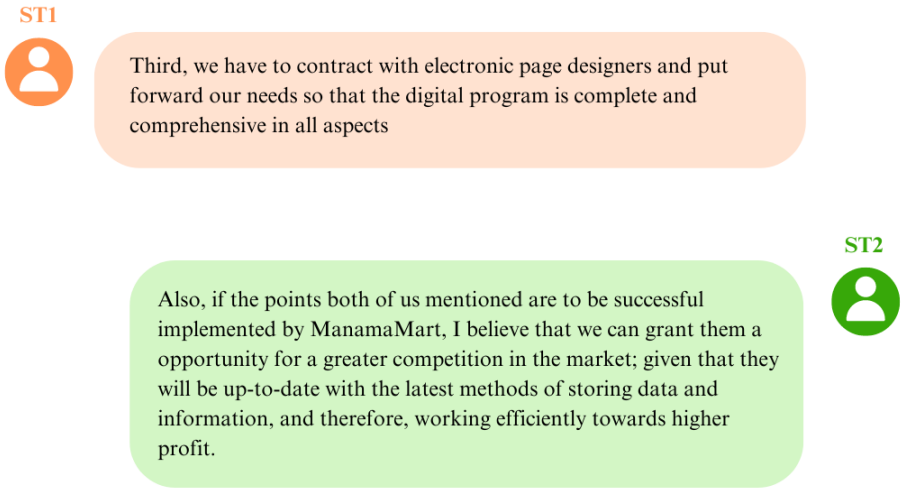
Variable	Sub-code	Control Group	Experimental Group
Autonomy	Regulation by taking the facilitator role	2	5
	Selection through Clair's Interventions	-	3

4.4.2 Competence

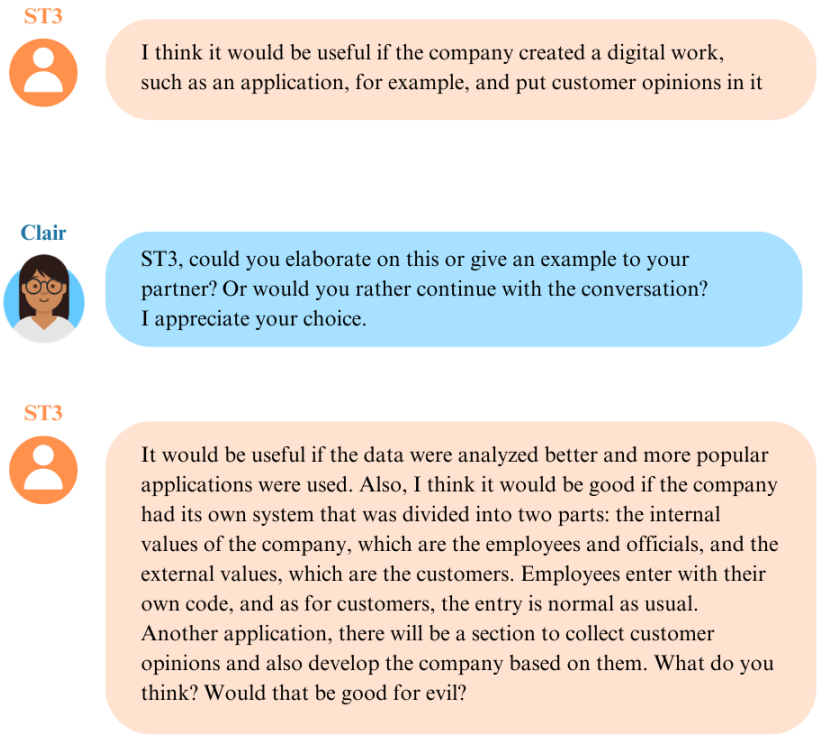
Control group. Participants demonstrated competence 12 times across different dyads in the control group. Competence was demonstrated four times through analysis by delving into the nuances of the case study, and showcasing critical thinking skills before providing an answer to the discussion questions. This approach revealed a grasp of the questions at hand but also set the stage for providing insightful answers that went beyond basic responses. For instance, participant ST1 highlighted the importance of understanding the causes before suggesting solutions, basing their argument on a deep understanding of the case study and supporting it with concrete examples. This effort was matched by their peer, participant ST2, by expanding on participant ST1's insights, agreeing with their analysis, and providing additional justifications for their point of view:



Additionally, participants demonstrated competence four times by synthesizing information across different dyads. Not only did they provide their arguments throughout the discussion but they also synthesized their own and peers' ideas, bringing a unified perspective. For instance, participant ST2 synthesized their own and their peer's opinions, effectively linking their insights with those of their peer to form a more cohesive argument:

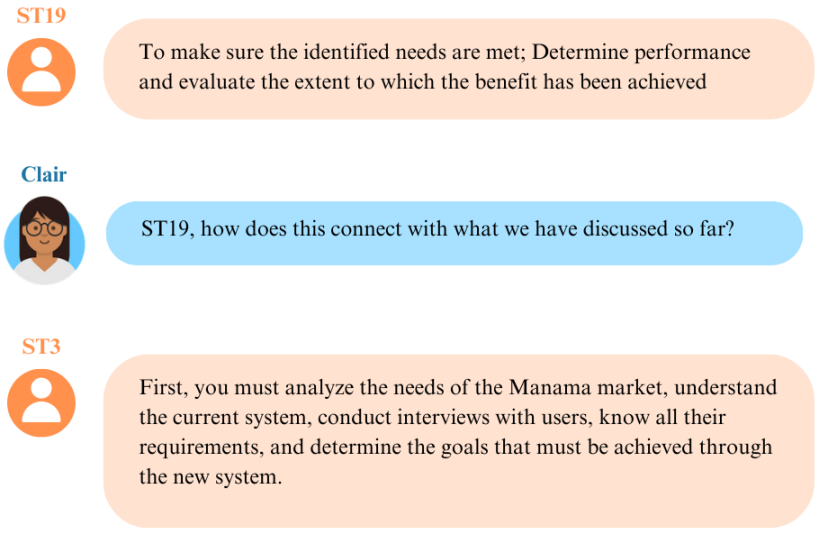


Moreover, participants showcased their competence four times across various dyads by extensively elaborating on their arguments and providing concrete examples. Notably, in two of these interactions, where Clair would have intervened, participants themselves recognized the need to expand on their ideas, even without the presence of Clair. This emphasizes participants' ability to thoughtfully engage with the subject matter and enrich the conversation without external prompts. For example, participant ST3 expressed their opinion and later elaborated on their argument by providing examples and providing justifications:



Experimental group. As for the experiment group, 10 responses demonstrated competence across various dyads. In all dyads, participants demonstrated competence six times through elaboration. Initially, participants provided brief answers at the beginning of the conversations. However, with Clair's intervention, participants gave more detailed answers, thereby building on their argument. For instance, participant ST19's answers were limited to

listing key points—a straightforward approach that lacked depth. However, after Clair's intervention, participant ST19 provided more explanations of the listed key points, enriching their responses with relevant examples:



