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Argumentation Competence: Students' Argumentation Knowledge, Behavior and Attitude and their Relationships with Domain-Specific Knowledge Acquisition

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ABSTRACT

Following constructivist paradigms for learning, this article explores the relationships between the components of argumentation competence (knowledge, behavior and attitude), their relationships with domain-specific knowledge acquisition, and the differences in argumentation behavior between successful and less-successful students. An exploratory study, with a pre- and post-test design, in an authentic, non-scaffolded, online learning environment was conducted. Contrary to our expectations, no significant relationships between the components of argumentation competence were found. Nevertheless, a significant relationship between argumentation behavior and domain-specific knowledge acquisition was found. Moreover, results suggested that the capacity of students to transfer argumentation behavior to similar argumentation tasks can be related to students' domain-specific knowledge acquisition. Finally, successful students in terms of domain-specific knowledge acquisition scored higher with regard to their argumentation behavior than less-successful students. These findings are discussed followed by theoretical and practical implications and suggestion for future work.

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Introduction

In constructivist paradigms for learning, learners of all ages are supposed to engage in discussions and argumentation with their peers, take positions, negotiate meaning and understand various perspectives of issues which would also lead to co-constructing knowledge and solving authentic tasks (Noroozi, Kirschner, Biemans, & Mulder, 2018). Given the increasingly global nature of the controversial issues and the need for domain-specific and domain-general expertise to solve today's complex issues, helping higher education students learn to argue and work together in groups for sharing their knowledge, expertise, and experiences from different perspectives is a priority for higher education (Noroozi, Weinberger, Biemans, Mulder, & Chizari, 2012).

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Argumentation and domain-specific knowledge acquisition have been facilitated using diverse instructional scaffolds integrated in online learning environments (Noroozi et al., 2012; Scheuer, Loll, Pinkwart, & McLaren, 2010). Yet, according to the meta-analysis review of Rapanta, Garcia-Mila, and Gilabert (2013), there is no homogenous definition of argumentation competence among researchers nor a standardized instrument to analyze and assess argumentation competence components. Moreover, there is a lack of knowledge of the relationships between various components of argumentation competence, and between such components and domain-specific knowledge. Therefore, it is important, for both educational research and practice, to address this gap in the literature.

This exploratory study aims to expand our understanding of the relationships between the components of argumentation competence, and their relationships with domain-specific knowledge in an authentic, non-scaffolded, online learning environment. In addition, this study explores the differences in argumentation behavior between successful and less-successful students in terms of domain-specific knowledge gain.

Argumentation competence

Higher education students are commonly required to solve complex problems in teams, within which team members may have a different perspective on the issue at hand, and different disciplinary backgrounds (Noroozi et al., 2012). In such scenarios, students should be able to present their opinion, think critically, argue, and reason logically, to reach conclusions and make critical decisions (Andriessen, 2006; Kuhn, 1991). Different types of instructional scaffolds have been used in online learning environments to facilitate the acquisition of argumentation and domain-specific knowledge acquisition (Noroozi et al., 2012; Scheuer et al., 2010) despite the lack of a clear definition of the concept of argumentation competence, its comprising components and their relationships with domain-specific knowledge (Rapanta et al., 2013). Rapanta et al. (2013, p. 488)'s definition of argumentation competence comprises "the different types of skills related to argumentation that are manifested in a person's performance in both monological (individual) and dialogical (peer-to-peer) contexts."

In line with the lack of a homogenous definition of argumentation competence among researchers, there is no standardized instrument to analyze and assess argumentation competence components (Rapanta et al., 2013). Researchers typically measure argumentation competence in terms of the skills students manifest during argumentative discourse activities, e.g., argument form, use of strategies or achievement of specific argumentation goals (Rapanta et al., 2013), or by tests of argumentation knowledge prior to and after collaborative discourse activities (Noroozi, Weinberger, Biemans, Mulder, & Chizari, 2013). Nevertheless, in some situations, students' actual knowledge on argumentation is not reflected in their behavior during argumentative discourse activities. For example, in several studies (Kollar, Fischer, & Slotta, 2007; Noroozi, Weinberger, et al., 2013; Stegmann, Wecker, Weinberger, & Fischer, 2012; Stegmann, Weinberger, & Fischer, 2007), students demonstrated knowledge regarding the construction of single arguments, but failed to apply such knowledge in argumentative tasks, such as discourse. Therefore, a reliable measurement of argumentation competence should rely on both students' argumentation knowledge and their behavior during

actual discourse (see Andrew & McMullen, 2000). Furthermore, students' argumentative discourse activities may be affected by psychological-, emotional-, motivational-, and social factors (Polo, Lund, Plantin, & Niccolai, 2016). For instance, some students may present emotions, such as nervousness or anxiety, while presenting a claim or receiving a question (Gilbert, 2004). In addition, if students are emotionally attached to the topic under discussion (e.g., controversial issues like genetically modified food, animal testing or politics), argumentation may prove unfruitful, complicated, or even impossible (Baumeister & Scher, 1988; Leith & Baumeister, 1996). In contrast, emotions may also result in successful and fruitful argumentation as students use their emotions as a resource to argue (Polo et al., 2016; Polo, Plantin, Lund, & Niccolai, 2017) or operate on the reasoning of their learning partners to highlight or make more salient socio-cognitive conflicts related to their individual positions regarding the controversial issue at stake (Fischer, Bruhn, Gräsel, & Mandl, 2002; Weinberger, Ertl, Fischer, & Mandl, 2005).

To conclude, argumentation competence is comprised of students' knowledge on argumentation, argumentation behavior and attitude toward argumentation, since these components appear to be interwoven and, thus, may influence the learning outcomes of the discourse. In the following sections, we discuss argumentative essay writing, collaborative argumentation, and transactivity as three main aspects of students' argumentation-based learning.

Writing argumentative essays

Undergraduate students are typically required to complete assignments in the form of writing opinion papers and argumentative essays (Mei, 2006). Such assignments require students to investigate a topic, gather and evaluate evidence, and write a clear and concise report in the form of an argumentative essay. In such assignments, argumentation and reasoning have essential role for writing argumentative essays and texts (Kelly, Chen, & Prothero, 2000; Kelly & Takao, 2002; Kelly, Regev, & Prothero; 2008; Mei, 2006; Wingate, 2012).

