How do medium naturalness, teaching-learning interactions and Students' personality traits affect participation in synchronous *E*-learning?

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ABSTRACT

This study explores students' participation in synchronous e-learning interactions to understand its nature and improve its effectiveness. An innovative synchronous videoconferencing technology was used to examine the assumptions of the Medium Naturalness Theory (Kock, 2005), which compares the characteristics of different media to face-to-face communication, having the highest degree of naturalness. The data was collected in two settings: (1) a controlled lab experiment (76 participants), in which teaching-learning interactions were compared across three communication channels (face-to-face, one-way and two-way synchronous lessons) and (2) synchronous lessons in real-life academic courses (87 participants). Four factors that play a major role in participation in online discussions were examined: medium naturalness, teaching-learning style, personality traits (extroversion-introversion and emotional stability-neuroticism), and the growing acquaintance between participants as the course progresses. The findings of Study 1 revealed passive learning behavior among the majority of participants, who tended not to interrupt the instructor's lecture, spontaneously ask questions, or initiate interactions. However, participation was much higher and more frequent when the instructor explicitly encouraged the students to participate, comment, and ask questions. As for the effect of personality traits, extroverts spoke more in almost all types of teaching-learning interactions; however, no effect was found for emotional stability-neuroticism. Consistent with the findings of the first study, the findings of Study 2 indicated that transferring the responsibility for learning from the instructor to the students, by allowing them to "lead" the lesson, promoted their participation and initiation of interactions. We discuss the implications for theory and design of synchronous interactions.

1. Introduction

In recent years, with the proliferation of communication technologies for learning in schools and higher education systems, synchronous and asynchronous online collaborative learning has become common in teaching and learning processes. Today, most academic courses include technological components that enable the incorporation of online collaborative learning and online discussion elements (Allen & Seaman, 2011; Banna, Lin, Stewart, & Fialkowski, 2015; Blau & Shamir-Inbal, 2017a, 2017b; Bondi, Daher, Holland, Smith, & Dam, 2016; Brenton, 2015; Dixson, 2012; Kauffman, 2015).

Research findings indicate that in the past, face-to-face learning was preferred and found more effective than online learning, mainly because of the limited teaching-learning interactions enabled by the

available technologies (Abrami, Bernard, Bures, Borokhovski, & Tamim, 2011; Brenton, 2015). An example of such limited communication includes the one-way interactions between instructor and students, in which students could see the instructor but the instructor could not see students, and students could not see each other (Weiser, Blau, & Eshet-Alkalai, 2016a).

In recent years, there is some indication that the availability of advanced technologies for synchronous online learning can bridge the gap between online learning and face-to-face learning processes (Abrami et al., 2011; Brenton, 2015; Redpath, 2012; Weiser, Blau, & Eshet-Alkalai, 2016b). However, since our knowledge regarding the effect of online learning technologies on the quality of learning processes and outcomes is still inconclusive (Redpath, 2012), it is important to reexamine the compatibility and modification of traditional

teaching-learning paradigms to online learning, using state-of-the-art videoconferencing technologies (Blau & Shamir-Inbal, 2017b).

Accordingly, the current study focuses on the effect of synchronous communication technologies, instructional design and participants' personality on students' participation in learning. In the research literature, students' participation is a major well-established component of effective learning in general, and of e-learning in particular. For example, students' participation in synchronous videoconferencing lessons was found to be a significant predictor of their grades on the final exam (Giesbers, Rienties, Tempelaar, & Gijselaers, 2013). Participation in a textual synchronous discussion was also found to be a significant predictor of elementary school students' grades in writing and reading (Zheng & Warschauer, 2015).

This study employs the Medium Naturalness Theory (Kock, 2005) as a theoretical framework. The theory examines the characteristics of communication channels and compares those characteristics to face-to-face communication, which is considered to have the highest degree of naturalness. The Medium Naturalness Theory describes five criteria for analyzing the degree of naturalness of a communication channel: (1) co-location in a common physical space, (2) a level of synchronicity that allows immediate and spontaneous response to stimuli, (3) the possibility of identifying and transmitting facial expressions, (4) the possibility of identifying and transmitting body language, and (5) the possibility of receiving and transmitting natural speech.

According to the Medium Naturalness Theory, a reduction in the degree of a given medium's naturalness may lead to a decline in learning effectiveness as a result of the increased cognitive load imposed on the learner, higher ambiguity of the conveyed message, and lower psychological arousal. On the other hand, a communication channel that has a higher degree of medium naturalness can encourage more effective communication, which might lead to better teaching-learning interactions. Hence, effective e-learning should aim to reach the highest degree of naturalness, as in face-to-face interactions (Blau, Weiser, & Eshet-Alkalai, 2017; Sun & Cheng, 2007). Research shows that communicating via media that support several input channels (e.g., simultaneous writing and speaking using textual chat and voice chat) is usually associated with higher cognitive load, higher ambiguity, and, consequently, decreased quality of learning processes and outcomes (Blau & Caspi, 2008, 2010; Kock, 2005). In contrast, other studies on synchronous discussions have not found a difference between online and face-to-face environments in students' level of participation (e.g., Setlock, Quinones, & Fussell, 2007).

In the present study Zoom videoconferencing technology was used to examine the basic assumptions of the Media Naturalness Theory regarding participation in synchronous lessons. Zoom (https://zoom.us/) is an innovative platform for two-way videoconferencing, which enables learners and instructors to conduct elaborate spontaneous (both visual and verbal) learning interactions (Weiser et al., 2016a). Fig. 1 compares face-to-face, two-way videoconferencing and one-way videoconferencing learning interactions, based on the criteria of the Medium Naturalness Theory. As the figure shows, these communication channels are only similar in synchronicity and the ability to convey natural speech - two of the five criteria for medium naturalness. The co-location criterion is only present in face-to-face communication, but not in synchronous e-learning. Regarding the criterion of facial expressions, both face-to-face and two-way videoconferencing convey all participants' facial expressions, whereas one-way videoconferencing only conveys the instructor's facial expressions. The body language criterion is fully expressed in face-to-face communication, while two-way videoconferencing only partially conveys the participants' body language, and one-way videoconferencing partially only conveys the instructor's body language (Blau et al., 2017). It is evident from Fig. 1 that communication via one-way videoconferencing enables students to be "invisible" to the instructor and to their peers, while face-to-face and two-way videoconferencing, both do not afford visual anonymity, and convey some non-verbal social communication cues.

In addition to the degree of medium naturalness, the following three factors play a pivotal role in determining the quality of the learning process: the teaching-learning style, student personality traits and the degree of acquaintance between learners. Regarding the teaching-learning style, the research literature suggests (e.g. Abrami et al., 2011; Banna et al., 2015; Bernard et al., 2009; Moore, 1989) that the quality of online learning depends on the quality of interactions that take place during the teaching-learning processes: (1) instructor-student interactions, (2) student-peer interactions and (3) student-content interactions. The present study does not focus on student-content interactions, but rather on the quality of the interactions between the instructor and students and among peers. In online learning, the sense of community created between participants during these interactions produces a positive effect on students (Abrami et al., 2011; Digmann, 2016). Following the comprehensive approach employed by Blau, Weiser, and Eshet-Alkalai (2016), in the present study, we categorized the analysis of the learning discourse to five teaching-learning interaction styles: (1) instructor's presentation - direct instruction and content explanations conducted by the instructor; (2) student as instructor - students explain content and share insights or present their learning outcomes/artifacts to the class; (3) instructor-student interaction - the instructor explicitly encourages students to participate by commenting and asking questions; (4) student-instructor interaction - students spontaneously make comments and ask the instructor questions; and (5) interaction among peers - students spontaneously interact with each other regarding the studied topic.