Moreover, participants demonstrated competence four times through analysis by taking the time to understand the stated problem and the discussion question presented to them. This was done by integrating the context of the case study into their responses. For example, participant ST20 incorporated the broader context of the case study into the discussion. This prompted their peer, participant ST19, to consider other aspects of their argument, resulting in a more in-depth conversation:

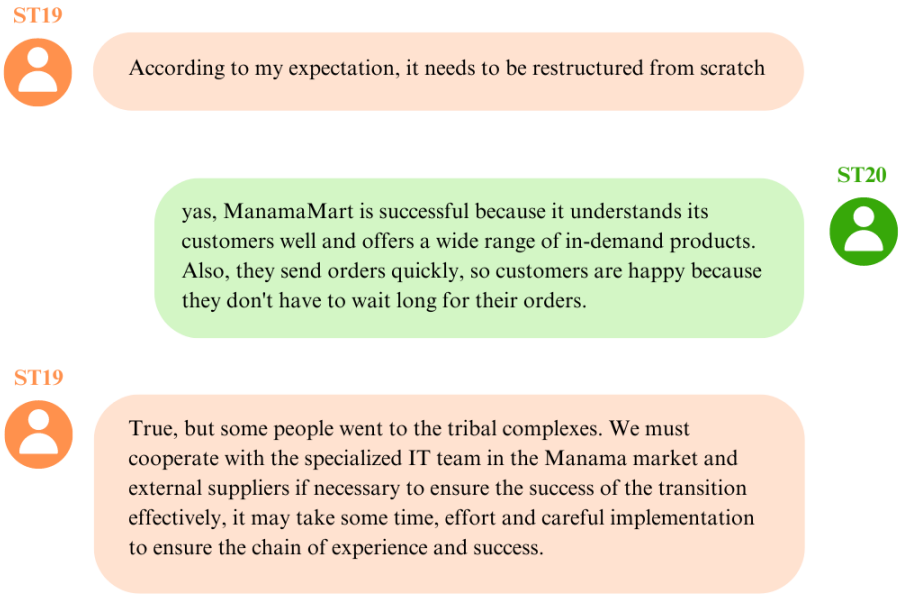


Table 11 summarizes the responses of competence in both the control and the experimental groups.

Table 11

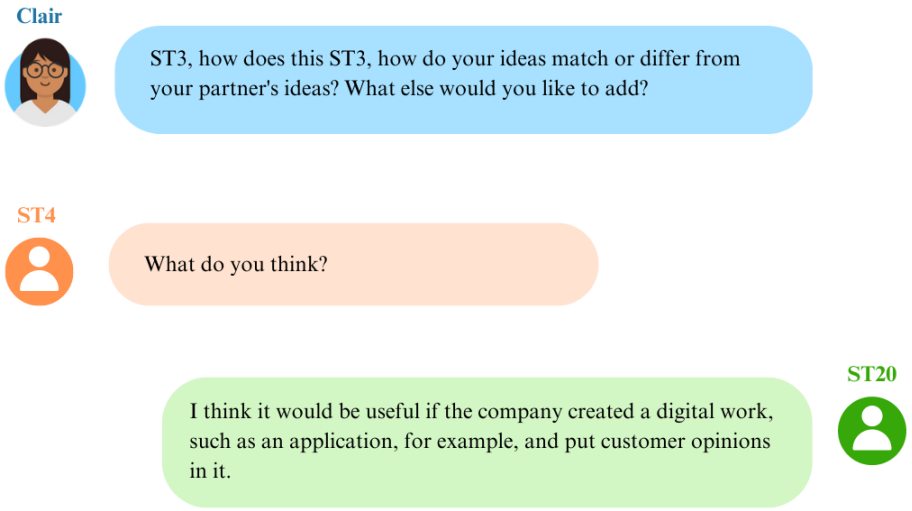
Frequency of Competence Sub-codes in Control and Experimental Groups

Variable	Sub-code	Control Group	Experiment Group
Competence	Analysis by bringing the context of the case study and its nuances	4	4
	Elaboration through providing justifications and examples	4	6
	Synthesizing information by linking one's and peer's opinion	4	-

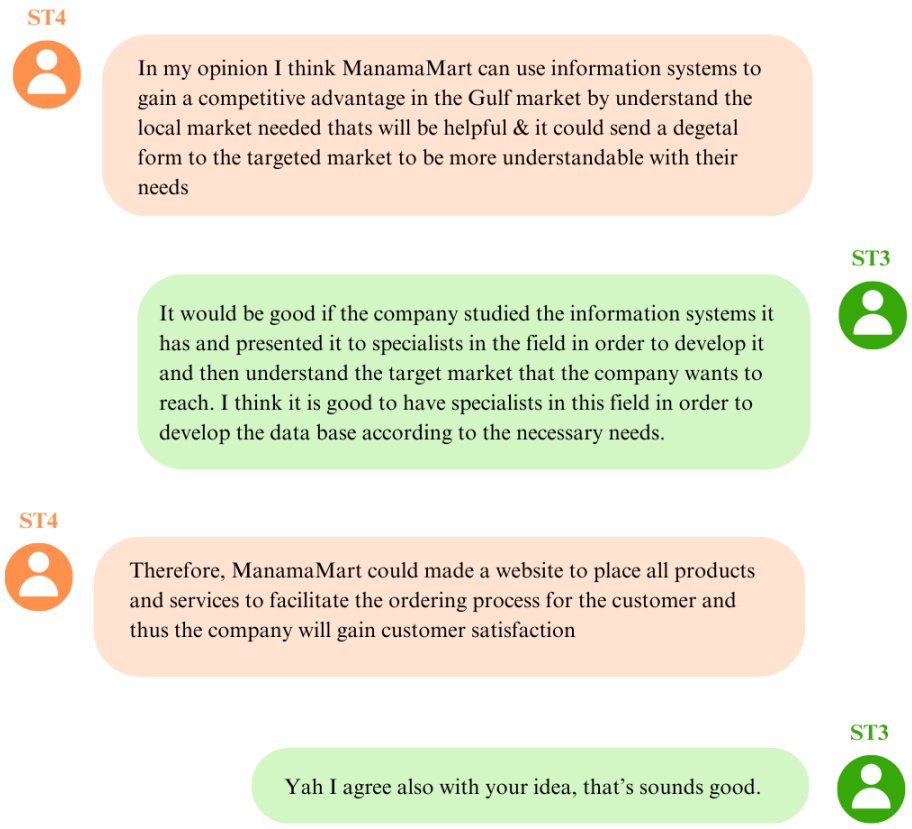
4.4.3 Relatedness

Control group. In the control group, relatedness was demonstrated 25 times within different dyads. Participants demonstrated relatedness 11 times through inquiry in which they

were keen on asking their partner's opinion, leading to actively sharing ideas among each other. Interestingly, their timing for posing questions coincided with moments when Clair would have potentially intervened. For example, although Clair could have potentially intervened, directing a question to ST3, ST4 posed a question to their peer, participant ST3, that is similar to Clair's intervention. In response, ST3 responded to their peer by sharing their opinion and providing more examples:

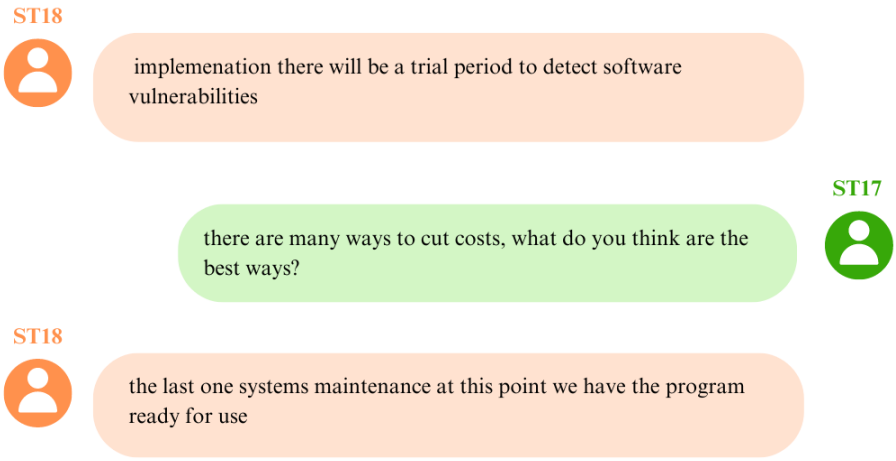


Additionally, participants demonstrated relatedness 11 times through opinion, in which they stated their point of view. This encouraged their peers to express agreement with the presented ideas. However, in these interactions, the majority of participants agreed with their peers' opinions without detailing the reasons for their agreement. For example, when Participant ST4 shared their perspective, their peer, participant ST3, merely expressed agreement, without offering any insights on the reasons for their agreement:

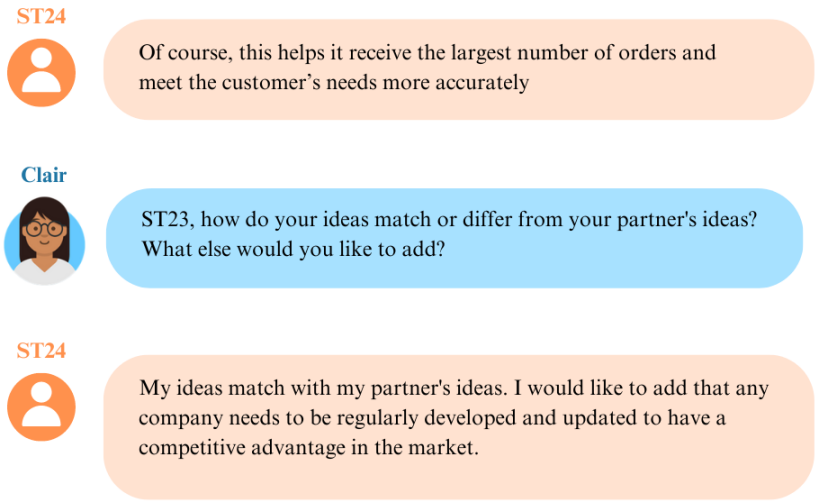


In three different dyads, participants demonstrated relatedness three times through appreciation. They concluded their conversations by expressing gratitude to each other and appreciating the shared insights throughout the discussion. They recognized how their collaborative discussions led to effective solutions. For example, participant ST4 thanked their peer, participant ST3, for their active participation, noting how the dialogue enhanced their understanding of the topic. Likewise, participant ST3 praised ST4's contributions, stating that these exchanges led to reaching the best solutions:

Experimental group. In the experiment group, relatedness was demonstrated eight times. Participants demonstrated relatedness three times through inquiry. Similar to the control group, participants frequently asked about their peer's opinions, indicating an interest in their point of view.



Relatedness was demonstrated four times through opinions in which participants expressed their agreement with their peers. This was evident, particularly following Clair's interventions, prompting participants to share their viewpoints and further add to their ideas. Rather than simply agreeing with their peers, participants enriched the dialogue by providing additional insights. For example, Clair's intervention prompted Participant ST23 to do more than just show agreement with their peer's points; they also offered additional information, adding more value to the discussion:



Finally, one dyad demonstrated relatedness one time through appreciation both peers thanked each other for their contribution at the end of the discussion. Table 12 summarizes the responses in relatedness in both the control and the experimental groups.

Table 12

Frequency of Relatedness Sub-codes in Control and Experimental Groups

Variable	Sub-code	Control Group	Experiment Group
Relatedness	Inquiry through asking for peer's point of view	11	3
	Opinion through stating one's personal perspective	11	4
	Appreciation through showing gratitude to peers' contribution	3	1

5. Discussion

The primary objective of this study was to investigate whether Clair, grounded on the SDT theory, affects students' three basic psychological needs —autonomy, competence, and relatedness—during peer discussions. To achieve this objective, the demonstration of students' autonomy, competence, and relatedness was coded in the chatlogs of the dyad online discussion for the control and the experimental group. The following chapter highlights the most important findings, starting with the effect of Clair on students' autonomy (RQ1), followed by her effect on students' competence (RQ2), and finally her effect on students' relatedness (RQ3).

5.1 RQ1: Investigating the Effect of Clair on Students' Autonomy

Participants in the experimental group demonstrated more autonomy than the control group. Upon close examination of students' dyad discussions, similarities and differences in the interaction between students were found in the two groups. One striking similarity in both groups is that participants occasionally assumed a facilitator role, actively regulating the discussion by posing questions to their peers. This behavior was reported in various studies in which autonomy was associated with the adoption of regulation strategies (Heirweg et al., 2019; Baars et al., 2017; Dörrenbächer & Perels, 2016; Liu et al., 2014).

A possible explanation for this may be a response to the flexibility and freedom online environments offer, thereby providing learners with more autonomy to interact with each other (Chen et al., 2010).

Participants in the experimental group engaged with peers who took the facilitator's role. Notably, the experimental group favored continuing discussions with their peers over responding to Clair's interventions, with only a single instance recorded where a peer's response to Clair's intervention involved providing an example. This suggests students' autonomy in navigating their learning experience by choosing how to respond to Clair's intervention, in particular, when students are presented with choices, they tend to make decisions that are more aligned with their interests (Deci et al., 2013). In contrast, participants in the control group responded in two ways to the peer-facilitated role: a) participants engaged with their peer facilitator role during the discussion, thereby enhancing and enriching the dialogue by building upon each other's ideas; and b) participants did not engage with their peer facilitator role and continued to state their own opinion and without building on each other's arguments. The observed difference in the participants' responses aligns with research in the field of CSCL indicating that engagement levels vary among learners in online environments (Rienties et al., 2009). According to Hadwin et al. (2017), differences in metacognitive activities among participants significantly influence how learners regulate their thinking and motivation, both individually and within groups. Essentially, students with more developed metacognitive skills are better equipped to regulate their learning processes and monitor their comprehension and understanding actively (Moos & Azevedo, 2008). Therefore, the level of metacognition could have played a role in learners' responses during the online discussion.

