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ORIGINAL PAPER

Argumentation-based learning with digital concept mapping and college students' epistemic beliefs

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Abstract
We designed an educational activity for undergraduate students and assessed how this newly-constructed activity promoted students' argumentation skills, thereby fostering their epistemic beliefs. This argumentation-based learning activity involved digital concept mapping. A quasi-experimental design involved pretests and posttests that were administered to 52 research participants in a group and 61 participants in a control group. Students' argumentation skills were qualitatively examined by analyzing the structure of their arguments before and after the activity. Their perceptions of the activity and epistemic belief types (from absolutism to evaluativism) were measured with the Epistemic Beliefs Scale and the Concept Mapping for Problem-Based Learning Scale. The designed activity evoked epistemic change toward evaluativism among the students who were enrolled in the activity, whereas nonsignificant results emerged for the control group. However, for both pretest and posttest, the highest score was for Absolutist, followed by Multiplist, and Evaluativist had the lowest mean. The technology-enabled concept-mapping tool supported the research group's online argumentation design. This tool helped students mainly at the cognitive level to discern between the arguments and better learn the topic. These findings are interpreted in relation to student characteristics.

Keywords Argumentation-based learning · Argumentation skills · Digital concept mapping · Epistemic beliefs

Introduction

Broadly defined as an individual's "beliefs about the nature of knowledge and knowing" (Hofer & Pintrich, 1997, p. 116), personal epistemology has become an exciting new venue for further research especially for educational scholars. Despite the mounting number of reports of interdisciplinary research into the precursors and outcomes of epistemic beliefs (Greene & Yu, 2016; Muis et al., 2015), research that aims to promote epistemic change is only at a nascent stage and is hampered by a lack of validated models and measurement instruments (Asterhan & Schwarz, 2016). Recently, however, interest in epistemic change

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has surged (Kerwer & Rosman, 2018; Muis et al., 2016). At least partially, this could be attributable to the requirements for a sophisticated standpoint in a knowledge-based society (Kienhues et al., 2016). Accordingly, a variety of quasi-experimental interventions (Bendixen, 2016; Kienhues et al., 2016; Muis et al., 2016) have been shown to be effective in inducing short-term change toward advanced epistemic beliefs. However, most of these short-term intervention studies are often focused on science education and failed to indicate the kind of desired change in epistemic beliefs and to ensure that advanced epistemic beliefs prosper (Kerwer & Rosman, 2018).

In this study, an argumentation-based learning approach with digital concept mapping was used to foster argumentation skills, thereby shaping individuals' epistemic development. Argumentative reasoning is considered to be one of the essential twenty-first century cognitive skills that should be promoted in higher education and that seems to be effective in nurturing advanced epistemic beliefs (Nussbaum & Bendixen, 2003; Nussbaum & Schraw, 2007; Nussbaum et al., 2008). To assess this speculation in this quasi-experimental study, a learning activity was designed and activated, followed by students' argumentations being evaluated and the effect of the activity on students' epistemic beliefs being examined. Moreover, because differences in culture, socio-economic status (SES), prior domain-specific knowledge, and prior argumentation skill potentially could affect students' epistemic beliefs (Assenheimer et al., 2016; Asterhan & Schwarz, 2016; Chan & Elliott, 2002; Ozkal et al., 2011), these student characteristics were addressed in order to examine and control their potential effects on epistemic beliefs. Our research might contribute to a better understanding of learning environments that potentially affect epistemic change among higher-education students.

Literature review

Epistemic beliefs

Different terms have been used to define cognitions about epistemic matters, such as epistemic cognition (Greene et al., 2008), reflective judgment (King & Kitchener, 2004), or epistemic beliefs about knowledge and knowing (Muis et al., 2015). Hofer and Pintrich (1997) used the term 'personal epistemology' to depict beliefs about the nature of knowledge and the processes of knowing, including the dimensions of sources of knowing and justification (such as the use of evidence). Chinn et al. (2011) suggested the term *epistemic cognition* as an overarching concept encompassing all kinds of cognitions related to epistemic issues, including "knowledge, its sources and justification, belief, evidence, truth, understanding, explanation, and many others" (p. 141). They underscored the importance of this cognition for learning processes and outcomes. In the current study, the term 'epistemic beliefs' was used to refer to students' beliefs about knowledge and knowing, more directly.

This study drew on Kuhn et al.'s (2000) model which is particularly relevant to argumentation (Asterhan & Schwarz, 2016). This model includes three stages of epistemic beliefs and understanding: *absolutist, multiplist*, and *evaluativist* levels. From an absolutist point of view, knowledge comprises facts that are to be discovered. Absolutists believe that knowledge is certain and unchanging, and that an objective truth exists. For multiplists, knowledge is seen as inherently subjective, consisting not of facts but of opinions, generated by human minds, uncertain and not subject to evaluation. These individuals are

less likely to explore inconsistencies and to become genuinely involved in argumentation (Asterhan & Schwarz, 2016; Kuhn et al., 2011). The final level is called evaluativism, with individuals recognizing the significance of weighing evidence and addressing contradictory knowledge claims (Kuhn et al., 2000). Evaluativists are more disposed to engage in argumentation and they perceive knowledge as uncertain and subject to evaluation (Hofer & Pintrich, 1997). Hence, based on Kuhn et al.'s model, epistemological beliefs range from so-called naive, absolutistic beliefs in the existence of absolute truths to sophisticated beliefs that knowledge is, for instance, complex and tentative (Kienhues et al., 2008).