Unfortunately, students' essays rarely present sound argumentation and depth of elaboration to the same extent (Cooper et al., 1984). There could be multiple reasons that may cause the aforementioned issues such as the lack of diverse general and context-specific language skills (Kelly & Bazerman, 2003), because students do not know the features of good argumentative essays (Bacha, 2010), or because they struggle in transferring their knowledge to applications, such as writing argumentative essays (Noroozi, Teasley, Biemans, Weinberger, & Mulder, 2013).

The features of a good argumentative essay can be described in terms of macro- and micro levels (Noroozi, Biemans, & Mulder, 2016). At the macro level, a good argumentative essay is composed of a) a clear position, b) arguments and data in favor of the position, c) arguments and data that are against or weaken the position, d) integrations of arguments and data in favor and against the topic, and e) a conclusion (Noroozi et al., 2016). While at the micro level, argumentative essays are composed of single arguments according to Toulmin's "model of argumentation" (see below section "Construction of single arguments").

If students struggle to transfer their knowledge into applications such as writing argumentative essays, it is necessary to provide a learning activity where students can further develop their subject knowledge and argumentation competence. One option is collaborative argumentation.

Collaborative argumentation

In collaborative argumentation (CA), learners engage in argumentative knowledge construction which involves reasoning processes and collective exploration of the dialogical space (Noroozi, Weinberger, et al., 2013; Stegmann et al., 2007, 2012; Weinberger & Fischer, 2006). According to Munneke, Andriessen, Kanselaar, and Kirschner (2007), CA fosters reasoning and construction of knowledge since students can consider different viewpoints of a topic, and can question, clarify and explain to their learning partners, conceptions, doubts, beliefs and issues related to the topic. Similarly, CA facilitates deep elaboration of domain content, which is related to the acquisition of more and better organized domain knowledge (Jermann & Dillenbourg, 2003).

According to Weinberger and Fischer (2006), knowledge acquisition is directly related to the frequency with which learners engage in discourse and perform specific activities that can span multiple process dimensions. Weinberger and Fischer (2006) differentiated four specific processes of argumentative discourse activities, namely a participation dimension (quantity and heterogeneity of participation), an epistemic dimension (whether learners contributions are on- or off-task), an argument dimension (structural composition of arguments and their sequences) and a dimension of social co-construction or transactivity (to what extent learners refer to contributions of their learning partners).

This study focuses on the participation dimension, the argument dimension and transactivity. Such dimensions not only depict students' argumentation behavior at the macro- , i.e., transactivity and participation, and micro levels, i.e., argumentation, but also across social planes, i.e., individual and collaborative. The epistemic dimension [see Weinberger and Fischer (2006)] was deliberately not considered, because some epistemic activities were not captured by the nature of the study. In contrast to solving a task collaboratively, solving a task individually and discussing the answer collaboratively may trigger different epistemic activities that can require a different analysis and further elaboration, making it worth of a detailed investigation in future research.

Participation dimension

The participation dimension depicts if students participate, and if they participate on an equal basis (Weinberger & Fischer, 2006) and is given by the quantity of participation and the heterogeneity of participation. The quantity of participation indicates to what extent learners contribute during the task, which is deemed as an important indicator of knowledge construction, and can be measured by the number of words students produce. The heterogeneity of participation tells us if students' participation is homogeneous. When participation is homogeneous, all students within the group may benefit from knowledge co-construction and the chance that students are left behind is reduced. Highly heterogeneous participation has been associated with "social loafing" (Latané,

Table 1. Construction of single arguments based on Toulmin's "model of argumentation."

Element	Definition	Example
Claim	a statement expressing the position on an argument	"The earth spins around"
Datum	factual information supporting the acceptance of the claim	observations and experiences, e.g., "so we have day and night"
Warrant	a rule of inference or logical connection indicating how the datum is supporting the claim	definitions, theories, codes, laws, and rules
Backing	factual information	statistics or expert opinions, grounding the warrant
Qualifiers	used to limit the validity or scope of the claim. Specifically, a qualifier indicates the degree of certainty about the validity of the claim	typically formed by using modal adverbs, such as "perhaps," "maybe," and "probably"
Rebuttal	depicts the circumstances under which the claim is invalid	"provided that … ," and "if and only if … "

Williams, & Harkins, 1979) or "free riding" (Kerr & Bruun, 1983). Weinberger and Fischer (2006) argue that heterogeneity may be reduced if students collaborate in small groups, as their chance to participate in whole classroom settings proves rather difficult. Next to the participation dimension, the construction of single arguments and argumentative sequences is also deemed relevant.

Argument dimension

The argument dimension comprises the structural elements of single arguments (Kollar et al., 2007; Stegmann et al., 2007, 2012) and argumentative sequences (Leitão, 2000).

Construction of single arguments

The construction of single arguments is based on Toulmin's "model of argumentation" (Toulmin, 1958). Toulmin's model complements the traditional model of argument (based on premises-conclusion or data-claim), by further distinguishing more elements, namely *warrant*, *backing*, *qualifier* and *rebuttal*. Table 1 provides a definition and example of the elements of the Toulmin's "model of argumentation" (Erduran, Simon, & Osborne, 2004; Kollar et al., 2007; Noroozi, Weinberger, et al., 2013; Stegmann et al., 2007; Weinberger & Fischer, 2006).

Toulmin's model can be complex due to the relationships between its components or their ambiguity (Noroozi, Weinberger, et al., 2013; Stegmann et al., 2007). Moreover, all elements of the model rarely appear together in everyday language arguments (Stegmann et al., 2007). Therefore, Toulmin's model has been simplified in multiple studies to the elements: claim, grounds and qualifications (M. Baker, 2003; Kollar et al., 2007; Leitão, 2000; Noroozi, Weinberger, et al., 2013; Simon, 2008; Stegmann et al., 2007, 2012). The elements datum, warrant, and backing of Toulmin's model are grouped together under the element *grounds* (Stegmann et al., 2007). Similarly, Toulmin's model fails to capture and recognize the dynamic process of collaborative discourse, the dependencies and relationships of moves among participants (Andrews, 1995), or the opponent's part in the argumentation process (Andriessen, 2006). Therefore, the argumentative sequences during collaborative argumentation should be considered.