Research shows (e.g., Amichai-Hamburger et al., 2016; Blau & Barak, 2012) that in addition to medium naturalness characteristics and teaching-learning styles, learners' personality traits, as described in the Big Five Personality Traits Model (Costa & McCrae, 1992, 2008), play a pivotal role in determining the level of their participation in online discussions. The model consists of five personality traits: extroversion, neuroticism, conscientiousness, openness and agreeableness, among which extroversion-introversion and emotional stability-neuroticism were found to be the most relevant in the analysis of learners' behavior in online environments (Amichai-Hamburger & Ben-Artzi, 2003; Blau & Barak, 2012; Maldonado, Mora, Garcia, & Edipo, 2001; McKenna, Green, & Gleason, 2002; Weiser et al., 2016b). An extrovert is a friendly person who seeks company, desires excitement, takes risks, and acts on impulse, whereas an introvert is a quiet, reflective person who does not enjoy large social events, prefers his or her own company, and does not crave excitement (Eysenck & Eysenck, 1975). Studies have shown that extroverts feel a similar level of comfort in face-to-face and in online communication, whereas introverts feel more comfortable in online environments which allow lower exposure and reserved anonymity (Amichai-Hamburger et al., 2016; Amichai-Hamburger, Wainapel, & Fox, 2002; McKenna, Seidman, Buffardi, & Green, 2007). Under certain conditions, they may even adopt extroverts' behavior (Amichai-Hamburger, 2007). Neuroticism is a measure of emotional stability, which manifests at one extreme as anxiety, moodiness, and low self-esteem (Eysenck & Eysenck, 1975). Neurotic individuals tend to be lonely and to use websites that promote social interactions in order to avoid loneliness (Amichai-Hamburger & Ben-Artzi, 2003) and to feel a sense of community (Malone, Pillow, & Osman, 2012). They tend to avoid participation in online activities, but their participation may increase in situations in which they receive reassurance of their unique contribution to the community (Cullen & Morse, 2011).

1.1. Research goals

The current research explores four factors that were found in previous studies to play a major role in affecting the level of participation in synchronous online discussions: medium naturalness, teaching-learning style, personality traits and acquaintance between participants (Hew & Cheung, 2012; López-Pérez, Pérez-López, & Rodríguez-Ariza, 2011; Salmon, 2013). Unlike most previous studies, that focus on
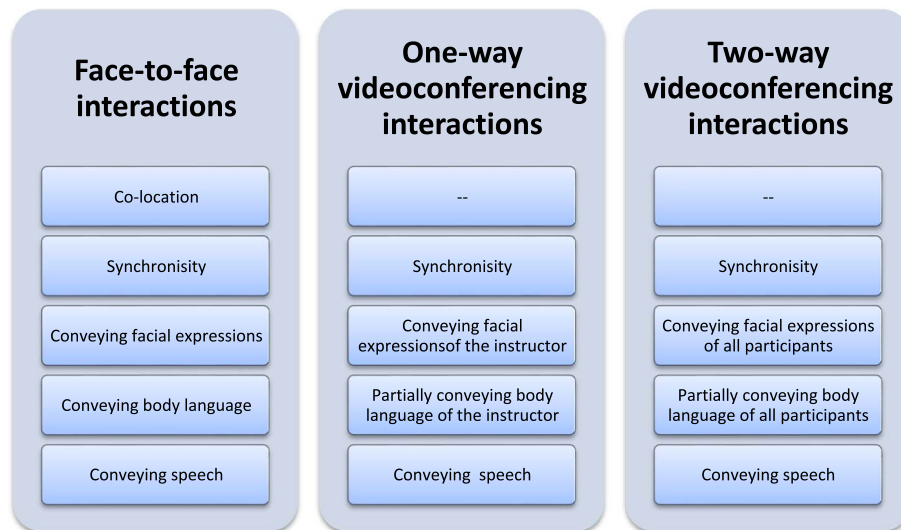
Fig. 1. Comparing face-to-face, one-way videoconferencing and two-way videoconferencing interactions in terms of the Medium Naturalness Theory (Kock, 2005).

participation in discussions in a non-learning setting or in asynchronous learning, this study examines the degree of active participation in the under-researched setting of synchronous e-learning. We compared between learning through three communication channels (i.e. face-to-face, one-way videoconferencing, and two-way videoconferencing), each of which employed a variety of teaching-learning styles (instructor's presentations, discourse between instructor and students, and between students and their peers).

This research explores the same phenomenon through two different studies: (1) a controlled lab experiment, in which teaching-learning interactions were compared across different communication channels, taking participants' personality traits into account, and (2) an analysis of authentic, 'real-life' teaching-learning interactions during synchronous lessons in academic courses. In Study 1, the interplay of technological affordances, participants' individual differences, and instructional design was explored, whereas the aim of Study 2 was twofold: Increase the ecological validity of the findings of Study 1, as well as reach a deeper understanding of the pedagogy appropriate for synchronous learning through videoconferencing.

2. Study 1 – participation in learning: a controlled lab experiment

2.1. Research questions and hypotheses

Study 1 is a controlled lab experiment that focuses on comparing students' participation in learning conducted through three different communication channels (face-to-face, one-way and two-way videoconferencing). The study explored the following research questions and hypotheses:

(1) How are the degree and frequency of students' participation in synchronous lessons affected by the naturalness of the communication channel (face-to-face, one-way and two-way videoconferencing) and by the teaching-learning style (instructor's presentation, discourse between instructor and students, and between students and their peers)?

Following the basic assumptions of Media Naturalness Theory (Kock, 2005), we hypothesized that students' participation levels would be higher in the communication channels which have a higher degree of naturalness, and that compared to the instructor's presentations, participation would be higher in instructor-student discourse and in peer discourse. We also hypothesized that teaching-learning styles would moderate the effect of medium naturalness, namely that discourse-based teaching-learning styles would increase the participation in online lessons, and thus blur the medium differences (the interaction effect).

(2) How are the degree and frequency of students' participation in synchronous discussions affected by **students' personality traits** (extroversion-introversion or emotional stability-neuroticism) and

teaching-learning style (instructor's presentation, discourse between instructor and students, and between the students and their peers)?

We hypothesized that extroverts and emotionally-stable students would participate more than introverts and neurotic students. Compared to the instructor's presentations, participation would be higher in instructor-student discourse and in peer discourse. We also hypothesized that teaching-learning styles would moderate the effect of the participants' personality traits, namely that discourse-based teaching-learning styles would increase the participation of introverts and neurotic students and thus blur the effect of personality traits (the interaction effect).

3. Method

3.1. Participants and context

Seventy six students, 44 of whom were women (57.9%), participated in a controlled lab experiment. The participants were randomly assigned to three experimental conditions, 24 in the face-to-face condition and 26 students in each of the online conditions (see details below). Participants' age was not normally distributed (Range: 18–58, Median: 29, Mean: 31.45, SD: 9.835, Skewness: 0.962). Participants were recruited from the research participants' repository of the lab and by publishing an announcement on the university's Facebook page. The sample was not limited to students studying education and psychology, who are required to participate in laboratory experiments for academic credit, but rather represented a wide range of university students from a variety of academic disciplines. Since language proficiency may influence participation in discussions, to ensure sample homogeneity, only native Hebrew language speakers or students living in Israel for at least 10 years and ranking themselves as highly proficient in Hebrew, were enrolled in the experiment. Each participant was awarded a participation fee of 200 NIS (equivalent to 50 US$).