Individuals can progress along their epistemic development (Kuhn et al., 2000). For example, an individual who initially believes that knowledge is certain and stable can become convinced over time that knowledge is more complex and relativistic, and shift to the notion that knowledge is construed individually, changes over time and is the outcome of constructive and reasoned endeavors (Kienhues et al., 2008). However, researchers (Kerwer & Rosman, 2018) suggest that not all individuals reach the last stage and, in relation to designing intervention programs, "the same instructional approach may be fruitful for absolutists, while it at the same time unintentionally evokes doubt on evaluativists' advanced beliefs" (p. 3).

Teaching methods for inducing epistemic change

Epistemic beliefs were often reported as valuable precursors of students' cognition, motivation for learning, learning approaches, adaptive learning, and achievement (Greene et al., 2018; Muis et al., 2015). However, while it is widely acknowledged that personal epistemology impacts students' behavior, prior research falls short of addressing the use of educational programming to efficiently affect individuals' epistemic development. Indeed, a variety of short-term experimental interventions (Bendixen, 2016; Muis et al., 2016) have been shown to be effective in instigating a short-term epistemic change (Kienhues et al., 2016), for example, by presenting students with conflicting information. However**,** Kerwer and Rosman (2018) claim that most of these short-term interventions, which strive to evoke changes in domain-related epistemologies, often focused on science education, simply reduce absolutism but do not nurture evaluativistic beliefs. Therefore, they propose teaching methods that advance argumentation skills, thereby inducing an epistemic change.

Promoting argumentative reasoning is considered an important higher-education learning outcome. Although widely investigated in relation to scientific thinking, argumentation has been studied in diverse fields, such as psychology, education, and interdisciplinary domains (Mouraz et al., 2014). Walton (2006) views argumentation as an interactive dialogue in which participants advance arguments by proving or refuting presumptions. Van Eemeren (2018) defines it as a "a communicative and interactional act… aimed at resolving a difference of opinion with the addressee by putting forward a constellation of propositions" (p. 3). Despite the differences, all these definitions point to the use of argumentation to rationally resolve divergent opinions, questions, and issues in critical discussions (Noroozi et al., 2012). This study embraced Toulmin's (2003) definition of argumentation as a process that produces assertions and provides support by way of evidence.

Epistemic beliefs have been shown to relate to learning and instructional approaches associated with argumentation, such as problem-solving (Bendixen, 2016). Problem-based learning approaches are recommended to heighten student engagement with argumentation (e.g. moral or socio-culture dilemma-based activities where moral conflicts are discussed by means of pros and cons arguments) (Lind, 2005). Discussing a conflictual situation

destabilizes cognitive equilibrium and creates an imbalance in one's cognitive-moral structure. Finding a break-even point requires one to raise new, sustainable arguments and present information that is necessary to establish arguments (Patry et al., 2013).

Additional studies (Nussbaum & Bendixen, 2003; Nussbaum & Schraw, 2007; Nussbaum et al., 2008) demonstrated the relationships between epistemic beliefs and students' argumentation skills. Students with more-advanced epistemic perspectives were inclined to disconfirm evidence and use evidence to address others' claims. However, researchers claim that not all students have the skills necessary to engage in argumentation. They note the lack of instruction in argumentation and raise a call for teachers to use instructional methods that provide students with the tools that they need to develop argumentation skills and scaffolds to enhance the quality of students' arguments. Such learning environments, where argumentation is practised, should expose learners to the criteria used to construct an argument, help them to gain the ability to identify a coherent argument, and engage them in dialogical discourse (Duschl & Osborne, 2002). Nussbaum and Schraw (2007) suggest encouraging students to use both arguments and counterarguments when writing opinion essays using criteria instruction and a graphic organizer. Hence, it seems that instruction on constructing a sound argument is needed if students are to benefit from argumentation.

In these learning environments where argumentation is employed, students are encouraged to recognize the importance of weighing evidence and various knowledge sources. The process includes formulating structured queries and conducting searches of resources from which reliable evidence can be acquired (Horntvedt et al., 2018). Based on their previous experience, students can be accustomed to the traditional way of learning which corresponds to an absolutist point of view; hence, the most challenging step in these processes is getting students to recognize uncertainties (Kuhn et al., 2000). Embracing uncertainties seems to be a challenge for students, but could provide better opportunities for epistemic development. Web-based experiential learning strategies are suggested for improving students' engagement and experience in learning environments aimed at getting students to recognize uncertainties through argumentation.

Concept mapping for supporting argumentation processes

Asterhan and Schwarz (2016) discuss a number of software tools that have been designed to facilitate argumentation, such as computerized collaboration scripts, visual representations of argumentation structures, and predefined sentence openers which move the participants to create maximal divergence of ideas. Yet, although their review shows the effectiveness of technology design in supporting students' online argumentation, the authors point to several lacunae, mainly that the research has focused on the effects of software design on online argumentation without empirically considering its effects on the social aspects of argumentative dialogue.

To circumvent this problem in the current study, a technology-enabled concept mapping method was used for the first time to facilitate argumentation processes. A concept map is a visual representation of knowledge which enables one to organize and structure information and the relationships between them within a particular domain (Novak & Gowin, 1984). This could be accomplished in a wholly-graphical manner (i.e., using images, photos, colors etc.) to highlight differing concepts and their interrelationships or by identifying key concepts by names or titles, and enclosing them in visual boxes (Jennings, 2012).

