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Valuating the Effect of Toulmin Argumentation Model on Critical Thinking and Epistemological Beliefs in Online Education

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Abstract

This study investigates the effectiveness of the Toulmin argumentation model in developing critical thinking skills and epistemological beliefs concerning the internet in an online educational setting, especially during the global coronavirus pandemic. The subject of the research was carried out in the "Child Development Department" of a state university with the participation of 68 volunteer students, mostly from Eastern and Southeastern Anatolia, aged between 19 and 25. It employed quasi-experimental design in the course of the ten weeks in the 2020-2021 academic years. Data were collected through online tests and evaluations during child science and technology lessons focusing on various spatial and contemporary scientific topics. Students' critical thinking skills and epistemological beliefs were according to predetermined scales, and were analyzed using SPSS 22. Differences between the control and experimental groups were not significant for critical thinking skills or epistemological beliefs. This suggests that the implementation of the Toulmin model in an online format did not have any significant effects on these areas. Further, a very weak correlation between epistemological beliefs and critical thinking skills emerged, indicating that these constructs can work independently in online learning contexts. The results stress the complexities behind promoting critical thinking and epistemological beliefs in online learning environments, making it imperative to involve new theory in the integration of argumentation models, such as that of Toulmin's, into online education. The study seems to offer valuable theoretical guidance to the teachers and curriculum developers to effectively embed critical thinking and epistemological understanding in the digital age of education. Future research will involve longer interventions, diverse samples, and innovative strategies of teaching to affect epistemological beliefs and create opportunities for critical thinking in digital learning spaces.

Keywords: Argumentation, Online education, Epistemological beliefs, Critical thinking

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Introduction

With the global pandemic of COVID-19, the learning continuum has observed a complete change, wherein online learning came in as a viable alternative for the formal classroom learning (Telli & Altun, 2020). This paradigm shift, which primarily aims to ensure the continuity of educational activities for students, has gained ever-growing significance. The effectiveness of stages of online education is indeed a most important issue. There is an urgent need to measure and assess the effectiveness of online schooling, especially as compared to traditional face-to-face classrooms, considered as much more economic. In this context, the present study sets out to investigate the processes of students' argument construction and participation in argumentation in the online learning environment. Particularly, it studies the detailed influence of students' epistemological beliefs about the internet and their critical thinking skills in the online learning process. The research assumes that if online education proves sufficiently effective, there might be a shift to wholly online courses at some point in the future.

Literature Review

Epistemological beliefs towards the Internet

The development of technology has given the opportunity to increase technological innovations and to use them especially in the educational environment. Internet, which is one of the technological innovations, has captured almost every stage of our daily lives. The internet provides the user with the convenience of accessing all kinds of information and can provide online participation in many activities that can be done simultaneously such as messages, mail, news, and communication (Yılmaz, 2016).

The epistemological belief of the Internet refers to beliefs that individuals bring to bear regarding the nature of knowledge-how it should be achieved and measured in the data available online. Given the rising prominence of the Internet in knowledge distribution and belief formation, this very notion has attracted much interest. Users' belief in the structure, source and certainty of this information and access shows the individual's epistemological belief towards the internet (Kılıç-Çakmak, et al., 2015). Moreover, there is evidence that there is a relationship between individuals' epistemological beliefs and their preferences for internet-based learning environments (Tsai & Chuang, 2004; Lee & Tsai, 2005). Research has shown that individuals' epistemological beliefs play an important role in shaping their online information seeking strategies and their ability to critically evaluate the reliability of online information (Zimmermann et al., 2022; Yılmaz & Çakmak, 2016). For example, individuals with developed epistemological beliefs are more likely to use effective search strategies and critically evaluate the information they encounter online (Chua et al., 2020; Tsai, 2004). It shows that epistemological beliefs not only affect information seeking behavior but also affect individuals' learning experiences in online environments. Moreover, the rise of personalization on the Internet has been identified as a factor that can control and limit

the information that individuals consume, thus affecting their epistemological beliefs (Pariser, 2012). This highlights the potential impact of online personalization in shaping individuals' understanding of knowledge and information. It shows that individuals' epistemological beliefs play an important role in shaping their interactions with online information, influencing their information seeking strategies, learning experiences and decision-making processes. Understanding and studying these beliefs is essential for promoting critical thinking, effective information evaluation and informed decision-making in the digital age.