In cases where participants engaged with the peer-facilitated roles in both groups, the quality of the discussion significantly improved, leading to providing more in-depth answers through detailed explanations. This implies that when participants take an active role in facilitating their learning, their peers are prompted to engage and expand on their contribution, thereby enriching the discussion. This observation is similar to Yeh et al. (2018) findings that when participants actively engaged in facilitating learning in online collaborative settings, the discussion became more valuable.

5.2 RQ2: Investigating the Effect of Clair on Students' Competence

Participants demonstrated competence more in the control group than in the experimental group. Participants in the control group were proactive, independently initiating in-depth discussions and displaying a keen understanding of the material. Moreover, the participants in the control group skillfully synthesized various ideas, collaboratively building upon each other's contributions to form a cohesive and unified perspective—a dynamic that was not observed in the experimental group. The ability to integrate and build upon various perspectives may be attributed to the participants' level of metacognition. According to Kuhn (2015), students who actively participate in metacognitive processes are adept at connecting with and understanding their peers' thoughts. This includes the capacity to clearly articulate and substantiate their own viewpoints, as well as to respond thoughtfully to their peers (Chiu & Kuo, 2009).

Another notable observation in the control group is that participants were engaging in the discussion as if Clair was present in the chat by elaborating and giving examples to their arguments. This behavior suggests that the participants were capable of producing constructive and meaningful conversations. One possible explanation is that participants had a high level of competence due to their knowledge and familiarity with the discussion topics. Deci & Ryan

(2002) emphasize that when students engage in tasks that they master and feel confident in, they are more likely to demonstrate competence. Hence, this might suggest that students possessed the necessary knowledge of the topic to have a productive discussion without the need for Clair's interventions.

Discussions within the experimental group were initially presented at a somewhat superficial level, however, the depth and quality of these discussions improved following Clair's interventions. It is clear that after Clair's interventions, participants provided more elaborate and detailed answers to enhance their arguments. Additionally, participants incorporated context from the case study and conducted a more thorough analysis of the discussion question before responding. The increase in the depth of conversation could be the result of Clair's core design which is rooted in the principles of APT classroom practices aimed to create intellectually enriching conversations (de Araujo et al., 2023b). APT interventions, encourage students to engage actively in group discussions, articulate their reasoning, and pay attention to their peers. This process facilitates a deeper understanding and collaboration, allowing students to constructively build on each other's ideas (Michaels & O'Connor., 2015). Moreover, empirical research reports Clair's consistent reliability in diverse areas, including circuits and the study of languages like Dutch and Portuguese (de Araujo et al., 2023a). Therefore, the increase in the quality of discussions after the interventions of Clair could be due to Clair's ability to intervene in a timely manner, thereby encouraging students to engage in explicit reasoning.

5.3 RQ3: Investigating the Effect of Clair on Students' Relatedness

Findings reveal that participants in the control group demonstrated relatedness more than participants in the experimental group. In both groups, participants actively sought out their peers' opinions, reflecting an interest in their peers' perspectives

throughout the discussion. Interestingly, participants in the control group posed questions at a similar time as Clair's potential interventions. While this finding shows Clair's timely interventions, it also implies that the participants possessed the ability to recognize the need for peers' insights. Considering that Clair has not been used in contexts involving young adults, this behavior could be a reflection of the participants' high metacognitive abilities. Metacognition plays a role in completing tasks, both in individual and group settings, by facilitating cognitive processes (Heyes et al., 2020). Thus, participants' metacognitive skills may have enabled them to facilitate the discussion by actively posing questions to their peers.

While the control group demonstrated relatedness more than the experimental group, the dialogues were more elaborate than the control group. Participants in the control group simply showed agreement with their peers' opinions without elaborating or justifying their choice, whereas participants in the experimental group enriched the dialogue by providing more information in addition to agreeing with their peers' opinions. Interestingly, providing further explanation was particularly observed after Clair's interventions. This implies that Clair's interventions enriched the dialogue between students by prompting them to substantiate their agreement with peer opinions and offer further explanations. This observation is consistent with findings from research exploring the impact of agent-led interventions aimed at eliciting agree-disagree responses within online group discussions. The studies revealed that interventions by agents that encourage consensus-building can significantly enhance the depth and quality of students' discussions (Tegos et al., 2015; Adamson et al., 2014).

Moreover, both groups demonstrated a deep appreciation for the contributions of their peers, actively expressing gratitude and recognizing the collaborative effort that enhanced their learning experience. Participants went beyond mere acknowledgment; they detailed how their peers' insights contributed to a better understanding of the topic and highlighted the value of collaborative work in their learning. This suggests that peers felt a strong sense of connection with each other, emphasizing the importance of mutual support in the learning process. The SDT states that expressions of relatedness may differ across cultures, as they mirror the internalization of unique cultural values and norms (Ryan & Deci, 2000). Therefore, the observation that students openly expressed gratitude and acknowledged their peers' contributions could be a reflection of the cultural emphasis on the value of expressing gratitude to others.

5.4 Implications

The findings of the current study have several implications. To start with, it was observed that students in the experimental group provided more elaborate and detailed answers to their arguments after the intervention of Clair. This has implications for educators that CAs, like Clair, could be leveraged as valuable tools to guide students during online discussions. Furthermore, it was observed that participants demonstrated more autonomy when Clair was present. This provides implications for educators to make use of learning technologies to help students take charge of their learning as well as to automate the supervision of student interactions during these discussions.

Moreover, this study modifies the interventions Clair based on the SDT classroom practices. This introduces an innovative approach to incorporating SDT classroom practices in CAs. Considering the essential role of practices that contribute to pedagogical models in CSCL (Stahl

& Hakkarainen, 2021), researchers and learning technology specialists should further explore the application of the SDT to enhance the learning process.

5.5 Limitations

The present study has two limitations that should be taken into consideration. The first limitation is the small sample size. Coordinating the task remotely and synchronously with multiple stakeholders, including the researcher, teacher, and participants was challenging. As a result, a small group of participants were gathered, impacting the overall generalisability and reliability of the study. It is recommended that future studies have a larger sample size across various educational contexts.

Another limitation is that the study followed a controlled experiment design and the variables were measured at a single point in time. This meant that the experiment did not account for students under different conditions over time. It is recommended to conduct a longitudinal study to understand the possible effects of Clair on students over a longer period to investigate how interactions with Clair could impact the behavior of learners in the long run.