In contrast to lecture-based teaching methods, concept mapping is a student-centered method which has been demonstrated repeatedly to have a positive impact on the quality

of student learning by improving students' thinking and decision-making skills, abstract reasoning, critical thinking skills, and creativity compared with more-passive lecturing method (Chan, 2017). Concept maps provide a way to address twenty-first century skills identified as critical thinking and problem solving (e.g., Partnership for 21st Century Skills, 2014). Drawing on the ICAP framework that categorizes students' engagement behaviors into one of four modes (Interactive, Constructive, Active, and Passive), Chi and Wylie (2014) underscore the superiority of using concept mapping in a constructive, active manner when students must generate a map over a variety of passive activities such as reading a text or listening to a lecture. Research has also been increasingly devoted to investigating the effectiveness of collaborative concept mapping by which students co-construct their shared knowledge (Lin et al., 2016). Although concept mapping can easily be utilized to co-construct arguments, literature in the area of argumentation design through concept mapping remains sparse.

Individual differences affecting epistemic beliefs

Although cultural and socioeconomic status (SES) differences potentially could affect students' epistemic beliefs (Chan & Elliott, 2002), only a handful of studies reported differences in their results attributable to variations in cultural values. For example, when Assenheimer et al. (2016) measured first-year medical students' epistemic beliefs across Eastern and Western higher-education systems, they reported significant differences in the disciplinary epistemic beliefs held by students from Australia and Malaysia. The researchers suggest that some of these differences might stem, in part, from the different cultural and learning environments in the two countries.

There is some evidence that epistemic beliefs can be affected by the degree to which a culture is collectivist or individualist (HofstedeKim et al., 1994; Triandis, 1995). Felbrich et al. (2012) assert that, in individualistic countries, learners acquire knowledge mainly independently whereas, in collectivistic countries, the role of social relationships for the acquisition of knowledge is more prominent. Moreover, in individualistic cultures, learning and teaching are heavily skewed towards the student-centered approach whereas in collectivistic societies, teacher-centered approaches prevail with students expecting to be taught how to do something. The authors established this conclusion by reviewing several studies involving different Western and Asian countries and showing that learners from individualistic societies tend toward abstract conceptualization and active experimentation in learning. On the other hand, learners from collectivistic societies are more likely to prefer concrete learning experiences.

In Israel, the Arab culture reinforces collectivist orientations and stresses the priority of the extended family over that of the individual compared with Western societies (Dwairy et al., 2006). The formal Arab education K – 12 system mainly employs traditional teaching methods (Ben-Rabi & Hanadin, 2013). As a result, "the prospective academic students are not exposed at all to learning experiences that encourage questioning and critical reasoning, are not required to independently process information … to independently formulate an argument or conclusion, and so on. These are the basic skills required for academic studies" (Shaviv et al., 2013, p. 42).

In addition to cultural differences, SES also was found to be related to Turkish school students' scientific epistemic beliefs (Ozkal et al., 2011). Findings showed that high-SES students were more likely to hold tentative rather than fixed views about science compared with low-SES students. This study implies that students from high-SES

families are more likely to believe that knowledge is uncertain and they tend to be critical about knowledge provided by the authority compared with students from low-SES families.

Prior domain-specific knowledge and individual differences in argumentation skills might predict the quality of student argumentation in a specific domain, thereby shaping individuals' epistemic development. Asterhan and Schwarz (2016) argue that, in order to weigh meaningful alternatives, to produce counterclaims, and to rebut challenges, one should be knowledgeable about the topic of discussion and its domain. The researchers also indicate that few individuals attain skills of argumentation during adolescence and adulthood and that the main challenge pertains to distinguishing between evidence and explanation, providing adequate evidence for their claims, addressing their opponents' claims, refuting arguments, and producing alternative ideas.

This study

Based on the foundation of the aforementioned studies, the first purpose of our research was to design an argumentation-based learning activity with digital concept mapping for higher-education students. The analytical focus of this paper is on the importance of argumentative skills in higher education. Therefore, our second objective was to establish how the newly-constructed activity can promote students' argumentation skills. To this end, submitted assignment work produced by students was evaluated. The third purpose was to shed some light on how this designated activity can generate a change toward advanced epistemic beliefs. Accordingly, the following research questions and hypotheses were formulated:

Q1 How effective is an argumentation-based learning activity with digital concept mapping in promoting students' argumentation skills? To assess the effectiveness of the activity in promoting students' argumentation skills, the quality and structure of students' arguments before and after the activity were evaluated.
Q2 Can an argumentation-based learning activity with digital concept mapping elicit epistemic change toward advanced belief types (i.e., not simple reduction of absolutism at the cost of rising multiplistic beliefs but rather a simultaneous change toward evaluativism)? It was anticipated that students participating in the activity would be inclined to embrace advanced belief types by the end of the activity (posttest) compared with their beliefs prior to the intervention (pretest), whereas students who were not enrolled in the activity (control group) would not report significant changes in their beliefs (*H1*).
Q3 How do students perceive the effectiveness of using concept mapping in constructing arguments? An effort was made to identify the most-effective concept mapping factors that contribute to argumentation skills.

Accordingly, this quasi-experimental study included two main phases. In Phase 1, the learning activity was designed and activated. Students' argumentation skills were evaluated (*Q1*). Phase 2 included analysis of quantitative data gathered before and after the activity (*Q2* and *Q3*). Background variables (e.g., prior domain-specific knowledge and individual differences in the skills of argumentation, SES, age, gender, and ethnicity) were addressed to examine and control their potential effect on the research constructs. Figure 1 illustrates the research design.