Critical Thinking

Critical thinking in education is a very useful skill, which has enjoyed more attention since recent years. It has been recognized as an indispensable ingredient of quality education within fields as diverse as economics and political science. Despite agreements about the importance of critical thinking in education, there is major disagreement with regard to its precise definition and the manner in which it should be taught and assessed (Pasquinelli et al., 2021; Stassen et al., 2011). Critical thinking is a mental process in which an individual can analyses the information he/she has acquired and use and evaluate the ways of reasoning (Gülen, 2019). The concept of critical thinking is multifaceted with different interpretations and applications in educational settings (Kahlke & Eva, 2018). It is about the criticality behind the analytical process of one informing alternative solutions and reflecting on one prejudices thus providing thought process that is overly complicated due to diverse experiences in learning (Johnsen et al., 2012). It is one of the most important qualities to acquire for productive management and quality education in and of itself (Kettler, 2014). It is believed that emphasizing critical thinking in teacher education will lead to a critically thinking society at all levels and enable more effective problem solving in society (Allamnakhrah, 2013). Furthermore, critical thinking is considered crucial for decision-making and lifelong learning, emphasizing its role in personal, professional and societal change (Walker & Brown, 2020; Casiraghi, 2017). The application of critical thinking in higher education is seen as a way to promote students' lifelong learning and develop their speculative and creative thinking abilities (Ning & Dan, 2017).

Critical thinking towards the Internet is a very important skill in the digital age because the Internet has become the primary source of information on various aspects of life, including health, education, and social participation. Critical thinking is another skill that needs to be emphasized in open education processes. Since the information provided in the online process is independent of the social environment, the individual should learn in a way that is open to innovation and constructive knowledge in an environment of interaction and discussion by being excited without robotization (Arslankara & Usta, 2020). In the smart classroom environment, attention has been drawn to the impact of the Internet on students' critical and innovative thinking (Xing & Lu, 2022). In the field of digital literacy, the need to develop a culture of critical thinking to engage with internet

content, especially among students, has been emphasized (Tınmaz et al., 2022). This is supported by the claim that Internet literacy should encompass critical thinking due to the blurring of boundaries between virtual and real, work and leisure, and public and private spheres (Setiansah et al., 2021). In other words, it is the ability to recognise both the good and bad aspects of information. The implications of and for the notion of secondary education have thus fundamentally challenged the development of appropriate learning outcomes and criteria for its assessment within educational environments (Donnelly, 2018). Beyond that, a challenge facing critical thinking is a widely held belief that, while it is very much needed, critical thinking education methods presently in use continue to evoke question as to their effectiveness, thus calling for further works in this regard (Pasquinelli et al., 2021). It is a matter of curiosity whether the individual's belief in the internet is critical in terms of internet use. In particular, it is aimed that students are aware of the positive and negative aspects of internet use and online education.

Argumentation

The Toulmin Argumentation Model, introduced by Stephen Toulmin in his book The Uses of Argument (1958), provides an effective framework for constructing arguments through structured components such as claims, justifications, data, qualifiers, rebuttals and support. This model contributes to the development of argumentation skills by enabling students to follow a structured path in the analysis, evaluation and justification processes and is widely used in educational settings (Sampson & Blanchard, 2012; Erduran et al., 2015). The model form will instill analytical skills which allow the development of critical thinking by encouraging students to formulate arguments that are well justified and supported with reason. The Toulmin Model is thus regarded as a mighty tool to develop skills for critical thinking and finds application across many disciplines.