During the lab-experiment, students participated in a short lesson (~25 min), which focused on the topic of "The charisma of politicians = Vision + Presentation". The lesson was delivered by an expert instructor, experienced in both face-to-face and synchronous teaching and unaware of the research hypotheses. Fig. 2 illustrates the lesson delivery in each of the experimental conditions.

The lesson contained two major pedagogical components: (1) presentation (direct instruction and content explanations conducted by the instructor) and (2) learning-related dialogue (by asking questions, making comments, and promoting discussions between the participants): instructor-student interactions, student-instructor communication, and interactions between the students themselves.
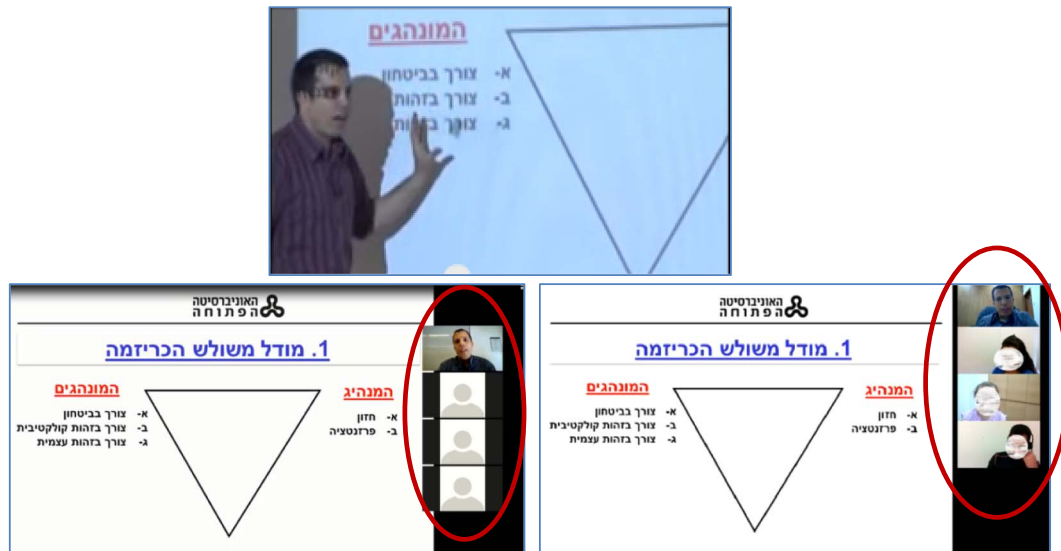
Fig. 2. Screenshots from the face-to-face, one-way videoconferencing (bottom left) and two-way videoconferencing (bottom right) lessons in the experiment.
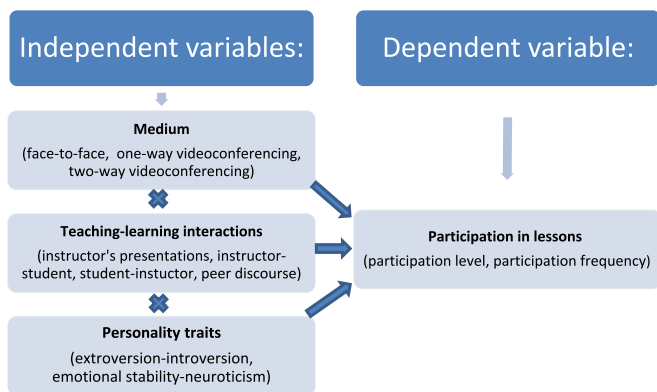

Fig. 3. The variables in Study 1.

3.2. Measurements

Dependent variables: *Students' participation* in the discussions was examined quantitatively, using two well-established measures of actual participation in spoken online/offline discussions in general and in learning in particular: degree of participation and frequency of participation (Blau & Barak, 2012; Blau & Caspi, 2010; Vetter & Chanier, 2006; Warschauer, 1996; Weiser et al., 2016a). Similar to previous studies referred to below, we calculated these measures in both absolute (actual number, e.g., number of words per participant) and relative terms (percentage, e.g., number of words per participant out of the number of words per lesson). Since the result of both calculations was very similar, we chose to only report the absolute values that present the data in a more intuitive way than the relative ones. (1) The degree of participation was calculated by summing up the number of words said by each participant during the lesson (Blau & Barak, 2012; Vetter & Chanier, 2006; Warschauer, 1996). The degree of participation was skewed left (Range; 0–437, Median: 83, Mean: 102.57, SD: 83.479, Skewness: 1.67). (2) The frequency of participation was calculated by summing up the number of verbal turn-takings taken by each participant (Blau & Barak, 2012; Vetter & Chanier, 2006; Warschauer, 1996). The term "verbal turn-taking" refers to a speech unit of a person until someone else starts speaking. This variable counts speech units regardless of their length. The variable was normally distributed (Range: 0–39, Median: 14, Mean: 14.96, SD: 7.937, Skewness: 0.69). The words spoken by the instructor were excluded from both measures of

participation. Contrary to the common practice in research, the students' participation level was not measured for the entire lesson in the current study, but rather, separately for each teaching-learning interaction type.

Independent variables: Four types of teaching and learning interactions were measured in the lessons: (1) Presentation – direct instruction and content explanations conducted by the instructor. (2) Instructor-initiated instructor-student interaction - the instructor encourages students to participate, express their ideas and opinions, make comments and ask for clarifications. (3) Student-initiated student-instructor interaction – students spontaneously make comments and ask the instructor questions and (4) interaction among peers - students interact between themselves regarding the learning content. Fig. 3 shows the variables in Study 1.

An online self-report questionnaire, which measured participants' demographics and personality traits, was administrated before each lesson. *Two personality traits* were measured by a short Hebrew version of the NEO-PI-R questionnaire (Blau & Barak, 2012), based on the Big Five model (Costa Jr. & McCrae, 1992): extroversion-introversion, e.g., "I see myself as someone who is outgoing and sociable" and emotional stability-neuroticism, e.g., "I see myself as someone who gets nervous easily". The Hebrew version of the inventory, which was used in this study, shows good parameters of validity and reliability (e.g., Blau, 2010). It is based on the recently revised version of the NEO-PI-R questionnaire instrument that takes into consideration the efforts invested in improving the psychometric quality of the inventory (Costa & McCrae, 2008; McCrae & Costa, 2004).

The index for *extroversion-introversion* was calculated as an average of the answers to 12 items (scale 1–6); internal consistency: Cronbach's $\alpha = 0.82$ (Range: 2.17–5.50, Median: 4.41, Mean: 4.30, SD: 0.627, Skewness: -0.79). For the purpose of statistical analysis, the participants' dominant personality trait was categorized according to the median of each personality variable. For the extroversion–introversion trait, participants with the median score and below were categorized as introverts. Accordingly, 51.3% of the participants were categorized as extroverts, and 48.7% as introverts.