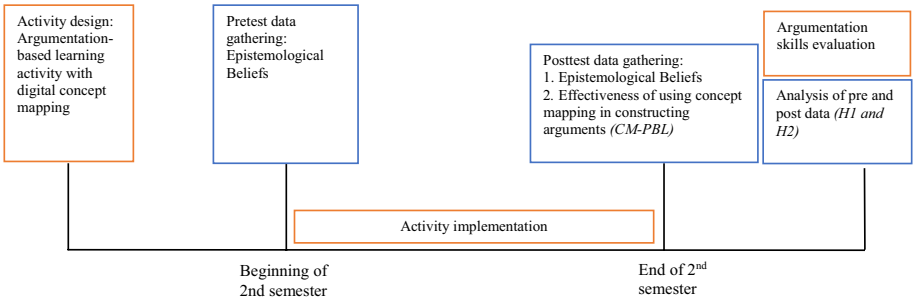

Fig. 1 Research design

Method

Participants

Quantitative data were gathered twice in (pretest and posttest) from students who chose to complete the questionnaires. The pretest involved 52 research group students (out of a total of 60) and 61 control group participants (out of a total of 75 students). The posttest involved 59 research group participants and 73 control group participants. Both the research and control groups included second-year Social Science (Family and Education studies) Arab Muslim undergraduate students from a major college, located on the periphery of Israel and established for the purpose of widening access to higher education for minority populations living there. Students comprising the research and control groups were enrolled in two identical compulsory 13-week courses entitled 'Conflict dynamics and negotiations' in the second semester by the same instructor and research assistant. These two groups were randomly selected from four identical courses during the second semester.

Two pretests were conducted to assess students' prior domain-specific knowledge and prior skills of argumentation. Students were first asked if they had previously studied the course content dealing with conflict. This examination revealed that the students in both groups had not previously studied the course or its contents according to their reports. Six students from the research group and five from the control group reported that they had learned the content of the course in non-academic settings. In addition, during the first lesson, a task was given to both groups to assess students' ability to construct an argument. The objective of this task was to ascertain their previous knowledge of dealing with and solving conflicts and their ability to construct an argument (additional details appear at the 'intervention program – stage 1'). Their responses revealed that the students from both the research and control groups were equally unfamiliar with the contents of the course with reference to the theories and known methods of coping with conflicts and were not experienced in constructing an argument.

With reference to additional characteristics, Table 1 details the research and control groups' characteristics (pretest). Nonsignificant between-group differences were found between the groups on the following variables: age, gender, and socioeconomic status (SES) assessed by the student's father's educational attainment (FEA) and mother's educational attainment (MEA). The most frequent MEA and FEA category in both groups was 3 = high school education.

Table 1 Characteristics of research and control groups at pretesting

Characteristic	Research group $n=52$	Control group $n=61$
Mean age (years)	23.16 ($SD=6.24$)	21.62 ($SD=1.82$)
Gender	17.6% male	11.5% male
FEA	2.75 ($SD=0.88$)	2.98 ($SD=1.02$)
MEA	3.11 ($SD=0.96$)	2.87 ($SD=0.83$)

Prior to obtaining participants' consent, it was explained that the questionnaires were anonymous and that it was acceptable for them to choose to return a partially-completed questionnaire. Finally, participants were assured that no specific identifying information would be processed. The study was preauthorized by the college's Ethics Committee.

Phase 1: Qualitative data (Q1)—activity design and evaluation of arguments

Activity design and procedure

The intervention program included three stages. At the beginning of the semester (*Stage 1*), an identical task was given to both the research and the control groups with the objective of assessing previous knowledge of the topic of coping with and solving conflicts and of constructing an argument. The task involved presenting a conflict between a couple named Dana and Rami. The students were asked to report how the conflict could be resolved, using appropriate arguments.

During *Stage 2*, both groups received identical treatment in that they were exposed to the course content that included models for dealing with conflicts, such as the Thomas-Kilmann Conflict Model (Kilmann & Thomas, 1977; Shell, 2001), models for cooperation (Adam Grant's Give and Take Approach; Grant, 2013), the Difficult Conversations Approach (Stone et al., 2010), and Marshall Rosenberg's Nonviolent Communication Model (Rosenberg, 2015). Students were taught the material through lectures and by reading academic articles. In addition, they received individual and group support throughout the 13-week duration of the course.

At *Stage 3,* the research group and the control group received different treatments. While the control group received an assignment in reading academic material and answering questions, the research group received a complex task with the objective of learning how to construct an argument. Argumentation instruction included sessions involving definitions of reasoning and evidence, digital literacy including information evaluation, the components of an argument, and how to develop claims (and counterclaims) backed by reasons that are supported by evidence. Students were asked to review the dilemma presented to them at the beginning of the course which dealt with a conflict between a couple. This time, however, they were asked to work in groups and to submit a paper that discussed the following:

1. Choose four models that can potentially either resolve the conflict or exacerbate it.
2. Note the names of the four models and describe them.
3. Describe how each model might resolve or deepen the conflict.
4. Base each argument on support or evidence provided by the study material or other sources such as articles in the press or educational videos.

5. Describe and explain at least two similarities or differences between the various models and arguments.

In addition, students were asked to present their work using Mindomo, a digital platform that allows the user to visually outline complex concepts, tasks, or ideas. It covers concept mapping, task mind mapping and outlining functionalities, enables real-time collaboration, and functions as a hypertext-based environment enabling the integration of a wide range of formats.

Finally, students were asked to relate to their personal learning process by writing a reflective journal in which they were instructed to write about their self-perceived progress from the departure point of their preliminary argument and progressing to a more complex one, and to describe their challenges and gains in light of the learning experience.