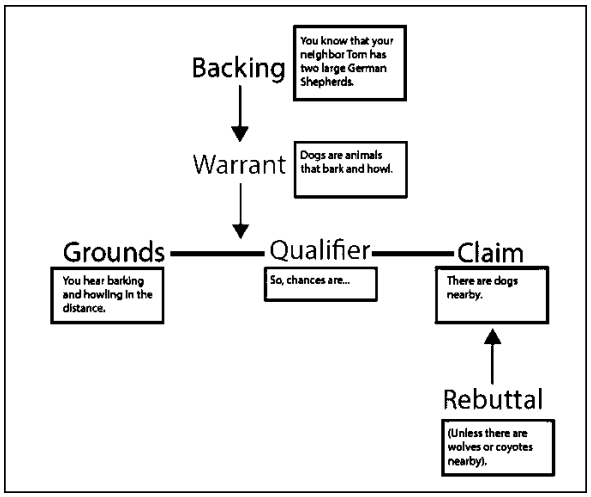

Figure 1. Toulmin Argumentation Model

The model in Figure 1 was developed by Toulmin. According to this model, the opinion or solution proposal put forward to find a solution to a certain problem is defined as claim, observations and facts used to support the claim are defined as data, reasons supporting the claim are defined as justification, giving examples to strengthen the justification is defined as support, positive aspects and pros of the claim are defined as qualifiers, negative aspects, cons and refutations are defined as refutations. Based on this model, the participants are expected to engage in the argumentation process and develop their critical thinking skills by using the information they have acquired online with the influence of their epistemological beliefs about the Internet. Basically, an individual is expected to form arguments about a topic or idea by using the knowledge he/she has acquired. When we analyze arguments, wherein one is describing claims, with some form of justification or support provided/indicated for the data with such claims, these are the arguments developed during this process, which is thus referred to as the argumentation process (Gülen & Yaman, 2019)

Different studies say that the use of the Toulmin Model in academic settings facilitates critical analysis and reasoning due to its huge effect on them (Lytzerinou & Iordanou, 2020; Nussbaum, 2020). Research emphasises that this model can guide students to critically evaluate knowledge through structured argumentation and that the model can be adapted to online environments such as virtual science learning (Acar & Azaklı, 2023; Telenius et al., 2020). Especially in online education, it has been stated that argumentation can broaden students' perspectives and deepen the understanding of classroom practices (Telenius et al., 2020). In addition, teaching argumentation skills has been found to have a positive effect on students' cognitive skills such as critical thinking and metacognitive abilities (Acar & Azaklı, 2023). In addition, the use of digital concept maps in argumentation conflict resolution studies has the effects of improving students' discussion skills and domain-specific knowledge (Kapshuk & Alt, 2022). The relationship between students' prior knowledge and online learning approaches on inquiry and argumentation skills is emphasised and it is stated that insufficient prior science knowledge limits the construction of quality arguments (Yang et al., 2015). The effectiveness of argumentation-based teaching strategies in improving students' understanding, reasoning and decision-making skills is also supported by research findings (Widodo et al., 2023). Students are expected to produce knowledge-based arguments and engage in the argumentation process.

Critical thinking is a core competency defined as the process of actively analysing, synthesising and evaluating information to make informed decisions in education (Ennis, 1996; Kettler, 2014). This skill plays an important role in education as it enables students to evaluate complex information and make inferences from various learning experiences. Educational approaches that promote critical thinking often include elements of discussion and questioning; these methods encourage students to question assumptions, seek evidence and refine their conclusions. The Toulmin model is aligned with critical thinking frameworks such as Bloom's Taxonomy and Ennis‘ theory as it offers a

structured argumentation process to develop students' critical thinking skills (Ning & Dan, 2017). The Toulmin model is considered to have the potential to support students to develop a critical approach to online information because it promotes the competencies of analysing and questioning information and developing counterarguments (Sampson & Blanchard, 2012; Erduran et al., 2015).

Research has shown that when students interact with Toulmin's model, especially in educational settings, it can influence their epistemological beliefs by promoting a deeper understanding of the nature of scientific and argumentative reasoning. A study that found that the use of a Toulmin-based argumentation model with epistemological content improved students' epistemological beliefs compared to traditional curriculum methods suggests that open discussions about knowledge within Toulmin's framework facilitate more detailed beliefs about knowledge (Kızkapan & Bektaş, 2021). Another analysis of Toulmin's model argues that it provides a flexible approach to understanding argument structures while avoiding the pitfalls of epistemological relativism. This supports the idea that Toulmin's framework promotes a balanced and critical perspective that can develop sophisticated epistemological beliefs about the standards and structure of knowledge (Bermejo-Luque, 2004). Having calculated this, research shows that the use of the Toulmin argumentation model could support students' development in the understanding of advanced epistemological ideas, as seen through their exemplary reasoning and metacognitive skills (Bromme et al., 2010). Additional research indicates that the Toulmin Model in a digital environment helps students' epistemological beliefs toward knowledge. In this context, it is believed that structuring discussions using the Toulmin Argumentation Model has the potential to build students' confidence and critical perspective regarding knowledge online. This study examines the Toulmin model in both critical thinking and epistemological beliefs concerning the Internet within the online academic context.