The index for *emotional stability-neuroticism* was also calculated as an average of the answers to 12 items (scale 1–6); internal consistency: Cronbach's $\alpha = 0.74$ (Range: 1.25–4.58, Median: 3.00, Mean: 3.00, SD: 0.675, Skewness: -0.04). For this trait, participants with the median score and above were categorized as emotionally stable. Accordingly, 47.4% of the participants were categorized as emotionally stable and 52.6% as neurotic.

Table 1

Participation level and frequency by communication channel and teaching-learning style: Descriptive statistics.

Teaching-learning style	Medium naturalness	N	Number of words		Number of turn-takings	
			M	SD	M	SD
Presentation by instructor	Face-to-face	24	1.46	4.15	0.42	0.83
	Audio	26	0.12	0.43	0.12	0.43
	Video	26	1.69	5.93	0.19	0.40
	Total	76	1.08	4.19	0.24	0.59
Instructor-Student interactions	Face-to-face	24	101.17	77.37	14.75	7.50
	Audio	26	93.89	91.01	14.42	7.10
	Video	26	91.85	57.19	13.23	6.52
	Total	76	95.49	75.52	14.12	6.98
Student-Instructor interactions	Face-to-face	24	4.29	11.63	0.46	1.10
	Audio	26	2.19	7.68	0.31	1.19
	Video	26	0.00	0.00	0.00	0.00
	Total	76	2.11	8.02	0.25	0.94
Student-Student interactions	Face-to-face	24	6.38	12.72	0.75	1.33
	Audio	26	3.19	10.21	0.23	0.59
	Video	26	2.31	10.59	0.12	0.33
	Total	76	3.90	11.17	0.36	0.87

3.3. Procedure

Each participant was randomly assigned to one of three *experimental conditions*: (1) A traditional face-to-face lesson, which was held in a classroom (face-to-face condition, *n* = 24), (2) A two-way video conferencing lesson ("video" condition, *n* = 26), in which both the instructor and the students communicated (video and voice) via *Zoom* video conferencing technology, and (3) A one-way videoconferencing lesson ("audio" condition, n = 26), in which the instructor used *Zoom* to communicate with the students through video and voice, whereas the students could communicate only by voice. The online conditions employed spontaneous voice communication and did not use a textual chat.

The experiment was conducted in the Education and Psychology lab of the Open University of Israel (OUI). Participants were assigned to gender-balanced lessons in groups of 7; however, due to a few non-attendances, the actual size of each group was 5–7 students. After completing the online questionnaire administrated through the Google Forms app, the students participated in the lesson according to the experimental condition which they were assigned to.

All lessons were video-taped, transcribed and then analyzed. The teaching-learning interactions were coded by a research assistant unaware of the research hypotheses. For inter-rater reliability, all transcripts were independently reviewed by a second judge and 25% of the transcripts were reviewed by a third judge. This was followed by a discussion that was held among the judges and a full consensus was reached regarding the attribution of each section in the lesson to a particular teaching-learning style.

4. Results

4.1. The impact of medium and teaching-learning styles on participation

In order to examine the effect of medium naturalness and teaching-learning styles on participation, a series of repeated measures ANOVA tests were conducted with medium naturalness as a between-subjects variable and the teaching-learning style as a within-subjects variable. Tables 1 and 2 present means and standard deviations and an analysis of variance for the two measures of participation: participation level (number of words per participant) and participation frequency (number of turn-takings per participant).

Examination of the students' **participation level** revealed a significant and very large main effect ($_p\eta^2$ = 0.61) for teaching-learning style. Post-hoc LSD tests revealed that more words were spoken by the participants during instructor-student interactions (M = 95.49)

Table 2

Participation level and frequency by communication channel and teaching-learning style: Analysis of variance.

Factor	Analysis of variance
Participation level	
Teaching-learning style	$F(3,72) = 115.85, p = .000, _p\eta^2 = .61$
Medium naturalness	$F(2,73) = .30, p = .75, _p\eta^2 = .01$
Interaction effect: teaching-learning style * medium naturalness	$F(3,72) = .07, p = 1.00, _p\eta^2 = .00$
Participation frequency	
Teaching-learning style	$F(3,72) = 306.30, p = .000, _p\eta^2 = .81$
Medium naturalness	$F(2,73) = .80, p = .46, _p\eta^2 = .02$
Interaction effect: teaching-learning style * medium naturalness	$F(3,72) = .24, p = .96, _p\eta^2 = .01$

compared to the three other teaching-learning styles (instructor's presentations M = 1.08, student-instructor interactions M = 2.11 and student-student interactions M = 3.90, *p's* = 0.000). The participation level during student-student interactions was found to be significantly higher than during the instructor's presentations (*p* = 0.038). No significant effects were found for medium naturalness and for the interaction effect. However, it should be noted that in contrast to the face-to-face and audio conditions, in the video condition, no interactions with the instructor were initiated by the students.

Similarly, the teaching-learning style was also found to have a significant and even larger main effect ($_p\eta^2$ = 0.81) on **participation frequency** than on participation level. Post-hoc LSD tests showed that, compared to the other three teaching-learning styles, participation frequency was higher when participants were explicitly encouraged by the instructor to ask questions (M = 14.12 for instructor-student interactions vs. M = 0.24 for the instructor's presentations, M = 0.25 for student-instructor interactions and M = 0.36 for interactions among peers, *p's* = 0.000). No significant effects were found for medium naturalness and for the interaction effect.

4.2. The impact of personality traits and teaching-learning styles on participation

In order to examine the effect of personality traits (extroversion-introversion or emotional stability-neuroticism) and teaching-learning styles on students' participation level and frequency, a series of

Table 3
Participation level and frequency by extroversion level and teaching-learning style: Descriptive statistics.

Teaching-learning style	Extroversion-introversion	N	Number of words		Number of turn-takings	
			M	SD	M	SD
Presentation by instructor	Introverts	37	1.70	5.78	0.24	0.60
	Extroverts	39	0.49	1.50	0.23	0.58
	Total	76	1.08	4.19	0.24	0.59
Instructor-student interactions	Introverts	37	80.43	60.71	12.51	7.06
	Extroverts	39	109.77	85.64	15.64	6.63
	Total	76	95.49	75.52	14.12	6.98
Student-instructor interactions	Introverts	37	1.22	5.32	0.08	0.36
	Extroverts	39	2.95	9.93	0.41	1.25
	Total	76	2.11	8.02	0.25	0.94
Student-student interactions	Introverts	37	2.43	7.30	0.38	1.01
	Extroverts	39	5.28	13.85	0.33	0.74
	Total	76	3.90	11.17	0.36	0.87

Table 4
Participation level and frequency by extroversion and teaching-learning style: Analysis of variance.

Factor	Analysis of variance
Participation level	
Teaching-learning style	$F(3,72) = 120.53$, $p = .000$, $_p\eta^2 = .62$
Extroversion-introversion	$F(1,74) = 2.99$, $p = .09$, $_p\eta^2 = .04$
Interaction effect: teaching-learning style * Extroversion-introversion	$F(3,72) = 2.83$, $p = .04$, $_p\eta^2 = .04$
Participation frequency	
Teaching-learning style	$F(3,72) = 322.92$, $p = .000$, $_p\eta^2 = .81$
Extroversion-introversion	$F(1,74) = 3.60$, $p = .06$, $_p\eta^2 = .05$
Interaction effect: teaching-learning style * Extroversion-introversion	$F(3,72) = 3.96$, $p = .01$, $_p\eta^2 = .05$

repeated measures ANOVA tests were conducted with personality traits as a between-subjects variable and teaching-learning style as a within-subjects variable.