Evaluation of students' arguments

To assess the effectiveness of the above argumentation-based learning activity with digital concept mapping in promoting students' argumentation skills, the quality of their initial arguments in relation to the dilemma was compared with their arguments presented by the Mindomo platform. In addition, the structure of their later arguments was assessed. Drawing on Reznitskaya et al.'s (2007) model, Schwarz and Baker (2017) present argument structure in the form of a metaphorical 'house' in which the top (the roof) represents the position being put forward; on the second floor, right beneath the roof, reside the 'reasons for' it (and objections to it); and the ground floor represents the supporting facts (examples and details) and responses. This figurative procedure enabled us to assess the quality of the structure of students' arguments. In addition, rubrics were designed to evaluate the structure of the arguments presented in the maps and were given to students at the beginning of a task to help them to establish appropriate goals, as illustrated in Table 2. The rubrics articulate the expectations for the assignment by detailing the assessment criteria and levels of quality in relation to each of these criteria (Panadero et al., 2013).

Below we present two examples to illustrate the progress of students in the research group. These examples show the initial argument, as documented at the beginning of the semester, followed by a map and a structured argument presented at the end of the procedure. The findings then are discussed in brief.

First example

The following is the student's initial argument. "This is a personal disagreement between a couple. In order to deal with the problem described here, Dana must talk to Rami about the problems that have been created between them regarding the arguments that have caused anger and tension between them. Dana has to explain to Rami calmly and pleasantly why it is important to her for him to go out with her when she spends time with her girlfriends, and try and convince him that she needs this and that it would be good for him to go out with her as a couple. The disagreement can be solved if they reach a compromise. Both Dana and Rami need to compromise. Dana can advise Rami about what to do to feel more comfortable when she goes out with her girlfriends and their husbands."

Table 2 Rubric for assessing the concept map

Criteria/score	Score			
	4	3	2	1
Arguments and supporting information	All four arguments and justifications with supporting items of information are included	Two–three arguments and justifications with supporting items of information are included	One argument and justification with supporting items of information is included	Arguments and justifications with supporting items of information are incomplete and/or incorrect
Hierarchy	The organization is complete and correct. The supporting information corroborates the arguments	The organization is correct but incomplete. Most of the supporting information corroborates the arguments	The organization is correct but incomplete. Most of the supporting information does not corroborate the arguments	The organization is incomplete and/or incorrect
Relationships among arguments/supporting information	Relationships were specified and well-explained	Relationships were partly specified but explained	Relationships were partly specified but not explained	Relationships were partly or not specified and poorly/not explained
Simplicity and easiness of understanding	The design is simple and easy to understand	Some relationships are difficult to understand	There is an excessive number of connections	Neither the relationships nor the hierarchy are understandable

Second example

The student's initial argument follows. "In my opinion, Dana needs to make Rami feel comfortable. Next time, she needs to be sure to sit next to him and to make sure that he feels comfortable with her girlfriends or with other guys. If he is still "suffering" and doesn't find his place after two or three more times, she should go by herself. After all, he told her that he doesn't feel connected and told her to go by herself. She should overcome her difficulty and go alone."

Analysis of the students' assignments revealed that, during the first stage, there were no differences between the research group and the control group in terms of their ability to construct an argument. Firstly, the initial argument did not include any reference to the theoretical literature or ways of coping with conflicts that have been validated previously. Secondly, in many cases, the initial argument lacked structure, basis, or rationale. For example, in his first argument, one of the students wrote: "The woman should try to find common interests between herself and her partner. That way, perhaps they will learn to like each other." This answer lacked any reference to questions such as why this proposal is effective, why her partner would agree to this possibility, and how "learning to like each other" constitutes a solution to the conflict. Accordingly, the first answers were actually opinions that were chosen freely and intuitively by the students. Most of the answers to the initial argument began with "In my opinion…" as seen in the second example. This strengthens the assumption that the students were simply expressing their opinion in their answer rather than offering a complete and substantive argument.

In the research group, there were significant differences between most of the students' initial answers and the subsequent answers that made use of a concept map. The argument using the concept map was more complex and broad, in contrast to the initial answers, in three aspects: (1) the number of models and their basis upon theories for coping with conflicts, which served as the basis for selecting the proposed model, (2) the component of application for which students needed to show how the theory is expressed in an example, and (3) the element of comparison that enables the student to compare several arguments and present their similarities and differences. This complexity is expressed in the above examples which illustrate the structure of the argumentation, with the top rectangles being used by students in their maps to explain each theoretical model and the reason why it can successfully resolve conflicts. The model was then applied to the conflict of the couple and strengthened and supported with links to short explanatory videos or academic materials.

The tasks of choosing four models, providing a theoretical explanation for the basis of each model, applying them to the conflict, and providing examples using articles were fulfilled thoroughly in the majority of projects that were submitted. However, the most difficult part of the entire process of writing the argument and creating the concept map was the comparison between the four models. This part of the task required the use of conceptual knowledge. It appears that the use of the digital concept map helped students to perform the comparison itself (specifying lines between models), but in a relatively-superficial manner. For example, when comparing the Thomas–Kilmann collaborating win–win model with a competing winner-loser model, students usually noted that the differences lay in the fact that the first model includes only winners, while the second includes a loser. A more-comprehensive comparison would have featured an understanding of the difference between the models from the aspect of coping with conflicts, adapting each to the different types of conflicts and situations,

and their connections to a broader theory about coping with disputes. For example, in the application of the first collaborating model to long-term relationships, the nature of past and future relationships is important, while the competing model describes a one-time encounter in which the past and future of the relationship is unimportant.

Phase 2: Quantitative data (*Q2* and *Q3*)

Measurements of epistemic beliefs

Drawing on Kuhn et al.'s (2000) model, which is particularly relevant to argumentation, the following question was formulated to ascertain students' epistemic beliefs on three levels before and after the intervention: an Absolutist level at which knowledge is understood to be certain and unchanging; a multiplist level according to which knowledge consists not of facts but of opinions, freely chosen by their holders as personal possessions; and an evaluativist level at which knowledge assertions are judgments that can be evaluated and compared according to criteria of argument and evidence. The following scenario was constructed by the current study's researchers to measure the participants' epistemic beliefs in relation to an authentic and highly-debated issue raised every year in Israel.