Relationship Between Argumentation, Critical Thinking and Epistemological Beliefs

Useless arguments are rather preparatories for individuals to rationalize and defend their opinions. In other words, critical thinking is a vital act that enables the life of argumentation. While critical thinking encourages a researcher or scientist to analyze and evaluate information, to conclude these abilities to be put into practice, an argumentation framework becomes necessary (Akbaş, 2021; Lukitasari et al., 2022). Evidence has shown that argumentation is effective in developing critical thinking skills. For example, in a study directed at digital argumentation performance, a high correlation was found between students' critical thinking and argumentation skills (Lukitasari et al., 2022). Argumentation-based teaching approach was also revealed to enhance students' critical thinking and argumentation skills (Akbaş, 2021). In summary, the Ability to Argue promotes the process of critical thought. Critical thinking also works on the processes of

argumentative writing. The Argument Based Inquiry (ABI) model positively influenced the critical thinking skills of the students (Nazila et al., 2019). While such models improve students' argumentation skills, they also reinforce their critical thinking skills. The relationship between argumentation and critical thinking has also been examined with variables such as gender differences. They found that the ADI model increased critical thinking skills in both male and female students (Nazila et al., 2019). This suggests that argumentation can improve critical thinking regardless of gender.

Individuals' epistemological beliefs shape their commitment, quality and approach to argumentation. For example, individuals with more sophisticated epistemological beliefs, such as those who view knowledge as constructed and evolving, are more likely to engage critically and constructively in argumentation (Nussbaum & Bendixen, 2003). It has been discovered that the epistemological beliefs that people hold affect how they deal with arguments with contradictory viewpoints. For instance, "those who consider knowledge as a complex and evolving construct make more elaborate and stronger arguments than those who view knowledge as being fixed" (Ku et al., 2014). In educational situations, those students having evaluative epistemological beliefs (i.e., seeing knowledge as evidence-based) produce higher quality arguments; they are more competent in constructing, refuting, and supporting arguments than their counterparts who hold simpler epistemic views (Mason & Scirica, 2006). The teaching of argumentation by the science teachers is closely tied to their epistemological beliefs. These with more sophisticated thoughts about science being constructivist nature tend to support high-quality argumentation practices in the classroom (Şengül et al., 2020).

Research on both epistemological beliefs and critical thinking has shown that these beliefs have a significant influence on the ability of individuals to carry out critical thinking-related tasks. People who understand knowledge as being certain, or unchanging or absolute, tend to perform more poorly when faced with conflicting arguments (Chan et al., 2011). Students who perceive knowledge as provisional and open to change usually engage in more extensive information processing by using critical thinking to evaluate and verify information. In contrast, students who rely on authority figures for validation exhibit a more superficial interaction with knowledge, showing a relationship between epistemological beliefs and depth of cognitive processing (Hyytinen et al., 2014). Epistemological beliefs of knowledge structure and malleability are found to be positively related to critical thinking and academic achievement because these beliefs promote deep learning strategies, which, in turn, encourage students to critically analyze the material (Amiri, 2018). Instructional methods that coach students to think critically can also foster students' epistemological beliefs by encouraging students to question knowledge sources (Valanides & Angeli, 2005). Together, critical thinking intervention has the potential to help students recognize and avoid the use of epistemologically unwarranted beliefs, such as pseudoscientific beliefs. Intervention in these areas indicates that critical thinking is closely tied to knowledge validity beliefs (Dyer & Hall, 2018).

While the literature shows that there is a strong relationship between these variables, there is no study focusing on critical thinking and epistomological development in the argumentation process in online education.

Importance of Research

An examination of how well these different online learning environments are viewed, using the Toulmin argumentation model, provides some perspective on the way of developing argumentation and critical thinking skills in these environments. It focuses on the development of critical thinking skills in students, which is a fundamental aspect of educational pedagogy. Understanding how online learning affects these skills will make important contributions to the field of education, especially in science and technology courses. The research investigates the relationship between students' epistemological beliefs about the internet and their critical thinking skills. This is very important in an age where the internet is the primary source of information and it is crucial to understand how beliefs about the nature and reliability of online information affect learning outcomes. The information might help instructors and curriculum developers understand the main elements that one should keep an eye on while laying strategies for effective online education, particularly development of thinking and argumentation abilities. The study carries far-reaching implications for educational practice and policy in a large number of ways. For instance, it seeks to develop integration technology vis-a-vis education and understand the position of learners' beliefs with learning.

Aim

The aim of this study is to evaluate the effect of the Toulmin argumentation model on students' critical thinking skills and epistemological beliefs about internet-based information within an online educational context, as well as to examine the relationship between these constructs in a structured argumentation setting. Sub aims are;

To assess the impact of the Toulmin argumentation model on students' critical thinking skills within an online learning environment

To explore changes in students' epistemological beliefs about the reliability and structure of internet-based information following exposure to Toulmin-based argumentation activities

To examine the relationship between critical thinking skills and epistemological beliefs in the context of Toulmin argumentation in online education.