4.3. Extroversion-introversion

Tables 3 and 4 present means and standard deviations and an analysis of variance for participation level and frequency, according to teaching-learning style and extroversion level.

The examination of **participation level** revealed a significant and very large main effect ($_p\eta^2 = 0.62$) for teaching-learning style. LSD post-hoc tests indicated that students' participation level was significantly higher during instructor-student interactions (M = 95.49) compared to the three other styles (M = 1.08 in presentations by the instructor, M = 2.11 in student-instructor interactions and M = 3.90 in peer interactions, $p's = 0.000$). Students' participation levels during student-student interactions were significantly higher than during the instructor's presentations ($p = 0.043$). A marginally significant main effect with a moderate effect size ($p = 0.09$, $_p\eta^2 = 0.04$) was found for the participation of extroverts compared to introverts. A significant interaction effect between the teaching-learning style and the level of extroversion-introversion was found. Introverts had lower participation levels than extroverts in all teaching-learning styles, except during the instructor's presentations, in which introverts' participation level was higher than extroverts' (for introverts and extroverts respectively, M = 1.70 vs. M = 0.49 during the instructor's presentations, M = 80.43 vs. M = 109.77 during instructor-student interactions, M = 1.22 vs. M = 2.95 during student-instructor communication, and M = 2.43 vs. M = 5.28 during student-student interactions).

The teaching learning style was also found to have a statistically significant and even larger main effect ($_p\eta^2 = 0.81$) on students' **participation frequency** than on participation level. LSD post-hoc tests revealed that, compared to the three other styles, participation frequency was significantly higher during instructor-student interactions (M = 14.12 vs. M = 0.24 in the instructor's presentations, M = 0.25 in student-instructor interactions and M = 0.36 in student-student interactions, $p's = 0.000$). Regarding the impact of personality on participation, a marginally significant main effect with a moderate effect size ($p = 0.06$, $_p\eta^2 = 0.05$) was found for the extroverts' participation in comparison with introverts. A significant interaction effect between the teaching-learning style and the extroversion-introversion level was found. Introverts participated less frequently during the instructor-student interactions and during the student-instructor interactions (for introverts and extroverts respectively M = 12.51 vs. 15.64 in instructor-student, and M = 0.08 vs. M = 0.41 in student-instructor interactions), whereas in the other two teaching-learning styles, no significant differences were found between extroverts and introverts.

4.4. Emotional stability-neuroticism

Means and standard deviations, as well as an analysis of variance of participation level and frequency according to teaching-learning style and the level of emotional stability-neuroticism are presented in Tables 5 and 6.

Findings related to students' **participation level** revealed a significant and very large main effect ($_p\eta^2 = 0.61$) for teaching-learning style. LSD post-hoc tests indicated that compared to the other three styles, the students' participation level was significantly higher during the instructor-student interactions (M = 95.49 vs. M = 1.08 in the instructor's presentations, M = 2.11 in student-instructor interactions and M = 3.90 in student-student communication, $p's = 0.000$). The participation level during peer interactions was significantly higher than during the instructor's presentations ($p = 0.047$). No significant effects were found for the emotional stability-neuroticism trait or for the interaction between teaching-learning style and emotional stability-neuroticism.

Teaching-learning style was found to have a significant and even larger main effect ($_p\eta^2 = 0.81$) on the **frequency of students' participation** than on the level of participation in the lessons. LSD post-hoc tests revealed that compared to the other three styles, participation frequency was significantly higher when the instructor actively encouraged communication (M = 14.12 for instructor-student interactions vs. M = 0.24 in presentations by the instructor, M = 0.25 in student-instructor interactions and M = 0.36 in communication among peers, $p's = 0.000$). No significant effects were found for emotional stability-neuroticism, while the interaction effect was marginally significant with a moderate effect size ($p = 0.08$, $_p\eta^2 = 0.03$).

Table 5

Student participation level according to emotional stability-neuroticism level and teaching-learning style: Descriptive statistics.

Teaching-learning style	Emotional stability-neuroticism	n	Number of words		Number of turn-takings	
			M	SD	M	SD
Presentation by instructor	Stable	36	0.56	1.68	0.19	0.52
	Neurotics	40	1.55	5.55	0.28	0.64
	Total	76	1.08	4.19	0.24	0.59
Instructor-student interactions	Stable	36	99.22	76.25	15.25	6.91
	Neurotics	40	92.13	75.67	13.10	6.97
	Total	76	95.49	75.52	14.12	6.98
Student-instructor interactions	Stable	36	2.83	10.28	0.33	1.22
	Neurotics	40	1.45	5.28	0.18	0.59
	Total	76	2.11	8.02	0.25	0.94
Student-student interactions	Stable	36	1.56	5.84	0.19	0.52
	Neurotics	40	6.00	14.13	0.50	1.09
	Total	76	3.90	11.17	0.36	0.87

Table 6

Participation level and frequency by emotional stability-neuroticism and teaching-learning style: Analysis of variance.

Factor	Analysis of variance
Participation level	
Teaching-learning style	$F(3,72) = 117.84$, $p = .000$, $_p\eta^2 = .61$
Emotional stability-neuroticism	$F(1,74) = .03$, $p = .88$, $_p\eta^2 = .00$
Interaction effect: teaching-learning style * Emotional stability-neuroticism	$F(3,72) = .32$, $p = .81$, $_p\eta^2 = .00$
Participation frequency	
Teaching-learning style	$)F(3,72) = 319.10$, $p = .000$, $_p\eta^2 = .81$
Emotional stability-neuroticism	$F(1,74) = 1.11$, $p = .30$, $_p\eta^2 = .02$
Interaction effect: teaching-learning style * Emotional stability-neuroticism	$F(3,72) = 2.61$, $p = .08$, $_p\eta^2 = .03$

Emotionally-stable students more frequently interacted with the instructor compared to neurotic participants, while neurotic students more frequently interacted with their peers in comparison with emotionally-stable participants.

5. Study 2 – analysis of students' participation in academic courses

5.1. Research questions and hypotheses

In order to validate the findings of Study 1 (the controlled lab experiment) in a real-life setting, in Study 2, we analyzed authentic learning interactions and students' participation in lectures given during academic courses. The following research questions were explored:

(3) How are the level and frequency of students' participation in synchronous discussions affected by the teaching-learning styles (the instructor's presentations, students' presentations, discourse between the instructor and students, and among students themselves)?

(4) How are the level and frequency of students' participation in synchronous discussions affected by teaching-learning styles (the instructor's presentations, students' presentations, discourse between the students and their peers) and the acquaintance between participants as the course progresses?

We hypothesized that, compared to participation during the instructor's presentations, the participation level would be higher during instructor-students interactions and during the discourse between the students and their peers, and that the acquaintance between the participants, which results from being a part of the course's learning community, would moderate this effect - the greater the acquaintance,

the higher the participation would be. However, we hypothesized that the dialogical teaching-learning style (i.e., instructor-students communication and peer dialogue) would blur the positive impact of acquaintance between the students on participation (the interaction effect).

6. Method

6.1. Participants and context

Eighty seven students, 71 of whom were women (81.6%), attended 6 synchronous lessons conducted by the same instructor. The lessons were part of two online graduate courses in Education at the OUI (three synchronous lessons for each course).