Construction of argumentative sequences

In dialogical argumentation, proponents express their opinions through discourse, then opinions are clarified, contested, and refined by the means of critical dialogue (Ravenscroft, 2011). Leitão (2000)'s *argumentative sequences* consist of specific sequences of *arguments*, *counterarguments*, and *integrations*, with an emphasis on the dynamic character of dialogical argumentation at a macro-level, to facilitate knowledge acquisition. *Argument* is defined as a statement favoring a specific proposition. *Counter-argument* is an argument opposing a preceding argument, and supporting an opposite proposition. Finally, *integration* is a statement aiming to balance and advance a preceding argument and counterargument (Stegmann et al., 2007; Weinberger & Fischer, 2006). Dialogic argumentation can be also described in terms of transactivity or the degree to which students refer to the contributions of their learning partners (Weinberger & Fischer, 2006), such co-construction of knowledge has been related to knowledge acquisition (Teasley, 1997).

Transactivity

Transactivity is connected to the level of cognitive elaboration and individual knowledge construction, and depicts the extent to which students build upon, relate to, and refer to what has been said by their learning partners during collaboration. The term transactive discussion was first adopted by Berkowitz and Gibbs (1983). Later the term transactivity was coined and introduced to collaborative learning by Teasley (1997). Transactivity means "reasoning operating on the reasoning of the other" (Berkowitz & Gibbs, 1983, p. 402). According to Teasley (1997), the benefit from learning together is directly related to the extent to which students build on the reasoning of their learning partners. Students not building upon their learning partners' reasoning may accept their learning partners' contribution too quickly and thus they will not engage in both critical and transactive discussions. Such acceptance depicts the lowest level of transactivity which is known as *quick consensus building* (Weinberger & Fischer, 2006). In contrast, in *integration-oriented consensus building* students operating on the reasoning of their learning partners integrate each other's opinions. In this situation, students revise, modify and adjust their opinions and ideas taking as basis their learning partners' contributions (Noroozi, Weinberger, et al., 2013; Weinberger & Fischer, 2006). There are also situations in which students engage in transactive discussions and critical argumentation with their learning partners. In such situations, students operate on the reasoning of their learning partners as there are socio-cognitive conflicts related to their individual positions on the solution of the issue at stake. This situation is referred as *conflict-oriented consensus building*, and is considered to lead to successful and fruitful collaborative learning (Fischer et al., 2002; Weinberger et al., 2005).

Research questions

Up until now, limited attempts have been made to examine the relationships between various aspects of argumentation competence and also their relationship with

domain-specific knowledge in an authentic, non-scaffolded, educational setting. Although Zohar and Nemet (2002) reported a positive impact of argumentation on domain-specific knowledge acquisition, the comprising elements of argumentation competence were not studied together. Similarly, Noroozi et al. (2012) reported positive impact of argumentation on domain-specific knowledge acquisition, but the relationship between the components of student's argumentation competence and their learning outcomes was not explored. Therefore, it is a crucial issue, and is imperative, for both educational research and practice, to clearly define the concept of argumentation competence, the relationships between its comprising components, and between these components and domain-specific knowledge. The aforementioned gap in the literature drives this study in the form of the following research questions:

1. What are the relationships between students' argumentation knowledge, behavior, and attitude and their relationship with domain-specific knowledge acquisition?
2. What are the differences in argumentation behavior between successful and less-successful students in terms of domain-specific knowledge gain?

Methodology

Context and participants

This exploratory study with a pre- and post-test design was conducted at a university in the Netherlands. One class following a law course in environmental law and policy at the Bachelor Degree level participated in the study. The class was comprised of 57 students. The mean age of the participants was 22.67 years (SD = 2.89, MIN = 20, MAX = 36). The numbers of Dutch (54.4%) and foreign students (44%) were roughly equal. Female students represented 58% of the participants as opposed to 42% male students.

Learning materials

The particular topic to be learned was World Trade Organization (WTO) law and its application to authentic cases. The students' task was to use WTO law (presented during class by the teacher) to answer different questions about a real life case. This case was about a country that has put in place measures concerning the import of agricultural products, primarily poultry, for two reasons: a) to avoid the spread of avian influenza, or bird flu, from other countries due to trade, b) to protect an endemic rooster from cross-breeding with chickens imported from abroad, because they are particularly important as a symbol of national pride. The learning task was authentic and complex, as it required students to individually investigate a topic, gather and evaluate evidence and applicable law, and write a solution presenting a position supported by sound reasoning, and a clear and concise conclusion. Moreover, students had to analyze, discuss and provide feedback to each other's solutions in triads on the basis of the theoretical background (conceptual space).

Table 2. Study phases descriptions.

		Assignments				
Phase	Pretest	Assignment 1	Assignment 2	Assignment 3	Assignment 4	Post-test
Activities	-Introduction -Intake questionnaire	-Write individual answer at home -Post individual answer to the discussion forum -Discuss answers with two learning partners (posting at least three relevant and meaningful contributions)(collaboratively at class) -Revise original answer (individually at class)				-Exit questionnaire -Debriefing
Time (min)	120 min	105 min	105 min	105 min	105 min	120 min

Online platform

The "group discussion boards" or forums with threaded discussions of the Blackboard learning management system were used in this study. The forums were private, only group members were able to see and make contributions. As Blackboard was user-friendly and the students were familiar with it, it was not necessary to spend much time explaining to students how to carry out the activities. The later aspect is important, as online learning systems demand user-friendly platforms (Noroozi et al., 2012).

Procedure

The class was randomly divided into groups of three students. All students received the same instructions and materials. The study consisted of six phases that took place over a period of three weeks, see Table 2.