Method

This research was conducted using quantitative research method. "Quantitative research uses inquiry strategies such as experiments and questionnaires and collects data with

predetermined instruments that provide statistical data" (Creswell, 2003). The research was conducted online with the quasi-experimental design method. Quasi-experimental design method is a research model used in experimental research. In this method, experimental and control groups are formed and cause-effect relationships between variables are examined. Quasi-experimental design is used when subjects are not randomly assigned (Çetinkaya, 2018). This design is a type of experimental design and allows observations to be made under the control of the researcher in determining cause-effect relationships (Baş & Beyhan, 2017). Quasi-experimental designs have similar characteristics to experimental designs and are preferred when the selection of subjects is not neutral (Gündüzalp, 2021). This design is used when the experimental and control groups cannot be randomly selected (Soytürk & Şahin, 2016). It is stated that quasi-experimental designs are more preferred than experimental designs (Gündüzalp & Göktaş, 2022).

Research Process

The research was conducted in the second semester of the 2020-2021 academic year. The data were collected during one hour of each science and technology lesson (one hour of each week was devoted to space and beyond and one hour to other current topics in science and technology). During the 10-week research process, the popular physics concepts (space and beyond) web page previously developed by the first author was used for all students (http://www.biyolojiegitim.yyu.edu.tr/kf/sg/sg.html). Students participated in the lessons by remote access (Google Meet) from their homes or suitable environments and the topics were covered. In addition, students who could not participate in the lessons had the opportunity to participate later. In general, the experimental and control group students used this web page throughout the research and made evaluations on the concepts of space and beyond with their lecturers. In addition to this, simple discussions were made in the experimental group based on the Toulmin argumentation model. These discussions were based on online and voluntary participation.

Table 1 shows the course programme used in the research. In this syllabus applied to all participants, the only difference applied to the experimental and control groups were the Toulmin argumentation model.

Table 1

Course programme applied in the study

Weeks	Transaction	Description
1	Pre-test	The tests used for the research were administered online.
2	Start-Informing	Both groups were informed in detail about the application and the research.
3	World	Experiment: Introduction to Toulmin argumentation model, examples, applications (2 lesson hours)
4	Stars	Control No activity related to the application was carried out this week.
5	Planets	All concept videos about the world were watched and comments were made on them. It was continued according to the questions from the participants.
6	Constellations	All concept videos about stars were watched and comments were made on them. General characteristics of stars, birth, life and death were emphasized.
7	Nebulae	All concept videos about planets were watched and comments were made on them. Detected planets, criteria for being a planet, current studies, and planetary characteristics were discussed.
8	Moon-Satellites	All concept videos about constellations were watched and comments were made on them. The relationship between constellations and people's naming with imaginary drawings, lonely stars and groups, life in star clusters were discussed.
9	Evaluation-Interpretation	During 8 weeks, the topics learnt were repeated and discussed through the questions from the participants and the points that were not understood.
10	Post test	The tests used for the research were applied online.

Note: Each week, at least one activity related to the subject according to the Toulmin argumentation model and at most a few activities depending on the participant's request are carried out in the experimental group.

Toulmin argumentation model was applied in the weekly online sessions of the experimental group. In each session, one of the components of the Toulmin model, such as claim, data, justification, qualifier and rebuttal, was introduced and students' argumentation skills were gradually developed. For example, students in a planetary science lesson were prompted to make claims about the habitability of selected planets based on the data given. Then, students were encouraged to justify their claims with scientific facts (reasons) and raise possible counterarguments (rebuttals). Such activities aimed to contribute to critical thinking through structured argumentation by allowing students to present their views but at the same time develop some critical considerations addressing opposing views. This had the dual focus of giving students structure for debate, with opportunities to see their views contrasted by critiques. Students were required to submit their independently written arguments and also participate in discussions among the teams so that all could participate. However, being an online course, challenges, such as varied student engagement, time constraints and limitations of virtual discussion, could probably have hampered the intended effectiveness of the model. Although the Toulmin model describes a learning situation that is interactive and discussion-based, the online format limited the depth of discussion by which face-to-face sessions often afford higher quality argumentation.