Both courses adopted a blended learning model and in addition to the online lessons, each of them included additional three face-to-face lessons that were not analyzed in this study. The length of each lesson (synchronous or face-to-face) was identical (2 h). Participation in both types of lessons was optional and not all students attended all of them. Since we explored participation in synchronous learning during the semester, only participants who attended all synchronous lessons were included in the analysis - 60 out of 87 students.

The lessons included teaching-learning style components of presentation and interaction between participants (instructor and students). Unlike in Study 1 (lab experiment), in Study 2, the researchers did not plan the lessons' management and did not interfere with the interactions between the instructor and the students. As in Study 1, the online lessons were conducted using *Zoom* technology for videoconferencing. Although the instructor encouraged student participation through two-way videoconferencing, students could choose to participate in the learning process solely through the audio communication channel.

6.2. Measurements and procedure

Participation in the discussions was examined quantitatively, using the same two measures as in Study 1 – participation level and frequency (See Appendix A for a summary of the procedure and measures of both studies). The level of participation was skewed left (Range: 1–1404, Medium: 290, Mean: 366.57, SD: 304.58, Skewness: 1.20), whereas the frequency of participation was normally distributed (Range: 1–45, Medium: 11.50, Mean: 12.88, SD: 8.93, Skewness: 0.89).

The lessons were video-recorded, transcribed and coded similarly to Study 1. According to the interaction patterns observed in the lessons, five **types of teaching-learning interactions** were defined. Four of them (the instructor's presentations and instructor-students, student-instructor, and peers interactions) were identical to the teaching-learning interactions that were observed in Study 1. The fifth style -
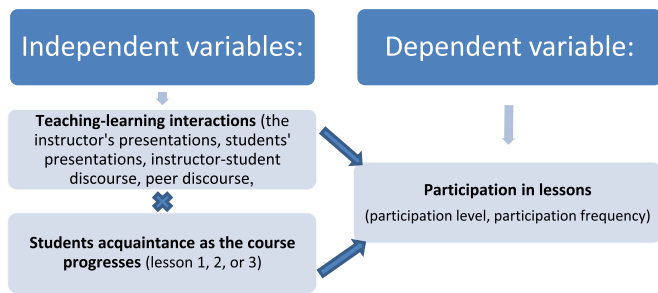
Fig. 4. The variables of Study 2.

"*student as instructor*" – in which students explain or present a particular topic or a learning outcome to their peers - was only observed in Study 2. It was observed during the second and third synchronous lessons, in which participants were required to present an online assignment to their peers.

The acquaintance between students was defined according to the number of synchronous lessons (out of three) which the students had attended,. The assumption is that as a result of continuous participation during lessons, teamwork and interactions in the course community, acquaintance between students grows as the semester progresses. We measured this within-subject variable as average students' participation in the first, second, and third online lessons of the semester. Fig. 4 summarizes the variables in Study 2.

6.3. Results

6.3.1. The impact of teaching-learning interactions on participation

In order to examine the effect of teaching-learning styles on the level and frequency of students' participation, a series of repeated measures ANOVA tests were conducted with teaching-learning style as a within-subjects variable. Means and standard deviations, as well as analyses of variance of the participation measures, are presented in Table 7.

The examination of students' **participation level** in the academic courses revealed a significant large main effect ($_p\eta^2 = 0.27$) for the teaching-learning style. LSD post-hoc tests revealed significant differences between the three teaching-learning styles, according to the following ascending order: the instructor's presentations M = 0.55, student-student interaction M = 12.53 and student-instructor interactions M = 35.02, for all differences $p's = 0.000$. In addition, significant differences were found between these three teaching-learning styles and the two other styles: instructor-student interactions M = 147.25, $p's = 0.000$, which explicitly encourage participation, and students' presentations M = 171.28, without significant difference between them ($p = 0.54$).

The teaching-learning style was found to have a statistically

significant main effect, with an even larger effect size ($_p\eta^2 = 0.37$) on **participation frequency** than on participation level. LSD post-hoc tests showed a significant difference between two teaching-learning styles with low participation frequency on the one hand (the instructor's presentations M = 0.05 and student-student interaction M = 0.87, $p's = 0.000$) and two teaching-learning styles with medium participation frequency on the other hand (students' presentations M = 2.23, student-instructor interactions M = 2.40, $p's = 0.79$). Significant differences were also found between those four styles compared to the fifth style, instructor-student interactions, during which participation frequency was the highest (M = 7.33, $p's$ for all differences = 0.000).

6.3.2. The impact of teaching-learning styles and acquaintance between participants on students' participation

In order to examine the effect of teaching-learning styles and acquaintance growth as the course progresses on participation level and frequency, a series of repeated measures ANOVA tests were conducted with acquaintance between the students (the number of the synchronous lesson in each course) as the between-subjects variable and the teaching-learning style as the within-subjects variable. Means and standard deviations, as well as an analysis of variance of participation level and frequency, are presented in Tables 8 and 9.

A large and significant main effect ($_p\eta^2 = 0.30$) was found for the teaching-learning style on the students' **participation level**. According to LSD post-hoc tests, no differences were found between the two styles that involve a high level of students' participation (i.e., students' presentations M = 171.28 and instructor-student interactions M = 147.25, $p's = 0.000$, without a significant difference between them, $p = 0.53$). However, compared to these teaching-learning styles which explicitly encourage students' participation, the participation level was found to be significantly lower in the context of teaching-learning styles which did not explicitly encourage comments and questions. Participation level was found in the following descending order: student-instructor interactions M = 35.02, student-student interactions M = 12.53 and the instructor's presentations M = 0.55, for all differences $p's < 0.05$. A significant large main effect ($_p\eta^2 = 0.16$) on students' participation was also found for the growing acquaintance level between students as the course progressed. A smaller number of words was spoken by the participants during the first synchronous lesson (M = 39.88, $p's < 0.03$ for all differences) compared to the other two lessons (second lesson M = 101.77, third lesson M = 79.66, $p's > 0.22$). A significant and large interaction effect ($_p\eta^2 = 0.17$) between the teaching-learning style and the acquaintance level was found. The students' average participation level in all three lessons was similar during the instructor's presentations (M = 1.68, 0.00 and 0.04). However, for the other teaching-learning styles, there were differences in the participation level during the three lessons: A decline in the participation level was found during instructor-student interactions (M = 179.16, 141.41 and 126.13). During students' presentations and

Table 7
Participation level and frequency by teaching-learning styles.

Descriptive statistics for the teaching-learning style	Number of words		Number of turn-takings	
	M	SD	M	SD
Presentations by instructor	.55	2.95	.05	.22
Presentations by students	171.28	261.69	2.23	3.17
Instructor-student interactions	147.25	127.34	7.33	6.76
Student-instructor interactions	35.02	68.42	2.40	3.55
Student-student interactions	12.53	33.54	.87	1.53

Dependent variable	Analysis of variance
Participation level	F(4,55) = 21.28, p = .000, pη2 = .27
Participation frequency	F(4,55) = 35.13, p = .000, pη2 = .37

Table 8
Participation level and frequency for teaching-learning styles and acquaintance between the students: Descriptive statistics.