5.6 Conclusion and Future Direction

The current study investigated the effect of Clair on the three basic psychological needs – autonomy, competence, and relatedness – during peer discussion among university students. Findings indicate that the control group demonstrated higher competence and relatedness whereas the experimental group demonstrated higher autonomy.

Future research could expand the scope of this study by using a larger sample size in the same geographical context. Additionally, applying Clair in the region's native language, Arabic, could eliminate challenges linked to communication in a non-native language, thereby providing

deeper insights into learners' behavior. Moreover, the study explores only one of the six mini-theories within the SDT. This theory offers a framework beyond intrinsic motivation as it covers a wide array of topics including internalization, life goals and aspirations, individual differences in motivation, and the role of motivation in personal relationships. Future research could investigate these areas of the SDT within the context of CSCL environments to bring insights into these factors and their implications for learning. Furthermore, the current study utilizes Clair in a university setting. This study reports some of the learners' ability to regulate the discussion, often taking the role of Clair as a facilitator. Future studies should explore an adaptive design, where Clair adapts her APT interventions based on the responses of learners, thereby providing personalized interventions based on learners' different interactions.

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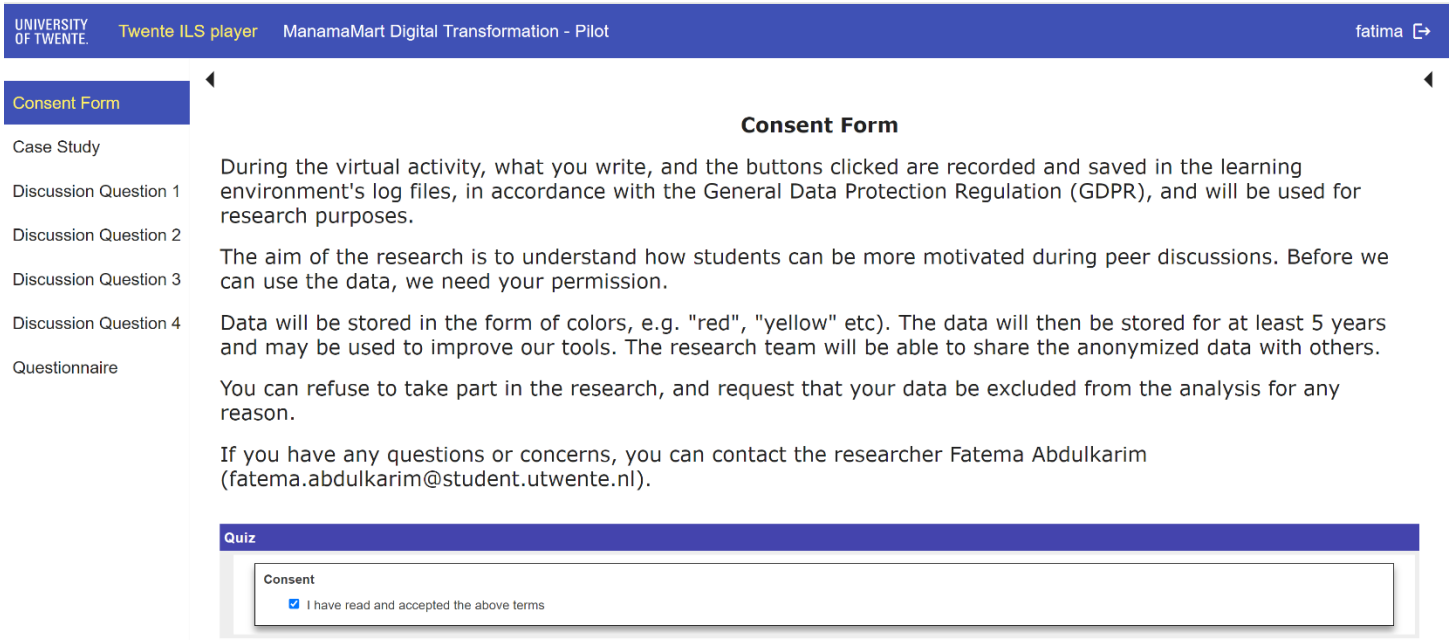
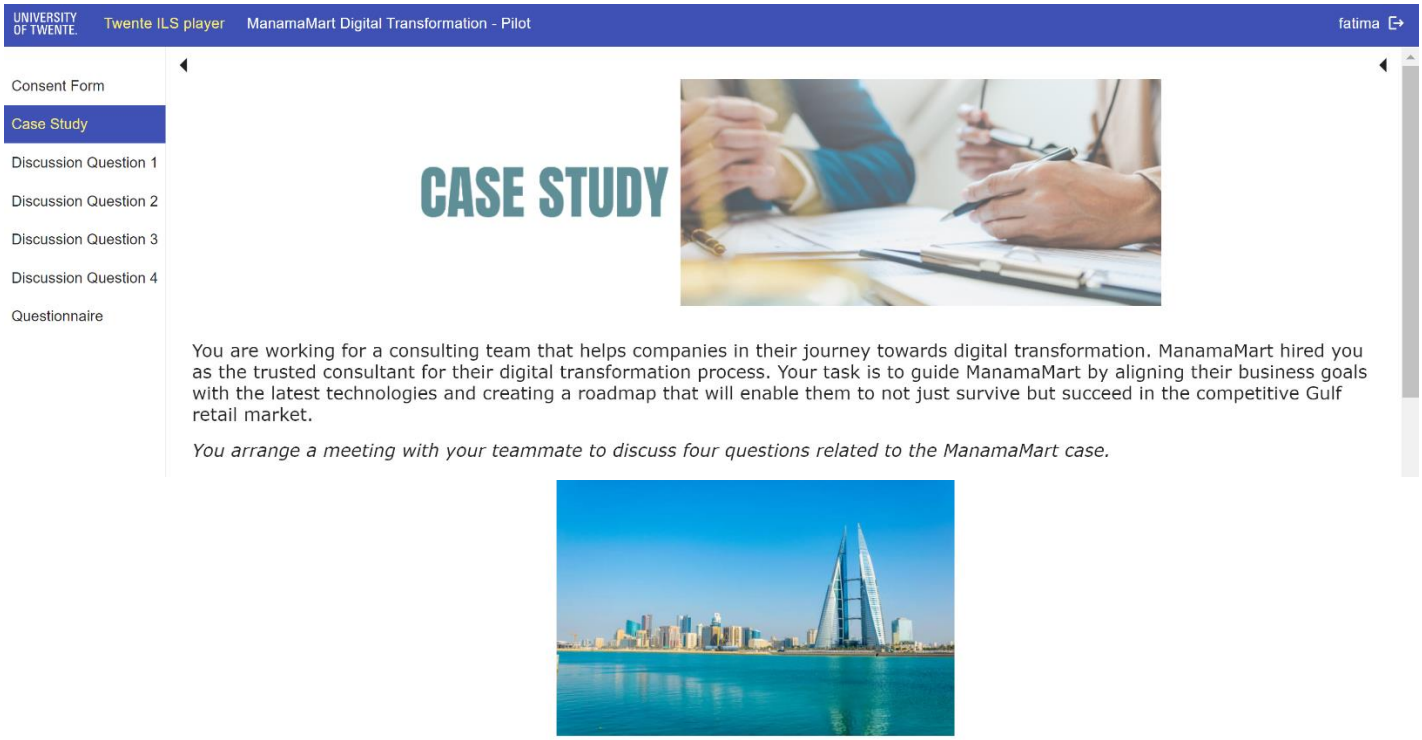
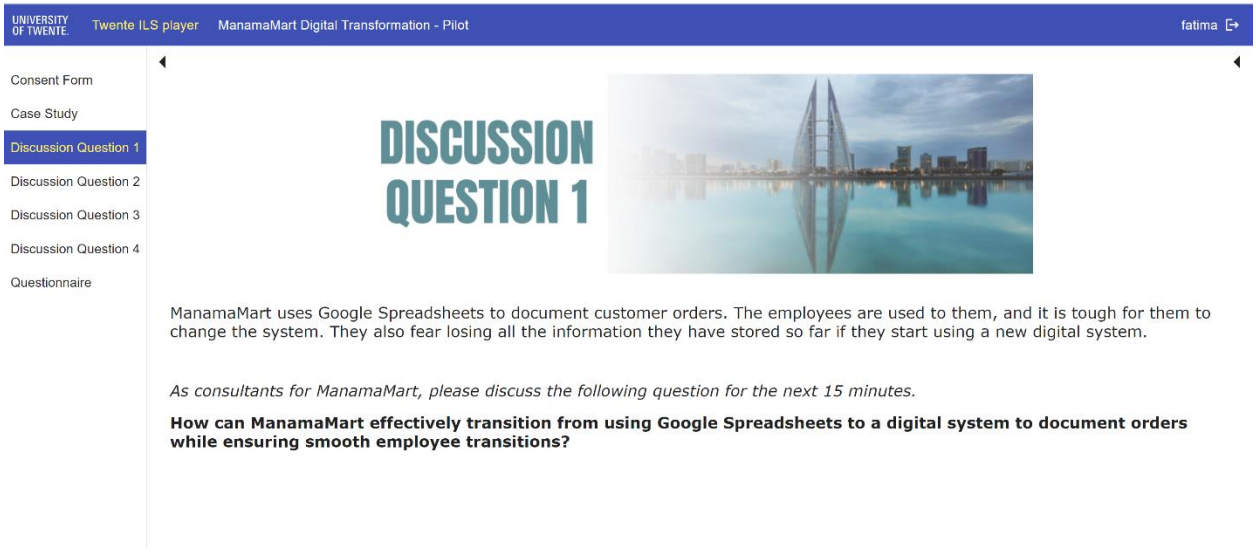
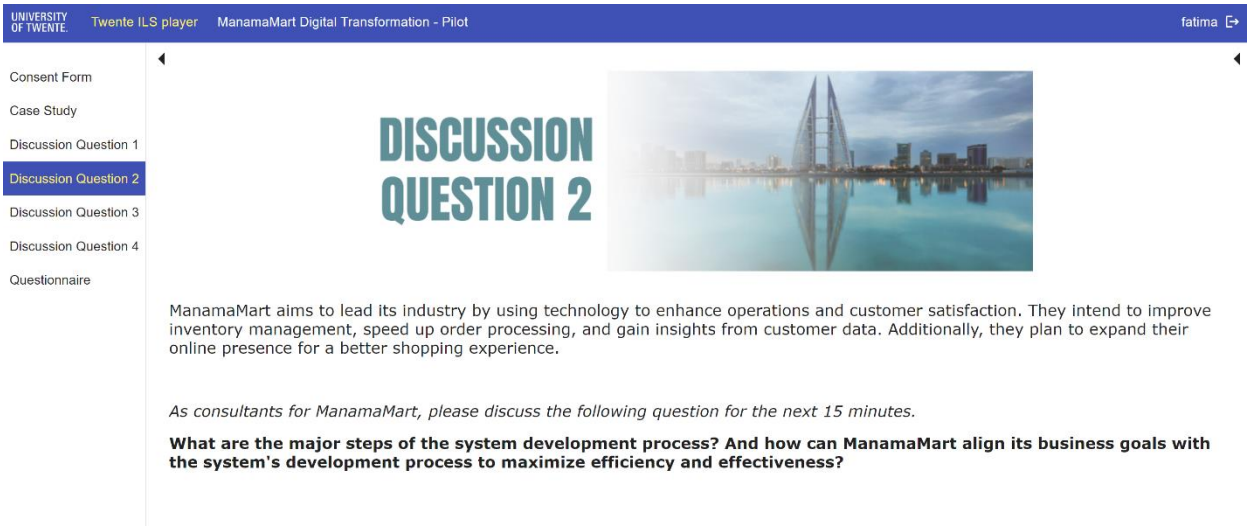
Appendix A. Consent Form