Sample

The sample of the study consists of students studying in the Child Development Programme at a state university. The students participating in the study voluntarily participated in the process. Student groups (branches) were randomly divided into

experimental and control groups. A total of 68 students participated in the study. It was determined that these students were from eastern and southeastern Anatolian provinces. It was determined that the age range of the participants was between 19-25 years and they were predominantly in their 20s. In addition, it can be said that all of the participants have internet access and use it actively even if they have limited opportunities. It is assumed that the participants were objective in their online participation and data collection. As a matter of fact, the grades obtained in the research were not used as midterm or final grades.Those who took voluntary part in the tests were declared to get full grades. But it must be said that all participants did achieve full marks.

The participant attendance and participation were recorded using Google Meet logs and attendance diaries. Overall, the students attended the sessions regularly and most participated in the weekly discussions. On the other hand, there was variation in attendance since among some students there was little or no contribution, and they mainly observed the discussions.

Data Collection Tools

Critical Thinking Skill

In determining the critical thinking skills of the participants, the scale was used with permission from Eğmir and Ocak's (2016) study "Developing an Achievement Test for Measuring Critical Thinking Skills". The KR-20 and KR-21 values of the multiple-choice test consisting of 25 items were found to be 0.61 and 0.63, respectively. In addition, the item difficulty index for the overall test was 0.37 (moderately easy) and the item discrimination index was 0.32 (very good item).

Epistemological Belief Scale

In this study, a scale was used to examine not only the impact of the Toulmin Model on critical thinking but also how it shapes students' epistemological beliefs towards online information. It is thought that interacting with information in an online environment, even in an academic context, contributes to students' critical thinking towards information on the internet. In this context, students' epistemological beliefs about the Internet were assessed in order to support their digital literacy skills. In determining the participants' epistemological beliefs towards the Internet, the scale from Kılıç-Çakmak, et al. (2015)'s "Adaptation of the Epistemological Belief Scale towards the Internet" was used with permission. The $\chi 2(463)= 316.77$, (sd=101, p.=.0000); $\chi 2/sd= 3.14$; RMSEA=.068, SRMR=.043, GFI=.92, AGFI=.89, IFI=.98, CFI=.98, NFI=.98 and NNFI=.98 values of this scale show its validity and Cronbach's Alpha coefficient (.81) shows its reliability.

Analyzing the Data

The scales used in online data collection were created with "Google forms" as pre-posttest. The collected data were transferred to Microsoft Excel and analyzed with the

help of SPSS 22. Frequency, mean and independent sample t-test were used in the analyses.

Ethical Considerations

In this study, points were offered for participation in Toulmin argumentation activities in order to encourage student engagement in the online format. Recognising potential ethical concerns, this practice was carefully considered in light of both educational and ethical standards. Participation grades were designed to encourage participation without tying students' academic achievement solely to these activities. Thus, full points were logged for participation rather than for quality or correctness of answers. The aim here was to create inclusivity whereby every student felt encouraged to actively engage in learning. On an ethical note, in an online context, the question of how appropriate it is to grade solely based on the notions of participation, openness, and fair academic conduct arises especially in the circumstance whereby the idea of participation-based grading competes with notions of educational values. Here, the strategy had to tackle the problem of participation in varied challenges that students might have keenly felt: that the online interface was literally disconnected. The grades reflected tangible motivation to cone members into subsequent participations, allowing practice rather than assessment as the basis of competition that let students sharpen argumentation skills. The ethical integrity had always remained intact in that students were told that participation grades would not be considered part of summative assessment but formative feedback to encourage their participation. Such practice aligns with the strategies of pedagogy designed to cultivate a conducive learning climate in keeping with current research on active learning and student motivation in online contexts (Dweck, 2017; Ryan & Deci, 2000).

Results

The findings obtained within the scope of the research are presented below.

Effect of Toulmin Argumentation on Critical Thinking Skills

Table 2

Findings related to critical thinking skills

Tests	Groups	N	N Mean	Standard Deviation	Standard Error	*t*	*p*
Pre-test	Experiment	31	15,097	4,053	,728	-0,208	0,836
	Control	37	15,270	2,815	,463		
Posttest	Experiment	32	14,406	4,362	,771	1,063	0,292
	Control	34	13,412	3,183	,546		

In Table 2, it was tested whether there was a statistically significant difference between the mean scores of the two groups before and after the application. In both tests,

t values and p values (-0,208 and 0,836 for the pre-test, 1,063 and 0,292 for the post-test, respectively) show that there is no statistically significant difference between the groups (p < 0,05). Based on the above findings, it came to be concluded that no significant difference existed in the critical thinking skills level between the experimental and control groups. Both these groups had similar levels of critical thinking skills, and there were no significant changes of such skills during the course of the research.