Phase 1 consisted of an intake questionnaire on the following areas: socio-demographic information, domain-specific knowledge, attitude toward argumentation and argumentation knowledge. Phase 2 to Phase 5 were assignments related to an overarching WTO law case, each assignment was comprised of one or two questions/activities (see section Learning Materials). During phases 2 to 5, students needed to: a) write an answer, in the form of an argumentative essay, b) post their answer, to seed the discussion, c) discuss in groups each other's answers (60 min for a, b and c), and d) revise original answer (45 min). Phase 6 consisted of an exit questionnaire that was the same as the intake questionnaire.

During the collaborative phase, students were asked to make at least three relevant and meaningful contributions, but this was not enforced. The students groups remained the same during the whole study. For this study, we only analyzed the pre- and post-tests and one assignment, namely the second assignment (Phase 3). The second assignment was deliberately selected because 1) students were already familiar with the activities of the assignment, and 2) it contained vast information, as students had to a) individually investigate, gather and evaluate evidence and applicable law, and write a solution, b) collaboratively analyze, discuss and provide feedback in triads on the basis of the theoretical background c) revise their original answer taking into account the feedback and arguments of their learning partners

Instruments, data sources and measurements

A revised version of the questionnaire and test employed by Noroozi, Weinberger, et al. (2013) and Noroozi, Teasley, et al. (2013) was used to gather socio-demographic

information (e.g., age gender, nationality), argumentation knowledge, and attitude toward argumentation. A questionnaire for domain-specific knowledge was developed by the course coordinator. Moreover, students' original and revised answers for each of the assignments, and discussions during collaboration were also collected. The coding scheme, coding rubrics, and rules for the coding process were obtained from previous studies (Noroozi, Teasley, et al., 2013; Noroozi, Weinberger, et al., 2013). These studies have already reported a high level of reliability for these coding schemes. The main author with ample previous coding experiences was responsible for coding all the data in this study. The coding process reliability was assured by creating detailed rubrics and coding 10% of randomly selected data with another experienced coder which resulted in 90% of identical scores. Furthermore, we revised the rubrics with further criteria and examples to facilitate the resolution of discrepancies, after consultation with the coauthors. Afterwards, the main coder individually coded the remaining data.

Assessing and measuring argumentation behavior

The argumentation behavior of students was measured individually (i.e., original and revised answers of the assignment) and collaboratively (i.e., students' discussion during the collaborative learning phase). The data were analyzed following the coding schemes developed by Weinberger and Fischer (2006), Noroozi, Teasley, et al. (2013) and Noroozi, Weinberger, et al. (2013). In particular, the assignment was analyzed for the quality of the construction of single arguments, while students' discussions were analyzed for the quality of the construction of single arguments, the quality of the construction of argumentative sequences, and the quality of transactivity. The unit of analysis for the construction of single arguments was a sentence, delimited by a period ".". Yet, preceding- and succeeding sentences were considered when deemed relevant (e.g., serving as grounds or qualifiers), as sometimes students do not connect them explicitly. The unit of analysis for argumentative sequences and transactivity was defined at the message level, which is all the text provided in one contribution. In summary, individual argumentation behavior is given by the score on the construction of single arguments, while collaborative argumentation behavior is the sum of the scores of construction of single arguments, argumentative sequences and transactivity.

Assessing and measuring quality of construction of single arguments

To measure the quality of the construction of single arguments, the messages were segmented. Then, the segments were coded as *simple claims*, *qualified claims*, *grounded claims*, *grounded and qualified claims* and *non-argumentative* moves following Weinberger and Fischer (2006), see Table 3. We assigned points to each segment as described in Table 3. Then, for each student, we counted and summed the points (Kollar et al., 2007; Noroozi, Weinberger, et al., 2013; Stegmann et al., 2007, 2012).

Assessing and measuring quality of argumentative sequences

To measure the quality of the construction of argumentative sequences, each student message was coded following Leitão (2000). The coding process distinguished between

Table 3. Assessing and measuring quality of construction of single arguments.

Segment type	Definition	Example	Points
Simple claims	Statements that advance a position and are not supported by grounds or limited by qualifications. Segment is a claim if it does not function as grounds or qualifiers for other claims.	"The measures taken by India are not based on international standards, guidelines or recommendations."	1
Qualified claims	Present a limitation of the validity of the claim (a qualifier) but do not present grounds. Common keywords: "if," "maybe," "under the circumstances," "perhaps," "probably," "provided that … ," "subject that … ," and "if and only if … ."	"However, they are deemed to be necessary to protect human and animal life and health and may be allowed, if they are based on appropriate risk assessments."	2
Grounded claims	Grounds warranting/supporting the claim but do not present limitations of their validity. Grounds can be data (e.g., case description information), warrants (e.g., definitions, theories, codes, laws, and rules), or backing (e.g., evidence, such as statistics or expert opinions). Common keywords: "because," "since," "due to the fact that," etc.	"According to WTO (2015), the measures are inconsistent with both Art. 3.1 and Art. 3.2 because they aren't based on 'the relevant international standard' according to Chapter 10.4 of the OIE terrestrial code"	2
Grounded and qualified claims	Claims present both grounds and limitations of its validity (qualification).	"Furthermore, if you regard the risk assessment as a source of 'relevant scientific evidence' for the justification of a ban, I argue that India has no sufficient scientific evidence to justify its SPS measures and is therefore not in compliance with 2.2."	3
Non-argumentative moves	Comprise questions, coordinating moves, and meta-statements on argumentation.	"What do you think about article 5.2?," "We could start with article 5.1," and "I really like your answer"	0

arguments, *counterarguments*, *integrations*, and *non-argumentative moves* (Kollar et al., 2007; Leitão, 2000; Noroozi, Weinberger, et al., 2013; Stegmann et al., 2007; Weinberger & Fischer, 2006). To address the problem of messages with two or more segments presenting different argumentative sequence codes, a weight-based hierarchy based on the elements' sequence order was used to decide the code with more weight, see Table 4. We assigned points to each message as described in Table 4. Then, for each student we counted and summed the points.