Appendix B. Case Study and Discussion Questions



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ManamaMart Digital Transformation - Pilot
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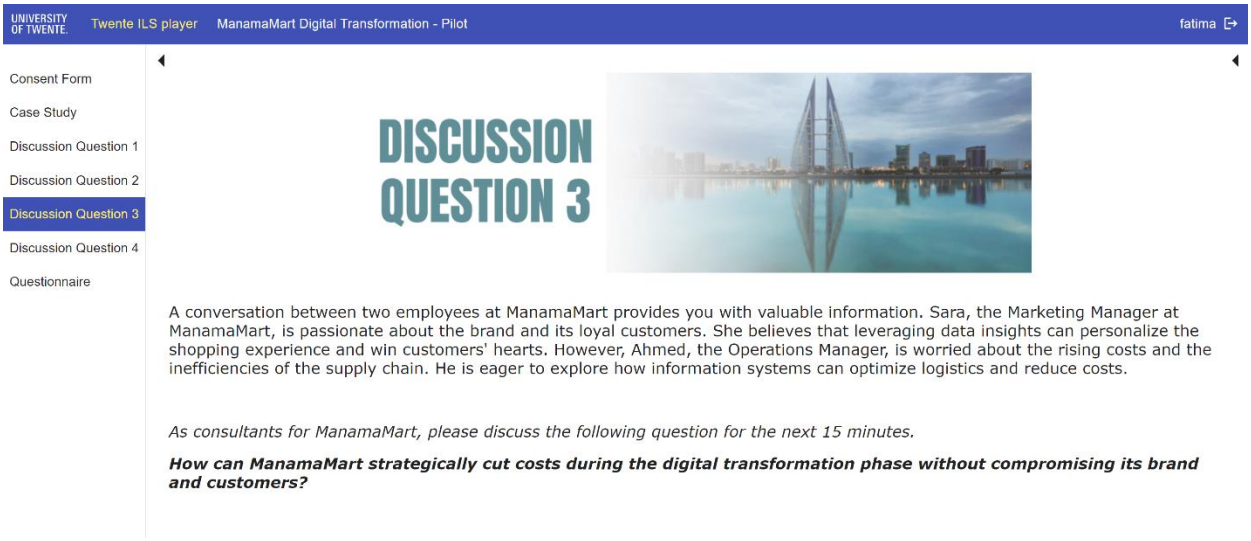
Consent Form
Case Study
Discussion Question 1
Discussion Question 2
Discussion Question 3
Discussion Question 4
Questionnaire
DISCUSSION QUESTION 2
ManamaMart aims to lead its industry by using technology to enhance operations and customer satisfaction. They intend to improve inventory management, speed up order processing, and gain insights from customer data. Additionally, they plan to expand their online presence for a better shopping experience.
As consultants for ManamaMart, please discuss the following question for the next 15 minutes.
What are the major steps of the system development process? And how can ManamaMart align its business goals with the system's development process to maximize efficiency and effectiveness?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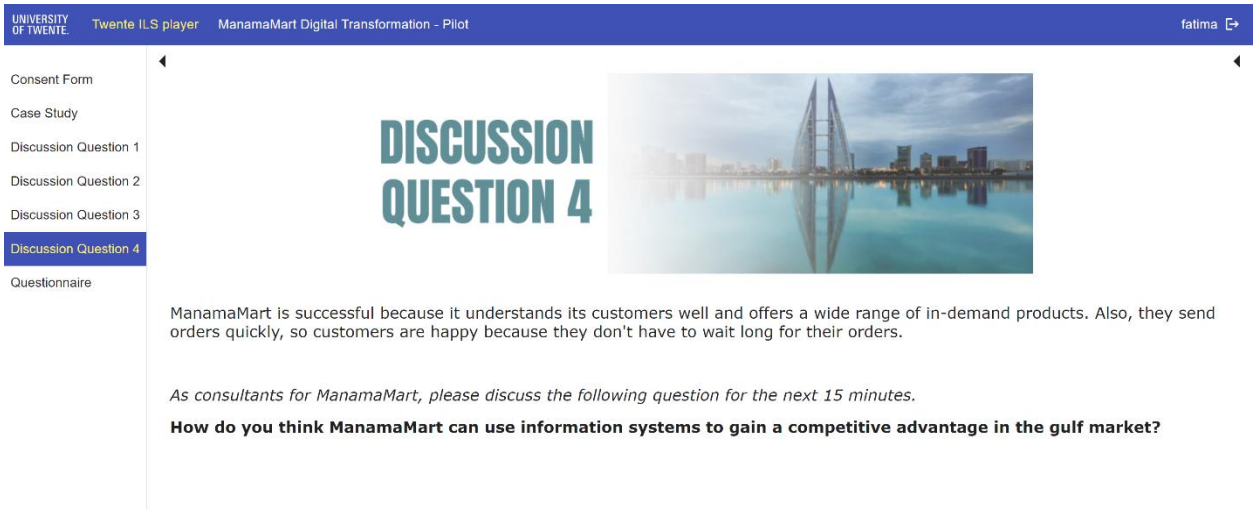