> Each year the public is urged to receive flu injections. Some people say that the injections are effective and prevent infection, while others say that they are ineffective against the disease. Select the option with which you agree the most from the following statements (each level was coded as 0 = not selected by the participant or 1 = selected by the participants):
>
> A. If an individual wants to know whether the injection is effective, he/she must test this against reality. Reality is directly knowable. Whatever cannot be tested in reality does not exist (or is not valid) and cannot be argued.
> B. It cannot be determined whether the injection is effective or not because everyone has a different opinion about the injection, and there is room for every opinion. There are consequently only opinions, and there is no way of proving what is correct and what is incorrect.
> C. In order to determine whether the injection is effective or not, one must judge the assertion of those who are in favor of the injection and those who are opposed to it. If the assertion can be evaluated and compared according to criteria of argument and evidence, we can accept it.

To establish content validity (Taherdoost, 2016), items were generated by the researchers based on the literature review. Five expert judges checked whether the items on a test were fairly representative of the Kuhn et al.'s (2000) model and reported their level of agreement using a three-point scale (1 = Disagree to 3 = Agree). They were asked to suggest alternative formulations in case the items were not fairly represented by the theoretical model. The content validity ratio (CVR) was calculated for each item (Lawshe, 1975). The items were rephrased and reevaluated by the experts until a valid CVR value for the evaluated items was attained (0.99).

Concept Mapping for Problem-Based Learning Scale (CM-PBL)

Based on the theoretical framework of concept mapping with a designated decision-making process in a problem-based activity, a 12-item questionnaire was designed (Authors, under review). The questionnaire aimed to capture students' perceptions of the effectiveness of using concept maps in the argumentation-based learning process and to assess how it helped them during their decision making in relation to the dilemma, along the four factors of cognitive aspect, affective aspect, self-regulation of learning, and transfer of learning. Participants were asked to indicate their level of agreement with each of the statements shown in Table 3 using a six-point Likert scale ranging from 1 = Strongly Disagree to 6 = Strongly Agree.

Confirmatory factor analysis (CFA) with the maximum likelihood method was used to assess the construct validity of the scale. Three fit indices were computed in order to evaluate the model fit: χ^2/df (p value should be higher than 0.05); comparative fit index (CFI) should be higher than 0.9; and root mean square error of approximation (RMSEA) should be less than 0.05 for 'good' fit and less than 0.08 for 'acceptable' fit (Bentler, 2006). Amos 22 software was used for CFA analysis. The goodness-of-fit of the data to the model was satisfactory ($\chi^2 = 85.22$, $df = 48$, $p = 0.001$; $CFI = 0.961$; $RMSEA = 0.056$), hence confirming the four-construct measurement model structure.

Findings

Participants' epistemic beliefs

To check the impact of the educational intervention on participants' epistemic beliefs, a repeated-measures analysis was used. The between-subject factor was *test* (pre/post). A significant result emerged between the tests ($F_{(2, 240)} = 4.552$; $p < 0.05$; $\eta^2 = 0.037$). Regarding the within-group analysis (research vs. control) significant result emerged only for the research group ($F_{(2, 108)} = 3.343$; $p < 0.05$; $\eta^2 = 0.058$) for the Evaluativist variable, for which a higher mean result was detected in the posttest compared with the pretest. Non-significant results were found for the control group ($F_{(2, 131)} = 0.937$; $p > 0.05$; $\eta^2 = 0.030$) between the tests for the dependent variables (absolutist, multiplist, and evaluativist). Table 4 provides the means and *SD* results for each group on both tests. It can be concluded that *H1* was partially confirmed.

To assess differences between the three dependent variables (absolutist, multiplist, and evaluativist) in each test (pre/post) for each group (research/control) a paired samples *t*-test was used. Regarding the research group, in both tests, significant differences were detected between evaluativist and the other variables: absolutist (pretest: $t_{(51)} = 8.057$, $p < 0.001$; posttest: $t_{(58)} = 3.390$, $p < 0.01$), and multiplist (pre-test: $t_{(51)} = 4.804$, $p < 0.001$; post-test: $t_{(58)} = 2.430$, $p < 0.05$). For both results, evaluativist had the lowest mean result. A nonsignificant result was found for both tests between absolutist and multiplist.

For the control group, in the first test, significant differences were detected between all pairs of variables: absolutist–multiplist ($t_{(60)} = 2.690$, $p < 0.01$); absolutist–evaluativist ($t_{(60)} = 5.890$, $p < 0.001$); and multiplist–evaluativist ($t_{(60)} = 2.558$, $p < 0.05$). For the posttest, significant differences were present only between evaluativist and other constructs: absolutist ($t_{(72)} = 2.981$, $p < 0.01$) and multiplist ($t_{(72)} = 2.419$, $p < 0.05$).