Teaching-learning style	Lesson N	n	Number of words		Number of turn-takings	
			M	SD	M	SD
Presentation by instructor	Lesson 1	19	1.68	5.14	0.11	0.32
	Lesson 2	17	0.00	0.00	0.00	0.00
	Lesson 3	24	0.04	0.20	0.04	0.20
	Total	60	0.55	2.95	0.05	0.22
Presentation by student	Lesson 1	19	0.00	0.00	0.00	0.00
	Lesson 2	17	290.59	324.06	2.71	3.04
	Lesson 3	24	222.38	255.21	3.67	3.60
	Total	60	171.28	261.69	2.23	3.17
Instructor-student interactions	Lesson 1	19	179.16	116.56	11.68	9.07
	Lesson 2	17	141.41	144.14	6.18	5.23
	Lesson 3	24	126.13	123.19	4.71	3.16
	Total	60	147.25	127.34	7.33	6.76
Student-instructor interactions	Lesson 1	19	14.37	27.30	1.58	2.80
	Lesson 2	17	44.35	92.49	1.59	1.91
	Lesson 3	24	44.75	70.42	3.63	4.59
	Total	60	35.02	68.42	2.40	3.55
Student-student interactions	Lesson 1	19	4.21	7.28	0.58	1.12
	Lesson 2	17	32.47	57.65	1.29	2.05
	Lesson 3	24	5.00	11.00	0.79	1.38
	Total	60	12.53	33.54	0.87	1.53

Table 9
Participation level and frequency by teaching-learning style and acquaintance between the students: Analysis of variance.

Factor	Analysis of variance
Participation level	
Teaching-learning style	$F_{(4,55)} = 24.41$, $p = .000$, $_p\eta^2 = .30$
Acquaintance between the students	$F_{(2,57)} = 5.60$, $p = .01$, $_p\eta^2 = .16$
Interaction effect: teaching-learning style * Acquaintance between the students	$F_{(4,55)} = 5.96$, $p = .00$, $_p\eta^2 = .17$
Participation frequency	
Teaching-learning style	$F_{(4,55)} = 45.92$, $p = .00$, $_p\eta^2 = .45$
Acquaintance between the students	$F_{(2,57)} = 0.26$, $p = .77$, $_p\eta^2 = .01$
Interaction effect: teaching-learning style * Acquaintance between the students	$F_{(4,55)} = 8.64$, $p = .00$, $_p\eta^2 = .23$

discussions between peers, participation level was higher in the second, compared to the first lesson, followed by a reduction in participation in the third lesson (students' presentations M = 0.00, 290.59 and 222.38, student-student interaction M = 4.21, 32.47 and 5.00). A similar pattern was found in the student-instructor interactions: Compared to the first lesson, the participation level was higher in both the second and third lessons (student-instructor interactions M = 14.37, 44.35 and 44.75).

The teaching-learning style was found to have an even larger significant main effect ($_p\eta^2 = 0.45$) on students' **participation frequency** than on participation level during the lessons. LSD post-hoc tests revealed that compared to the other four styles, participation frequency was the highest during instructor-student interactions (M = 7.33, $p's = 0.000$). A similar frequency of participation was found between student's presentations M = 2.23 and student-instructor interactions M = 2.40, $p's > 0.83$. The frequency was low for student-student interaction M = 0.87, and even lower for the instructor's presentations M = 0.05.

The main effect of the acquaintance between participants was not statistically significant. A significant and large interaction effect ($_p\eta^2 = 0.23$) was found between the teaching-learning style and the acquaintance between participants. Participation frequency was low in all three lessons during the instructor's presentations (M = 0.11, 0.00 and 0.04), but differences were found for the other four styles. As the courses progressed, the participation frequency increased during students' presentations (M = 0.11, 2.71 and 3.67) and decreased during instructor-student interactions (M = 11.68, 6.18 and 4.71). Participation frequency was the highest in the third lesson, during student-instructor interactions (M = 1.58, 1.59 and 3.63) and in the second lesson, during student-student interactions (M = 0.58, 1.29 and 0.79).

7. Discussion

This study examined students' participation in synchronous learning as a function of pedagogy, characteristics of the communication medium and participants' personality traits. Based on Media Naturalness Theory (Kock, 2005), a laboratory experiment comparing participation in lessons through three different communication channels (i.e. face-to-face, one-way and two-way synchronous communication) was conducted in Study 1. Findings of Study 1 were corroborated in Study 2, in an authentic educational setting. Beyond validating the findings from study 1, while relating to the same phenomenon, Study 2 reaches a deeper understanding of the pedagogy appropriate for synchronous learning through videoconferencing. Findings of the two studies are discussed in the following sub-sections.

7.1. Study 1 - the impact of teaching-learning interactions and communication medium on students' participation

Findings from Study 1 showed that the type of teaching-learning interaction significantly influenced students' participation and that this effect was far beyond the impact of medium naturalness and personality. In general, participants were passive and tended not to interrupt the instructor's lecture, spontaneously ask questions, or talk to each other. However, participation was found to be much higher and frequent when the instructor explicitly encouraged the students to participate, comment and ask questions. These findings emphasize the pivotal role of the instructor in promoting students' active participation in the learning process. This is exemplified in the finding that none of the participants initiated learning interactions with the instructor in the two-way videoconferencing condition, whereas such interactions were found in the other two conditions. We argue that this reflects both the high cognitive load involved in learning with rich media (Robert & Dennis, 2005), as well as the sense of insecurity associated with the

experience of learning via the innovative videoconferencing technology employed in this study (Blau et al., 2017). Support for this argument can be found in our finding that in the authentic educational setting and the significantly longer videoconferencing lessons in Study 2, students also refrained from initiating interactions with the instructor. These findings reinforce reports in the literature, concerning the major components involved in promoting students' participation in synchronous online discussions: proactive teachers' behavior (McBrien, Cheng, & Jones, 2009), employing instructional strategies that encourage interaction (Abrami et al., 2011; Blau & Caspi, 2010; Chen et al., 2015) and discussion (Dixson, 2012), as well as providing students with constant constructive feedback (Banna et al., 2015). According to Schneider (2015), employing these strategies helps students overcome their aversion to exposing their ignorance in a discussion – a pivotal factor that hinders students' participation in learning interactions, and especially in synchronous ones.

In addition, the results support previous research that did not find differences between the level of verbal participation in synchronous and face-to-face communication (Setlock et al., 2007). This is in contrast with Livny and Yair (2014), according to which, the interactions in face-to-face lessons are richer and include more explorative learning practices and students' input, whereas the online lessons are based on the lecturer's monologue to a greater degree. We explain the contradiction between these findings by arguing that employing similar pedagogical components in all learning conditions in a rigorous lab experiment in Study 1 enabled a comparison of learning through different media and helped identify participation patterns which were unique to learning in each communication channel.

7.2. The impact of personality traits and teaching-learning interactions on participation

Personality traits affect learners' studying behaviors, communication with the instructor and peers, as well as their preferences regarding the learning content (Tlili, Essalmi, Jemni, & Chen, 2016). The two personality traits investigated in our research (extroversion-introversion and emotional stability-neuroticism) were reported in a previous study (Vasileva-Stojanovska, Malinovski, Vasileva, Jovevski, & Trajkovik, 2015) as extremely important in assessing academic performance and accounted for up to 43.6% of the variance among K-12 students. Our approach for measuring participation, by actually counting the amount of words spoken by *each* (Blau & Barak, 2012; Vetter & Chanier, 2006; Warschauer, 1996; Weiser et al., 2016a, 2016b), enabled us to reach a high-resolution of understanding regarding the impact of personality traits (extroversion-introversion and emotional stability-neuroticism) on participation in different synchronous communication conditions.