Assessing and measuring quality of transactivity

To measure the quality of transactivity, student's contributions were coded using the *social mode dimension* following Noroozi, Teasley, et al. (2013) and Weinberger and Fischer (2006). The process of coding differentiated between six social modes: *externalization*, *elicitation*, *acceptance*, *integration*, *conflict* and *no-reaction*. To address the problem of messages with two or more segments presenting different social modes, a weight-based hierarchy, based on Teasley (1997)'s scale of transactivity, was used to decide the most transactive code (Noroozi, Teasley, et al., 2013). The hierarchy, from most to least transactive, is as follows: conflict, integration, elicitation, acceptance,

Table 4. Assessing and measuring quality of argumentation sequences.

Type	Definition	Example	Points/weight
Arguments	A statement put forward in favor of a specific proposition that comprises claims that have not been discussed previously.	Student 1 "That means that can have higher level of protection, which could we see as a right to ban importing of chicken from other countries, where they had AI? What is your opinion?"	1
Counterarguments	An argument that opposes or attacking a preceding argument, or an argument favoring an opposite proposition of a preceding argument	Student 2 "good job, you say 'precautionary principle', so for the protection, they have the available evidence, but for the whole trade, they do not, so they just can follow the precautionary action, means that is a kind of temporary action, they cannot restrict the trade for a very long time."	2
Integrations	A statement that aims to balance, integrate, and advance a preceding argument and counterargument on a higher level. Counterarguments and integrations can refer to learning partners' arguments or to own arguments.	Student 3 "I believe they can protect themselves by imposing a higher standard, but indeed, for a short amount of time because of the precautionary principle."	3
Non-argumentative moves	Comprised questions, coordinating moves, and meta-statements on argumentation.	"What is your opinion?" (see example for arguments)	0

externalization, and no-reaction. We assigned points to each message as described in Table 5. Then, for each student we counted and summed the points. In addition, we calculated for each student the proportion of conflicts, integrations, elicitations, acceptances, externalizations, and no-reactions with respect to his/her total amount of messages.

Assessing and measuring individual acquisition of domain-specific knowledge

The intake questionnaire and the revised assignment were used to measure the individual acquisition of domain-specific knowledge. The intake questionnaire, the original assignment and the revised assignment were scored considering seven points provided by the course coordinator, covering theoretical concepts, problem case facts and their relation. Students received a score-point for each solution-point they covered. The indicator of domain-specific knowledge for each participant was then the sum of points in a given assignment. The overall knowledge gain was calculated as the difference between the intake questionnaire and the revised assignment. The median (med = 3) of the overall domain-specific knowledge gain was used as criterion to differentiate between successful and less-successful students. Three students in the less-successful group were moved to the successful group as they were holding the same gain as 14 students in such group. Thus, we had 30 successful and 24 less-successful students.

Assessing and measuring argumentation knowledge

Students' knowledge of argumentation was measured in the intake and exit questionnaires using tests designed and employed previously by Noroozi, Weinberger, et al.

Table 5. Assessing and measuring quality of transactivity.

Segment type	Definition	Example	Points/weight
Externalization	When students expose thoughts to the group without reference to previous messages, such as the first discussion post or when students juxtapose externalizations, that is, students reply to previous externalizations by a further externalization.	"Your structure is indeed very clear, by the way!"	1
Acceptance	When a) students agree to what has been said without further elaboration, b) students agree to what has been said by only repeating what has been said, c) students accept what has been said in order to move on with the task. This does not mean that they are convinced or agree with what has been said, and may not indicate a chance of opinion, but is rather a coordination move.	"Thanks, I will do that in my revised version" "Very clear reasoning and use of sources. Nothing to add!"	1
Elicitation	When students ask for, or invite, a reaction from their learning partners. Elicitation aims at receiving information from the learning partners.	"What make you think India's measure was in concordance?"	2
Integration	When students adopt their learning partners' perspectives and reason on this basis. This implies that students revise or change their opinion.	"So, it looks like India thought it complied to the int. standards but the panel consulted the OIE and found it was not sufficient."	3
Conflict	When students present alternatives, reject, deny, modify, replace, or give a negative answer or evaluation to what has been said by the learning partner.	"But I say India didn't comply to international guidelines, and you say they did. So maybe we have an interesting discussion here"	3
No-reaction	When a) students do not respond to questions or other forms of elicitation from their learning partners, or b) students reply to a (parent) message of the learning partner without referring to what the learning partner has said in the message being replied.	Student 1 "The AB says that the Panel hasn't considered the arguments and evidence put forward by India. And that India only bans products from countries with AI, so that it's based on evidence (bluntly stated). And indeed only not a good risk assessment." Student 2 "By the way, the discussion is officially till 9.45 and the revising is from 9.45-10.15 :)"	0

(2013). The test was comprised of two tasks. Firstly, students had to identify the best argumentative texts and provide explanations and arguments supporting their selection. Students could receive a maximum of five points, two for selecting the correct text, and a maximum of three for the explanations and arguments supporting their selection. Secondly, students' individual knowledge of the quality of single arguments and argumentative sequences was measured in the intake and exit questionnaires. A student could obtain a maximum of fourteen points. Both the points were converted to a decimal scale, then the average was calculated and used as indicator of argumentation knowledge. The gain of knowledge from pretest to post-test was calculated and used as an indicator for the acquisition of argumentation knowledge.

Measurement of attitude toward argumentation

Students' attitude toward argumentation was measured using a revised version of the questionnaire designed and employed previously by Noroozi, Biemans, Weinberger, Mulder, and Chizari (2013). The questionnaire was comprised of 20 items on a five-point Likert scale ranging from "Strongly disagree" to "Strongly Agree." The items asked in the questionnaire aimed to ascertain students' attitudes toward argumentation. For example, students were asked to rate themselves on statements such as "argumentation fosters learning," "argumentation adequately addresses critical assessment of each other's work," "learning should involve social negotiation," "I try to avoid conflicts with my learning partners to keep away from discussions," etc. The reliability coefficient was sufficient (Cronbach $\alpha = .80$).

Measurement of participation dimension

The quantity of participation was measured by counting the number of words in the assignments using the count word function of word-processing software. Similarly, the heterogeneity of participation was obtained by counting the number of contributions during collaboration for each student.