Table 3 Sample items and reliability for factors of Concept Mapping for PBL Scale (CM-PBL)

Scale	Sample items	Alpha reliability
Cognitive aspect	Concept mapping helped me identify the interrelationships among arguments Concept mapping helped me specify interrelationships among arguments Concept mapping helped me learn about the topic	0.94
Affective aspect	I was satisfied using concept mapping in making decisions I liked using concept mapping to assist me in making decisions I enjoyed using concept mapping during the decision-making process	0.95
Self-regulation of learning	Concept mapping stimulated me to learn and think independently Concept mapping helped me to reduce barriers when dealing with decision-making Concept mapping enhanced my interest in decision-making	0.94
Transfer of learning	I think concept mapping can be easily used in other decision-making discussions I will consider using concept mapping in other complex decision-making processes I will consider using concept mapping to make decisions in the future	0.94

Table 4 Epistemological beliefs: pretest and posttest mean and standard deviation

Scale	Research group				Control group			
	Pretest		Post test		Pretest		Post test	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Absolutist	.615	.491	.474	.503	.606	.492	.438	.499
Multiplist	.365	.486	.372	.487	.295	.455	.383	.489
Evaluativist	.019	.138	.153	.362	.117	.385	.141	.350

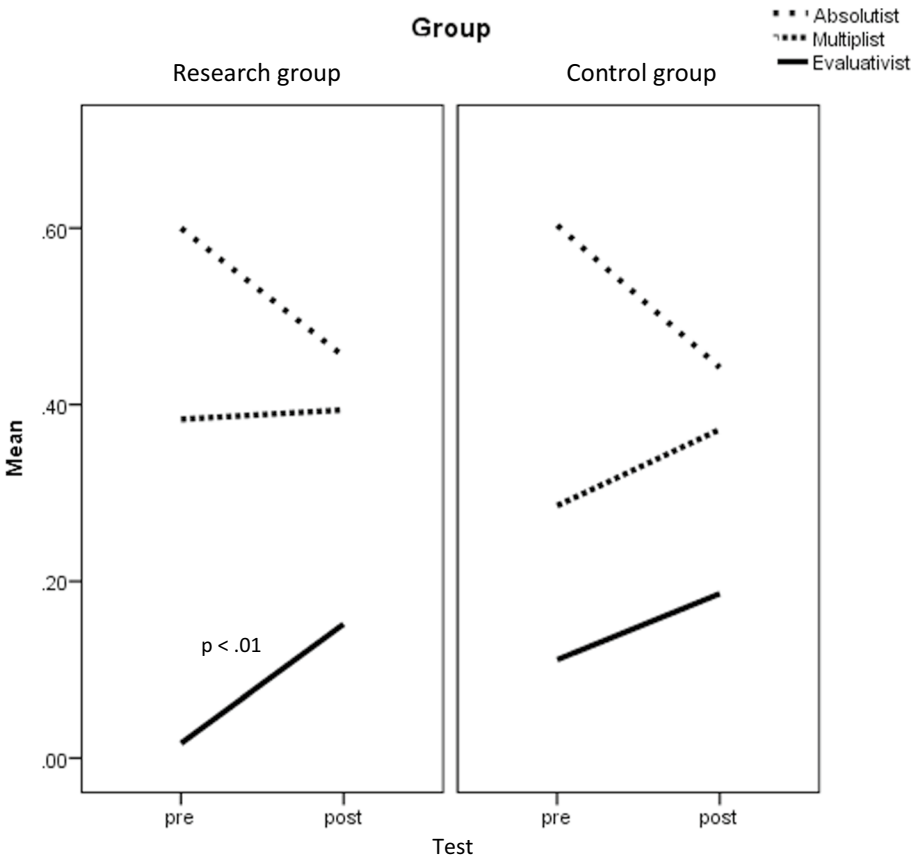

Fig. 2 Mean results for the between-tests analysis in each group

Figure 2 illustrates the between-tests differences for each group. Figure 2 suggests that, for both groups, and for both tests, the highest scores were for absolutist, followed by multiplist, and then evaluativist.

Perceptions of concept mapping for argumentation-based learning

Paired samples *t*-tests were used to assess the research group's perceptions of the effectiveness of technology-enabled concept mapping in the argumentation-based learning process. This involved comparing the means for the following CM-PBL's sub-factors: Cognitive aspect, Affective aspect, Self-regulation of learning, and Transfer of learning.

Figure 3 shows that Cognitive aspect ($M=4.532$, $SD=1.279$) and Self-regulation of learning ($M=4.456$, $SD=1.38$) factors had the highest means, with nonsignificant differences between them ($t_{(56)}=0.787$, $p>0.05$). Each had significantly-higher means than Transfer of learning ($M=4.260$, $SD=1.379$; $t_{(56)}=3.306$, $p<0.01$; $t_{(56)}=2.154$, $p<0.05$) and the Affective aspect construct ($M=4.231$, $SD=1.360$; $t_{(56)}=3.063$, $p<0.01$; $t_{(56)}=2.677$, $p<0.05$).

Discussion

The main thrust of this study was to design an argumentation-based learning activity using digital concept mapping for higher education students and to assess how a newly-constructed activity might promote students' argumentation skills and, in turn, their epistemic beliefs. Based on the findings, it might be inferred that the designed activity elicited