Effect of Toulmin Argumentation on Epistemological Beliefs

Table 3

Findings related to epistemological beliefs

Tests	Groups	N	Mean	Standard Deviation	Standard Error	*t*	*p*
Pre-test	Experiment	32	3,703	,426	,075	-1,52	0,133
	Control	36	3,889	,564	,094		
Posttest	Experiment	32	3,733	,536	,095	-1,878	0,065
	Control	34	3,966	,471	,081		

Table 3 shows that there is no statistically significant difference between the sample groups before and after the application in terms of epistemological beliefs. When the p values of the differences between both groups are analyzed, it is seen that these differences are not statistically significant (p > 0,05). However, the p value in the posttest (0,065) is lower than in the pretest, which may indicate that there may be a certain effect, but this effect is still not statistically significant. This indicates that education has no significant effect on epistemological beliefs.

Correlation between Critical Thinking Skills and Epistemological Beliefs

Table 4

Correlation between epistemological beliefs and critical thinking skills scores

		Epistemological belief	Critical thinking
Epistemological beliefs	Pearson Correlation	1	,050
	Sig. (2-tailed)		,693
	N	66	66
Critical thinking	Pearson Correlation	,050	1
	Sig. (2-tailed)	,693	
	N	66	66

Table 4 analyses the correlation (relationship) between epistemological belief and critical thinking skills scores with Pearson Correlation Coefficient. The correlation coefficient between epistemological belief and critical thinking skills is 0,050. This value indicates that there is a very weak relationship between the two variables. The p value testing the significance of the correlation between the two variables is 0,693 (p > 0,05). It is concluded that the relationship between epistemological belief and critical thinking

skills is not statistically significant. It shows that there is a statistically insignificant and very weak relationship between epistemological belief and critical thinking skills.

Discussion

Most of the studies on the impact of critical thinking and epistemological beliefs would consider traditional education environments, and at the same time, few studies have had their focus on the impact of argumentation models-like the Toulmin framework- on these competence skills in online educational contexts. In particular, structured argumentation has lacked research that examines whether it will improve critical thinking or affect beliefs about DSIL in virtual learning environments. The present study investigated the extent to which Toulmin's argumentation approach could influence students' critical thinking abilities and beliefs. Reflecting on the data gathered, the following major findings arose. The structured approach to argue using Toulmin did not significantly improve critical thinking skills between the experimental and control groups. Secondly, the only little change happens with epistemological beliefs, and again, the change is not significant. Correlation analysis between critical thinking and epistemological belief indicated only a weak and statistically insignificant correlation, thus lending support to the findings.

This research presents a clearer picture of the Toulmin mechanics of argumentation in the context of online learning and instruction. While other models have worked on the promotion of critical thinking within face-to-face interactive settings (Sampson & Blanchard, 2012; Erduran et al., 2015), our study found no significant improvements in critical thinking skills in online experimental groups when compared to their control counterparts. This result contradicts several studies showing the effectiveness of structured argumentation to increase cognitive engagement in traditional classroom settings (Gülen, 2019; Lytzerinou & Iordanou, 2020). (Telli & Altun, 2020) emphasised that critical thinking is closely linked to active, face-to-face interaction and that this interaction may be difficult to replicate in online environments where students may experience apathy and low motivation.

The limited effect of the Toulmin model on epistemological beliefs in our study is contrary to findings from previous studies in the literature. Prior studies indicate that, through critical engagement and argumentation, epistemological beliefs that knowledge is complex and evolving can develop sophistication (Ku et al., 2014; Mason & Scirica, 2006). However, the digital format may prevent students from fully engaging in this reflective process. Kılıç-Çakmak et al. (2015) and Yılmaz (2016) emphasised that continuous and interactive interventions are often required to meaningfully change deeply rooted epistemological beliefs about online knowledge. The implication here is that though the Toulmin model theoretically has the capacity for critical engagement, its possible impact on students, from the viewpoint of effecting a change in beliefs regarding internet-based knowledge, is relatively lower when face-to-face dynamics are absent.