Analysis

We used correlations to determine the relationships between students' knowledge, behavior and attitude toward argumentation. The Pearson product-moment correlation coefficient was used to determine the aforementioned relationships if the assumptions of normality, linearity and homoscedasticity were met. Otherwise, Kendall's tau was used. One-way analysis of variance (ANOVA) tests were used to compare mean differences of argumentation behavior between successful and unsuccessful students. Furthermore, factorial repeated measures ANOVA tests (or mixed between-within subjects or Split-Plot) were used to compare argumentation behavior of successful and less-successful students over time.

Results

In this section, we present the results for each of the research questions.

RQ 1: What are the relationships between students' argumentation knowledge, behavior, and attitude and their relationship with domain-specific knowledge acquisition?

The results are presented in Table 6. Students' knowledge, behavior and attitude toward argumentation did not present significant relationships either at the pretest and post-test. However, domain-specific knowledge (pretest) presented small significant relationships with argumentation behavior (pretest) and with the construction of single arguments (collaboration). Similarly, domain-specific knowledge (post-test) presented a medium significant relationship with argumentation behavior (post-test). The latter

Table 6. Correlations between argumentation knowledge, argumentation behavior, attitude toward argumentation and domain-specific knowledge.

			Pre				Collaboration				Post			
	Variable		1	2	3	4	5	6	7	8	9	10	11	12
Pre	**1 ArgAttitude**	ρ	–											
		Sig.	–											
		N	–											
	2 ArgKnow	ρ	0.138	–										
		Sig.	0.315	–										
		N	55	–										
	3 DomainKnow	ρ	−0.031	0.128	–									
	(assignment)	Sig.	0.825	0.351	–									
		N	55	55	–									
	4 ArgBehavior/	τ	0.03	0.16	**.282****	–								
	SimpleArg	Sig.	0.754	0.092	0.005	–								
		N	55	55	57	–								
Collaboration	**5 SimpleArg**	τ	−0.006	0.069	**.283****	**.290****	–							
		Sig.	0.948	0.474	0.006	0.003	–							
		N	55	55	57	57	–							
	6 Transactivity	ρ	−0.001	0.234	0.078	**.334****	**.397****	–						
		Sig.	0.993	0.086	0.563	.000	.000	–						
		N	55	55	57	57	57	–						
	7 ArgSequence	τ	−0.044	0.055	0.068	0.187	**.508****	**.341****	–					
		Sig.	0.653	0.58	0.513	0.058	.000	0.001	–					
		N	55	55	57	57	57	57	–					
	8 ArgBehavior	τ	−0.005	0.121	0.159	**.339****	**.726****	**.659****	**.589****	–				
	(5 + 6+7)	Sig.	0.959	0.203	0.114	.000	.000	.000	.000	–				
		N	55	55	57	57	57	57	57	–				
Post	**9 ArgAttitude**	ρ	**.666****	0.183	0.077	−0.017	0.127	0.025	0.009	0.106	–			
		Sig.	.000	0.204	0.587	0.868	0.206	0.862	0.93	0.285	–			
		N	50	50	52	52	52	52	52	52	–			
	10 ArgKnow	ρ	0.181	**.679****	0.194	0.157	0.092	0.186	0.023	0.138	0.104	–		
		Sig.	0.214	.000	0.172	0.112	0.36	0.192	0.824	0.161	0.467	–		
		N	49	49	51	51	51	51	51	51	51	–		
	11 DomainKnow	ρ	−0.027	0.115	**.864****	**.305****	**.262***	0.08	0.189	0.174	0.129	0.145	–	
		Sig.	0.849	0.414	.000	0.003	0.012	0.564	0.077	0.088	0.372	0.32	–	
		N	53	53	55	55	55	55	55	55	50	49	–	
	12 ArgBehavior/	τ	0.097	0.114	**.260***	**.669****	**.214***	**.223***	0.186	**.233***	0.026	0.074	**.368****	–
	SimpleArg	Sig.	0.314	0.239	0.011	.000	0.028	0.022	0.062	0.015	0.795	0.463	.000	–
		N	53	53	55	55	55	55	55	55	50	49	55	–

**Correlation is significant at the 0.01 level (2-tailed).
*Correlation is significant at the 0.05 level (2-tailed).

Variable	Description	Variable	Description
ArgAttitude	Attitude toward argumentation	DomainKnow	Domain-specific knowledge
ArgKnow	Knowledge on argumentation	SimpleArg	Construction of simple arguments
ArgBehavior	Argumentation behavior	ArgSequence	Construction of argumentative sequences
Pre	Pretest	Post	Post-test
ρ	Pearson	τ	Kendall's tau

results suggest that the more students know and understand about the topic, the more they will present arguments without regard for the application or the social plane.

Argumentation behavior at pretest presented small and medium significant relationships with the construction of single arguments, transactivity and argumentation behavior at collaboration. Similarly, the construction of single arguments, transactivity and argumentation behavior at collaboration presented small significant relationships with argumentation behavior at post-test (see Table 6). The latter suggest that students were able to transfer their argumentation behavior from the individual level to the collaborative level and back to the individual level.

RQ 2: What are the differences in argumentation behavior between successful and less-successful students in terms of domain-specific knowledge gain?

On average, successful students did better than less-successful students in terms of argumentation behavior in the original answer, the revised answer and also during collaboration (see Table 7). However, ANOVA tests indicated that the difference was only significant in the revised answer, $F(1, 52) = 4.43$, $p = .04$, $\eta 2 = .078$, $\omega 2 = .059$, with a moderate effect (Cohen, 1988, pp. 284–287; Kirk, 1996).

Factorial repeated measures ANOVA tests on argumentation behavior of successful and less-successful students over time indicated that there was a significant large effect of time on argumentation behavior, *Wilks' Lambda* $= .703$, $F(1, 52) = 21.95$, $p < .001$, $\eta 2 = .297$. Such result indicates *that the* argumentation behavior of both successful and less-successful students improved *over time. Also*, there was no statistically significant difference between the two student types, i.e., successful and less-successful students. Finally, t*he interaction effect was not significant, Wilks' Lambda* $= .929$, $F(1, 52) = 3.99$, $p = .051$, $\eta^2 = .071$. *However, results suggest that successful students gained more from the task.*

Finally, successful students wrote more words on average than less-successful students in both the original (369 vs. 296 words) and revised answers (443 vs. 336 words), but the difference was not statistically significant in either case. Regarding heterogeneity, successful students contributed slightly less (4.47 times) on average than less-successful students (4.58 times), but the difference was not significant (see Table 7).