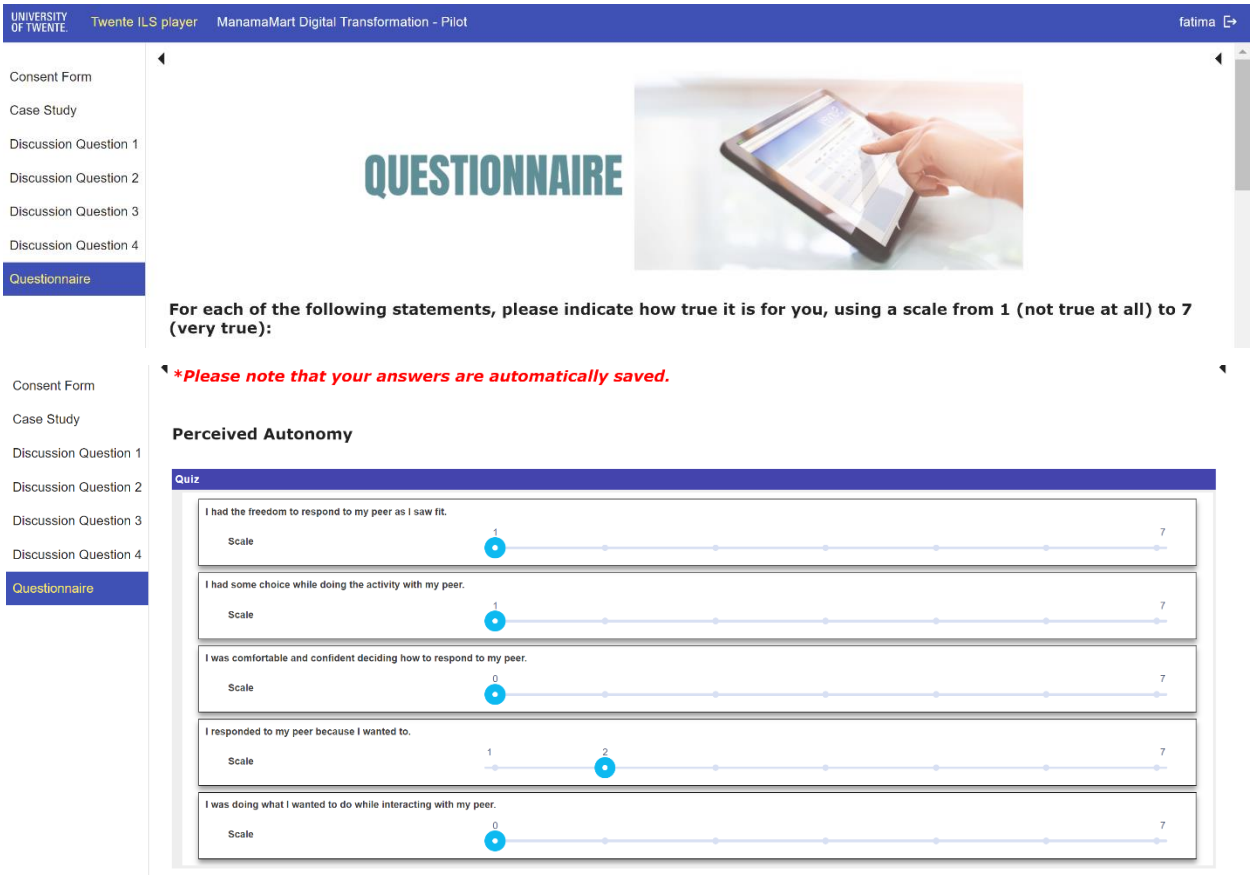
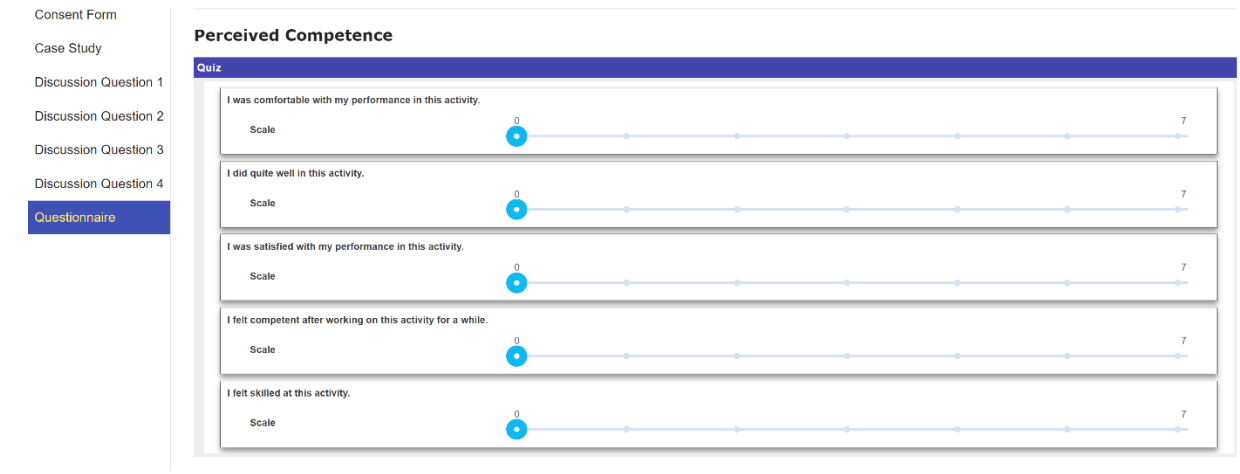
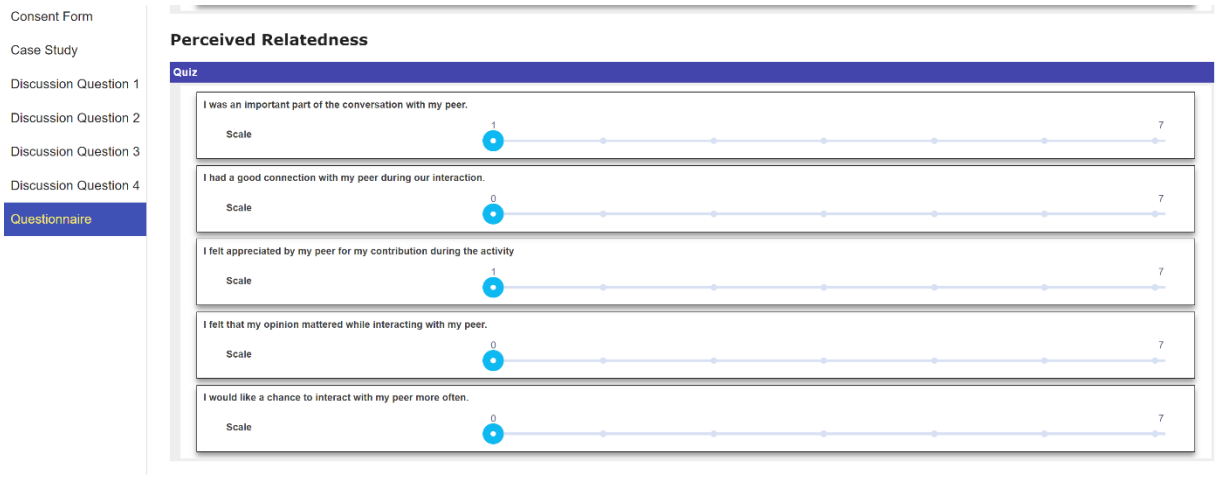
ManamaMart Digital Transformation - Pilot
fatima
Consent Form
Case Study
Discussion Question 1
Discussion Question 2
Discussion Question 3
Discussion Question 4
Questionnaire
DISCUSSION QUESTION 3
A conversation between two employees at ManamaMart provides you with valuable information. Sara, the Marketing Manager at ManamaMart, is passionate about the brand and its loyal customers. She believes that leveraging data insights can personalize the shopping experience and win customers' hearts. However, Ahmed, the Operations Manager, is worried about the rising costs and the inefficiencies of the supply chain. He is eager to explore how information systems can optimize logistics and reduce costs.
As consultants for ManamaMart, please discuss the following question for the next 15 minutes.
How can ManamaMart strategically cut costs during the digital transformation phase without compromising its brand and customers?