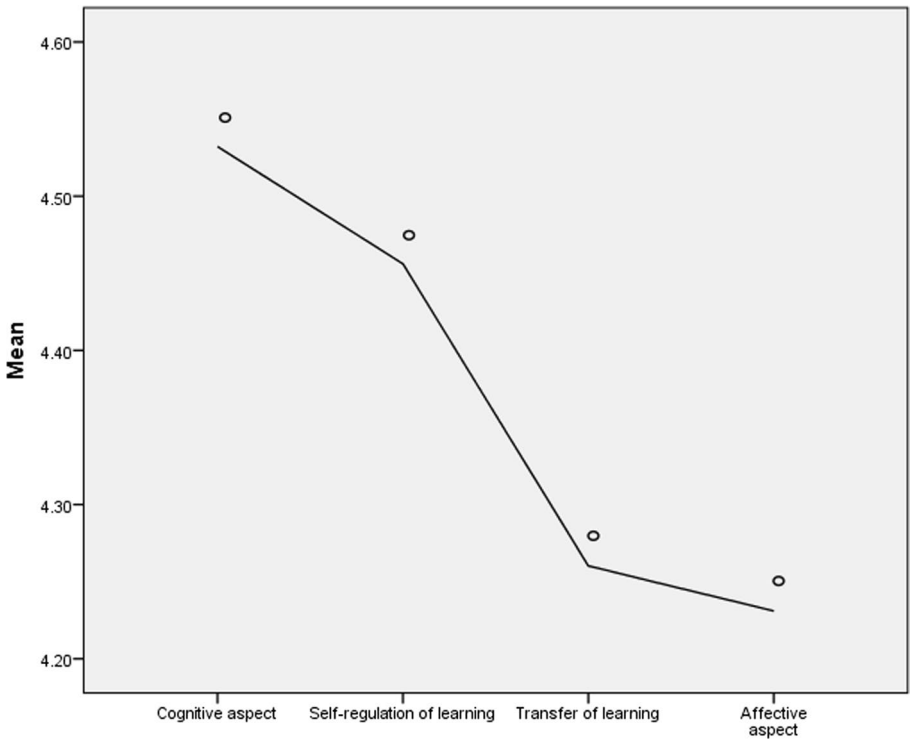

Fig. 3 Mean results for concept mapping for argumentation-based learning sub-factors

epistemic change toward evaluativism among the students who were enrolled in the activity, whereas nonsignificant results emerged for the control group.

Another important finding for both tests (pre/post) was that the highest scores were shown for Absolutist, followed by Multiplist, while the lowest mean result was shown for Evaluativist. This can be explained by student characteristics. Students comprising the sample were predominantly of low-SES and were affiliated with Arab minorities living in the periphery of Israel. This study elaborates past work by showing the stable effect of culture on students' epistemic beliefs, on the one hand. However, on the other hand, it exemplifies a promising educational effort that, over time, might slightly change students' epistemic beliefs.

When offering such activities to students of collectivist cultures, the designers should identify and accommodate students' previous educational experiences and expectation of the learning process. As indicated by previous research (Felbrich et al., 2012; Ozkal et al., 2011), SES and instructional approach within collectivistic cultures might impact students' epistemic beliefs. In individualistically-oriented cultures, inquiry-based approaches that provoke reflective thinking and self-regulation of learning prevail whereas, in collectivistic societies, teacher-centered approaches are more commonly practised, with students expecting to be taught how to do something (Shaviv et al., 2013). Moreover, having more-highly educated parents, students from high SES families are more inclined to possess advanced epistemic thinking compared with students from low SES families (Ozkal et al., 2011).

The current study revealed that, despite these characteristics, the proposed activity was valuable to some extent in promoting advanced epistemic beliefs. A possible contributing element to the activity, which was positively perceived by students, was the technology-enabled concept mapping tool which supported their online argumentation design. According to students, this tool helped them mainly at the cognitive level to distinguish between arguments and better learn the topic. This could suggest that, although not previously used for this purpose, platforms which enable concept mapping can be easily utilized to co-construct arguments. However, while the students in this study pointed to the positive effect of the concept mapping on their in-depth learning and self-regulation of learning, they also expressed less willingness to transfer the skills to other complex decision-making situations. It is plausible to assume that a more-consistent practice is needed to facilitate the transferability of the skills to other situations (Lobato, 2003; Quinlan, 2020).

Limitations and future directions

The present study had limitations that suggest directions for future research. Because the scale used in the study to gauge students' epistemic beliefs suggests an authentic dilemma that is not specifically skewed toward the students' main educational domain, it is based on the notion that differing beliefs on knowledge and knowing are not reliant on the content domain. This domain-generic approach (e.g., Schommer, 1993) assumes that individuals possess similar epistemic beliefs across content domains. However, based on recent assumptions, which indicate that epistemic beliefs encompass both domain-specific (and even specific topics within certain domains) and domain-generic aspects (Kerwer & Rosman, 2018), future interventions that correspond with the specificity of the information used to evoke changes in epistemic beliefs are advised.

While this study showed that argumentative skills can be honed to some extent through designated instructional activities, it did not explore how this in turn could impact the learning of domain-specific knowledge. Because this is considered an important topic in

recent studies (Asterhan & Schwarz, 2016; Schwarz & Baker, 2017), future researchers should investigate how the argumentation activity might be connected to learning outcomes other than argumentation skill enhancement, as well as how motivational factors might affect students' engagement in such activities.

Conclusions and implications

Epistemic beliefs evolve as individuals move through the education system and follow a common trajectory in developing increasingly-complex beliefs throughout their formal education. Yet, despite their central role, these beliefs are still poorly understood and the role of teaching and learning enterprises that might support them remains unclear (Assenheimer et al., 2016).

This study raises awareness of a technology-enabled argumentation-based learning activity for higher-education students that might advance students' epistemic beliefs by fostering their argumentative skills. However, its results need to be interpreted with caution. It is plausible that the designed activity helped participants to understand the structure of an argument and thus recognize the importance of providing evidence and facts to substantiate the reasoning for their position. However, a single three-month instructional intervention might not yield argumentation competencies, as shown by the qualitative evaluation of the students' maps. Underdeveloped competencies in argumentation might just be a matter of insufficient skill practice. These skills can be cultivated through programs of recurrent practice in dialogic argumentation (Asterhan & Schwarz, 2016). When argumentation activities become an integral part of the classroom experience, they might also be transferred to other subjects (Kuhn & Crowell, 2011). As shown in this study, given the challenges in fostering these essential learning outcomes, mere participation in a single activity neither automatically fosters these skills nor leads to an epistemic change. To achieve this outcome, special attention should be paid to the design and implementation of the activity, with a focus on the process and intended learning outcomes.

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