Discussion

In our theoretical framework, we defined argumentation competence as an integrated capability, in which its comprising elements, i.e., argumentation knowledge, argumentation behavior and attitude toward argumentation, are intrinsically interwoven. Such a statement suggests the existence of relationships between the comprising elements. Therefore, the present exploratory study aimed to investigate if such relations exist in a

Table 7. Descriptive statistics for behavior, assignment's words & score (domain knowledge), and contribution (during collaboration).

		Successful		Less-successful		Total (group)		
		M	SD	M	SD	M	SD	Test
Pre	**ArgBehavior**	16.87	10.23	14.17	7.78	15.67	9.24	$F(1, 52) = 1.14$, $p = .29$
	DomainKnow	3.27	1.26	1.46	1.25	2.46	1.54	
	No. of words	369	232	296	206	337	222	
Post	**ArgBehavior**	21.53	10.55	16.04	8.04	19.09	9.83	$F(1, 52) = 4.43$, $p = .04$, $\eta 2 = .078$, $\omega 2 = .059$
	DomainKnow	3.7	0.91	1.46	1.22	2.7	1.54	
	No. of words	443	226	336	234	396	234	
Collaboration	**Contributions**	4.47	2.2	4.58	2.5	4.52	2.32	
	SimpleArg	6.4	6.02	5.08	5.76	5.81	5.89	
	Transactivity	8.33	4.14	8.54	4.08	8.43	4.08	
	ArgSequence	3.1	2.63	2.46	2.6	2.81	2.61	
	ArgBehavior	17.83	10.42	16.08	10.68	17.06	10.47	$F(1, 52) = .368$, $p = .547$

regular, online learning environment, in which students' learning activities are not scaffolded at micro- or macro levels. We opted for such a setting, because scaffolding can facilitate students' participation, acquisition of skills or knowledge during a task or activity (Belland, 2010; Hannafin, Land, & Oliver, 1999; Wood, Bruner, & Ross, 1976), which may influence the outcomes (Noroozi et al., 2012; Scheuer et al., 2010). Following, the results of each research question are discussed.

Contrary to our expectations, students' knowledge, behavior and attitude toward argumentation did not present significant relationships at pretest or post-test. It is striking that attitude toward argumentation was not related to knowledge and behavior, as previous research indicates that students' attitude (e.g., psychological, emotional, motivational, and social barriers) may affect argumentative discourse activities (Baumeister & Scher, 1988; Gilbert, 2004; Leith & Baumeister, 1996; Polo et al., 2016, 2017; Rourke & Kanuka, 2007). Similarly, the (lack of) compensation participants receive for their participation may play a role. Students receiving compensation, e.g., a grade or money, may be extrinsically motivated by the reward and, thus, may perform better as participants without such an incentive. Beers, Kirschner, Boshuizen, and Gijselaers (2007, p. 539), conducted their study "under highly regulated circumstances with highly motivated participants" to reduce the effects of social processes. Therefore, the lack of compensation and less controlled nature of the present study context may explain the lack of relation between attitude toward argumentation and both argumentation knowledge and argumentation behavior. Moreover, students' argumentation knowledge and argumentation behavior were not significantly related. Such a result is in line with previous findings in the literature, in which students with knowledge of the construction of single arguments were not able to put their knowledge into practice during discourse or in a similar argumentation task (Kollar et al., 2007; Noroozi, Weinberger, et al., 2013; Stegmann et al., 2007, 2012). The results suggest that students experience problems in externalizing their argumentation knowledge both at the individual (argumentative essay) and collaborative levels (argumentative discourse), and that they need to further develop their argumentation competence. Therefore, the design, implementation, and

evaluation of instructional scaffolds to support and facilitate students' participation, externalization of current knowledge, and acquisition of argumentation skills and/or knowledge during collaborative learning (Belland, 2010; Hannafin et al., 1999; Wood et al., 1976; Zohar & Nemet, 2002) or the specific instruction of argumentation is required (Zohar & Nemet, 2002). For example, argumentation scaffolds can facilitate the construction of arguments, and can guide and engage students in fruitful argumentative discourse activities (Noroozi et al., 2018). Similarly, argumentation scaffolds can also facilitate the writing and the provision of peer-feedback to argumentative essays (Noroozi et al., 2016). An overview of research literature on argumentation scaffolds on online learning systems, e.g., graphical representations (diagrams formed by nodes and links, tables, and visualizations), or text-based representations (hints, prompts, or scripts), can be found in Noroozi et al. (2012), Scheuer et al. (2010) and Kirschner, Buckingham Shum, and Carr (2003).

An interesting result was the significant relationship between argumentation behavior at pretest and argumentation behavior at collaboration, and the significant relationship between argumentation behavior at collaboration and argumentation behavior at post-test that is across different applications and social planes. Such relationships suggest that students' argumentation behavior is not dependent of the application, e.g., argumentative essay or argumentative discourse, or the social plane, e.g., individual or collaborative, and that student's argumentation behavior can operate back and forth between applications and social planes. The aforementioned relationships may be explained by the positive relationship between students' domain-specific knowledge and argumentation behavior. Students having more domain-specific knowledge may be able to present a clearer position with data supporting or opposing it, or to consider or refute the point of view of their learning partners. The latter is in line with what the results from Von Aufschnaiter, Erduran, Osborne, and Simon (2008, p. 1) suggested, that is "the main indicator of whether or not a high quality of argument is likely to be attained is students' familiarity and understanding of the content of the task." In contrast to previous research (Belland, 2010; Kollar et al., 2007; Noroozi, Teasley, et al., 2013; Noroozi, Weinberger, et al., 2013; Rapanta et al., 2013; Stegmann et al., 2007, 2012; Weinberger et al., 2005; Weinberger, Marttunen, Laurinen, & Stegmann, 2013), the relationships of argumentation behavior across different applications and social planes highlights the importance of measuring argumentation knowledge and argumentation behavior before and after collaborative discourse, and argumentation behavior during the latter.