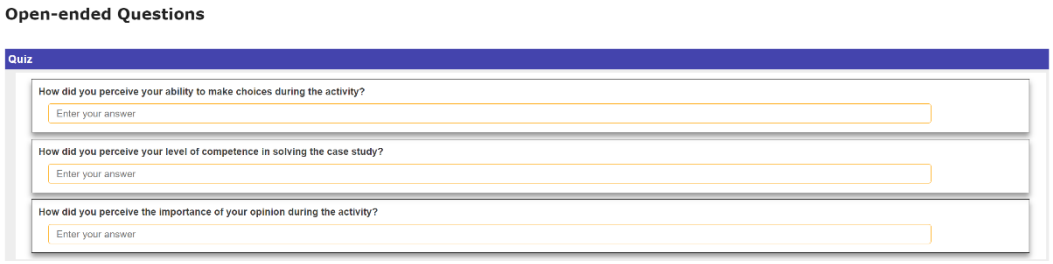


Appendix C. Questionnaire




Consent Form
Case Study
Discussion Question 1
Discussion Question 2
Discussion Question 3
Discussion Question 4
Questionnaire
Perceived Competence
Quiz
I was comfortable with my performance in this activity.
Scale
0
7
I did quite well in this activity.
Scale
0
7
I was satisfied with my performance in this activity.
Scale
0
7
I felt competent after working on this activity for a while.
Scale
0
7
I felt skilled at this activity.
Scale
0
7


Consent Form
Case Study
Discussion Question 1
Discussion Question 2
Discussion Question 3
Discussion Question 4
Questionnaire
Perceived Relatedness
Quiz
I was an important part of the conversation with my peer.
Scale
1
7
I had a good connection with my peer during our interaction.
Scale
0
7
I felt appreciated by my peer for my contribution during the activity
Scale
1
7
I felt that my opinion mattered while interacting with my peer.
Scale
0
7
I would like a chance to interact with my peer more often.
Scale
0
7


Open-ended Questions
Quiz
How did you perceive your ability to make choices during the activity?
Enter your answer
How did you perceive your level of competence in solving the case study?
Enter your answer
How did you perceive the importance of your opinion during the activity?
Enter your answer