In relation to the effect of **the extroversion-introversion** personality trait on *participation level*, we found that extroverts spoke more in almost all types of teaching-learning interactions. This finding is in accordance with our second hypothesis and with previous studies, which examined synchronous participation in audio and in textual chat (Blau & Barak, 2012), in unguided synchronous discussions (Blau, 2010) and in face-to-face discussions (Schneider, 2015). The exception in our study was during instructor's presentations, in which introverts' participation level was higher, plausibly because they focused more on the content presented by the instructor, as opposed to extroverts, who were more likely to be invested to a greater degree in directing their attention to social activities (Blau & Barak, 2009).

However, in our study, the analysis of the *participation frequency* revealed a slightly different pattern than the analysis of the participation level. Extroverts' participation frequency was higher than the introverts' during interactions that involved communication with the instructor (instructor-student and student-instructor interactions), but no difference was found between extroverts and introverts in the two other interaction types. We argue that this finding reflects extroverts'

tendency to take risks and to be in the spotlight (Eysenck & Eysenck, 1975). The differences between the participation level and participation frequency highlight the importance of examining these two measures separately, since they seem to reflect different aspects of participation.

In contrast with our second research hypothesis, no main effect was found for **emotional stability-neuroticism** on the *participation level* or *frequency*. It is possible that this trait has no effect on participation in synchronous discussions. Another possibility is that, similarly to Blau's study (2010), which explored non-facilitated online discussions in small groups, neurotic participants in the present study may not have felt pressure in small-group communication. Therefore, the impact of neuroticism may not have been evident in their e-learning behavior. An interaction effect between the emotional stability-neuroticism and teaching-learning style was found for the participation frequency when communicating with the instructor (instructor-student and student-instructor). Emotionally-stable students participated more frequently compared to the neurotic students in those two interaction types, while the opposite results were found in student-student interactions: neurotic students had a higher participation frequency than emotionally-stable students. The finding that neurotic participants did not feel comfortable in asking questions and interacting with the instructor is explained by their fear of interpersonal communication (Eysenck & Eysenck, 1975), especially with a person representing an authority – the instructor that was supposedly evaluating them. However, they did feel more comfortable in peer interactions that contain lower degree of evaluation.

7.3. Study 2 - teaching-learning interactions and participation

Our third research hypothesis was that, compared to students' participation during the instructor's presentations, the participation level would be higher during instructor-student interactions and during peer discourse. Consistent with this hypothesis and with the findings of Study 1, Study 2 exemplified the pivotal role of employing teaching-learning strategies for promoting participation. In the study, the teaching-learning interactions in two online courses were analyzed. In these courses, strategies recommended in the literature for effectively engaging students to participate in online synchronous learning (Abrami et al., 2011; Amichai-Hamburger et al., 2016; Banna et al., 2015; Blau & Caspi, 2010; Brenton, 2015; Chen et al., 2015; McBrien et al., 2009; Salmon, 2013; Schneider, 2015) were adopted. Findings revealed significant differences between the types of teaching-learning interactions, especially between those that encourage participation (instructor-student interaction and students' presentations) and the teaching-learning interactions that do not explicitly encourage participation (the instructor's presentations, student-instructor and student-student interactions). In Study 2, a fifth teaching-learning style, i.e. "students' presentations", was observed. Participation of the "audience" in this teaching-learning style was found to be very high. A similar very high level of participation was found in the "instructor-student" interactions, in which the instructor explicitly encouraged the students to participate, but didn't force them to do so.

7.4. Teaching-learning interactions, acquaintance level and participation

Unlike the short learning sessions analyzed in Study 1, in which participants were not able to develop mutual acquaintance, the semester-long learning in Study 2 enabled a longitudinal examination of the impact of the growing acquaintance between learners on their participation.

In contrast with our fourth hypothesis, that as the online course progresses, the growing level of acquaintance between students would result in an increasing level of participation, the highest participation level was found in the second (out of three) synchronous lesson of the course, and not, as expected, in the last one. We relate this finding to the pedagogical design of each lesson: while in the second lesson, teams

of students presented their collaborative learning outcomes, followed by a spontaneous discussion, the third lesson was partly devoted to preparation for the final exam and included a lower number of participation-promoting elements. This finding reinforces the previously-discussed critical importance of incorporating pedagogical elements that promote participation in online learning environments.

An interaction effect between the acquaintance level and the five teaching-learning interaction types was found for both measures – the level and frequency of participation. Despite the differences in participation level for the different teaching-learning interactions, a clear pattern was found when analyzing the change in participation over time: from lesson to lesson, the students needed less explicit instructor's encouragement to participate (e.g., "Who would like to share his opinion on this topic?" "Who can propose a solution to resolve this problem?"), and initiated more spontaneous learning interactions. In the last two lessons, the students asked more questions (student-instructor interactions) and also interacted more between themselves (student-student interactions). Thus, over time participation increased not only when students were required to speak, but also when the students themselves initiated interactions with the instructor or with peers. Zheng and Warschauer (2015), who tested the participation of fifth-grade students in textual online synchronous discussions during an eight-month course, reported similar findings. Namely, they found that over time, the teacher posted less explicit encouragements to participate and that peer interactions became more dynamic and spontaneous.

8. Implications, limitations and future studies

Applying similar pedagogical components in three different learning conditions (Study 1) illustrated the pivotal role of the instructor in promoting students' active participation in the learning process. Based on the findings of both studies, we recommend using the types of teaching-learning interactions that have been found to increase participation, such as students' presentations and explicit encouragement of participation by instructor-student interactions. Following Study 2, we recommend transferring the responsibility from the instructor to the students by allowing them to actually "lead" the lesson and thus, increase participation of the "audience" of their peers.

In addition, personality traits were found to have an impact on the learners' ability to participate in the interactions. These findings emphasize the importance of adapting the teaching methods to the learners' characteristics and of allowing learners to choose their own preferred method from a variety of options.

According to the findings of both studies, we suggest that follow-up studies with larger groups of participants, as well as longitudinal studies, are necessary in order to test the external validity of our findings. Such studies might allow examination of additional factors that were found to be relevant to online behavior and online learning, such as age and gender (Amichai-Hamburger & Ben-Artzi, 2003), motivation, technology, or user interface (Malinen, 2015).

Conflict of interest

The authors declare that they have no conflicts of interests.

Acknowledgement

Appendix A. Summary of the procedures in both studies

		Study 1			Study 2
Research design		Controlled lab experiment- students participated in a short lesson			Academic Courses- Analysis of all synchronous lessons in two graduate courses in Education
		(~25 min), which focused on the topic of "The charisma of politicians"			
Communication channels		two-way videoconferencing	one-way videoconferencing	face-to-face	two-way videoconferencing
Participants		N = 26	N = 26	N = 24	N = 87
Independent variables					
	Communication channels	Face-to-face One-way videoconferencing Two-way videoconferencing			Two-way videoconferencing
	Teaching-learning styles	Instructor presentation Instructor-student Student-instructor Student-student			Instructor presentation Instructor-student Student-instructor Student-student Student presentation
	Personality traits	Extroversion-introversion Emotional stability-neuroticism			N/A
	Acquaintance between participants	N/A			1,2,3 (Lesson #)
Dependent variable measurements					
					Participation level = # of words said by each participant Participation frequency = # of turn-taking of each participant

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