Results indicated that on average, successful students presented a higher quality of argumentation behavior in the original answer, the revised answer and during collaboration. However, the difference was only significant in the revised answer.

Results showed that argumentation behavior of successful and less-successful students increased over time. The improvement in the quality of argumentation behavior is in line with the claims from several authors on the field who argued that Computer-Supported Collaborative Learning (CSCL) has a positive effect on learning outcomes (Andriessen, Baker, & Suthers, 2003; Kollar et al., 2007; Noroozi et al., 2016; Noroozi, Biemans, et al., 2013; Noroozi, Teasley, et al., 2013; Noroozi, Weinberger, et al., 2013; Stegmann et al., 2007, 2012; Weinberger et al., 2005; Weinberger, Stegmann, & Fischer, 2010).

The improvement in quality may be related to different factors. For instance, students seeding the discussion with their original solution allowed them to explicate their knowledge and contrast their ideas and knowledge conceptions with those of their learning partners (Weinberger & Fischer, 2006). Awareness of learning partners' knowledge may lead to the use of their partners as a resource by asking questions (Dillenbourg, Baker, Blaye, & O'Malley, 1995). Also, students may engage in a process of negotiation to reach common ground (Clark, Brennan, Resnick, Levine, & Teasley, 1991). The negotiation process may engage students in argumentative discourse, which may lead to integration of each other's ideas, perspectives and conceptions (Roschelle & Teasley, 1995; Weinberger & Fischer, 2006). The negotiation process can also lead to conflict and critique, which has been deemed important in collaborative learning (Teasley, 1997). Students facing critique may be urged to evaluate others perspectives or to create better arguments to support their positions (Chan, Burtis, & Bereiter, 1997; Weinberger & Fischer, 2006). Providing a critique requires pointing out specific aspects of the partner's contributions, thus, students have to operate on the partner's reasoning on detail (Weinberger & Fischer, 2006). The aforementioned process of transactivity has been related to knowledge acquisition (Noroozi, Teasley, et al., 2013; Noroozi, Weinberger, et al., 2013; Teasley, 1997; Weinberger & Fischer, 2006).

The learning environment can also be related to the improvement in argumentation behavior. The threaded forum allowed students to keep track of the discussion, facilitated going back and forth to re-read the contributions, and made salient the relationships between contributions and replies. Moreover, CSCL environments can facilitate the generation of arguments, the discussion, elaboration, exchange and integration of ideas and knowledge, which could likely lead to a deeper understanding of the topic (Marttunen & Laurinen, 2001; Veerman, 2001; Veldhuis-Diermanse, 2002) and the development of higher-order thinking (Jong, Veldhuis-Diermanse, & Lutgens, 2002).

Finally, successful students wrote more words on average than less-successful students in the original assignment (pretest) and in the revised assignment (post-test). The previous results suggest that successful students made more substantial or meaning-level changes (K. M. Baker, 2016; Faigley & Witte, 1981) as they may be more skilled (Sommers, 1980). Yet, this cannot be confirmed as our analyses did not cover such level.

Conclusions, limitations and suggestions for future research area

This article explored the relationships between argumentation competence components (knowledge, behavior and attitude) and domain-specific knowledge, and the differences in argumentation behavior between successful and less-successful students, in terms of domain-knowledge gain. The study setting provided direct practical relevance of a learning scenario without argumentation scaffolds. Based on the results, it was suggested that the lack of relation between attitude toward argumentation and both argumentation knowledge and argumentation behavior may be related to the lack of compensation and less controlled nature of the present study. Additionally, based on the current study results, we argued the need to design, implement and evaluate argumentation scaffolds to facilitate the writing of argumentative essays, and to guide and engage students in fruitful argumentative discourse, since students struggle to transfer argumentation knowledge to applications. Moreover, relationships between argumentation behavior at

individual and collaborative levels suggested that students' argumentation behavior can operate back and forth between different applications and social planes. The latter may be explained by the relationship between students' argumentation behavior and their knowledge on the topic; the more students know and understand about the topic, the more they will present arguments without regard of the application or the social plane. Furthermore, although the argumentation behavior of successful and less-successful students increased over time, the former did better on average. The improvement in the quality of argumentation behavior contributes to empirical evidence that CSCL has a positive effect on the learning outcomes. Contrary to our expectations, no significant relationships were found between the elements of argumentation competence at pretest or post-test. Such results suggest the need to design, implement and evaluate instructional scaffolds to foster students' argumentation competence.

We made the deliberate choice of not having a control condition as the goal of the present study was not related to an intervention, but rather to the understanding of argumentation competence and the relationships between its comprising elements in a real unscaffolded educational setting. The setting of the present study offered some constraints and limitations that serve as starting point for future research recommendations. Real educational settings, as in this study, offer high practical relevance (high ecological validity). In the present study, students' participation was motivated by requiring submission of the assignments to take the final examination. Furthermore, students were not graded on the assignments, as that was not described in the course description. Not grading students' assignments may lure students to put less effort into the activities, which may produce different results due to possible variations in students' attitude and behavior. To achieve an authentic behavior from the students, it is necessary to treat experimental course content as regular content, that is, to grade it and count it toward the final grade. However, it is difficult to convince teachers to conduct experiments in their classes, and is even more difficult to have such content counted toward the final grade because teachers are afraid of negative course evaluations from the students. Therefore, teachers are only willing to change course content once educational innovations have been tested and results are positive. The latter implies that integration of new course content features requires an iterative process that may be long and bureaucratic, which may hinder innovation.

This study analyzed students' assignments and discussions in terms of construction of single arguments, construction of argumentation sequences, transactivity, and the participation dimension. Yet, it lacks an analysis on content improvement in terms of surface- and meaning-level changes and their relation to student's argumentation competence.

Future research should further investigate the relationship between argumentation behavior and domain-specific knowledge, e.g., if higher domain-specific knowledge implies better argumentation behavior. Furthermore, research should be conducted to assert the effect of highly-controlled environments and rewards in the relations between the elements of argumentation competence and domain-specific knowledge.

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