A low relationship between critical thinking skills and epistemological beliefs in this study is actually in contrast to most studies in traditional settings, where these constructs have generally been more interrelated (Chan et al., 2011; Hyytinen et al., 2014). In-person scenarios allow individuals who see knowledge as a constructed, ever-evolving phenomenon to engage more fully in critical thinking and analytical discourse (Nussbaum & Bendixen, 2003; Bromme et al., 2010). The online setting disrupts the synergistic relationship between epistemological understanding and critical engagement, which may explain why these constructs did not correlate strongly in either study. It is possible that the digital platform did not foster the social and cognitive presence needed for students to reflect on both their critical thinking skills and epistemological beliefs simultaneously, an element that face-to-face environments facilitate more organically (Telenius et al., 2020). The study concurs with the findings of Özdemir and Yalın (2007), who stated that asynchronous online learning environments are a hindrance to students in the development of collaborative and critical thinking skills as well. The online activities based on the Toulmin model in this study, although well-structured, lacked the features of spontaneity and that immediate feedback associated with face-to-face interaction, which explains the limited critical engagement seen. The findings also suggest that the very digital nature of the intervention may have asked for a compromise between the goals of supporting students' argumentation skills and reflective beliefs from their perspective because the probability of their active participation was, indeed, limited during the asynchronous discussions. These findings are also in line with those of Widodo et al. (2023), who state that face-to-face argumentation is more effective than online formats in supporting higher-order higher-order reasoning and thinking.

The findings of the study show that the Toulmin Model can be effective not only on critical thinking skills but also on epistemological beliefs towards information on the internet. In this study, which was conducted in an academic environment, students' level of confidence in knowledge can improve their critical approaches towards the information presented online. In this context, further research on how the Toulmin Model can be used to improve students' critical thinking skills when accessing information on the Internet is recommended.

The lack of significant differences in critical thinking skills and epistemological beliefs between the experimental and control groups may reflect the inherent difficulties in implementing the Toulmin model in a virtual format. Nevertheless, the emphasis on the strategy in the traditional classroom was very dynamic argumentation and responsive towards critical thinking. On the other hand, online may undermine their true potential when students do not attend or participate repeatedly. This finding suggests that the online implementation of the Toulmin model might benefit from additional strategies such as smaller breakout discussions, interactive polling, or real-time feedback to create a closer approximation of face-to-face learning. This indicates that the Toulmin model creates many complexities in online application in consideration of the need for

critical thinking aura and belief as opposed to just applying the simple model. Though the model has appealing ramifications at a theoretical level, it highlights that such digital well-being may just simply call for some additional encouragement methods in order for participation and interactivity to occur; these being paramount in critical thinking development. Future research could tackle this by developing an alternative hybrid model involving both online and face-to-face sessions, with some added interactive tools.

Conclusions

This study sought to examine the effectiveness of the Toulmin argumentation model in developing critical thinking skills as well as influencing epistemological beliefs. Importantly, the finding showed that although the model was kept structured, the implementation in an online format did not significantly influence students' critical thinking skills and beliefs concerning the reliability and nature of online information.

The study seems to show that, in the online environment, Toulmin's argumentation model lacks the depth of interaction and reflection that could help achieve significant change in critical thinking and epistemological development. Good for face-to-face argumentation and reflective dialogue, its presence in the virtual environment may not realize the full preparation of what it strives to accomplish. Empirical research in very recent years suggests that this reality calls for further investigation into how online educational contexts can be improved to support cognitive and epistemological development through structured argumentation.

Our findings thus suggest that educators ought to consider multimodal or hybrid strategies, such as those that intermix Toulmin-based argumentation with increased interactivity and reflection, in order to promote critical thinking and epistemological beliefs more effectively in online contexts. As education enters the digital and hybrid age, the best way to optimise such frameworks will be important to prepare students to deal with and critically navigate digital information.

Limitations

Several limitations may have influenced research results. First, the sample size was relatively small and geographically limited, which may have affected the generalisability of our findings. Second, online participation varied across students and the absence of face-to-face prompts may have limited participation. The online format of the study potentially limited the depth of argumentation and critical engagement that Toulmin's model can facilitate in a physical classroom setting.

Recommendations and Future Directions

Longer-term interventions with different and larger samples could investigate how argumentation models influence critical thinking in online education. Mixed methods research involving qualitative assessments of student engagement and perception may also provide more detailed information on how students interact with and engage with

argumentation frameworks. In the case of exploring online alternatives or modifications in the implementation of the Toulmin model, still, strategies will burgeon through the development of epistemological beliefs and critical thinking development. This can raise ethical issues in certain contexts, for grading participation in this study may possibly be seen as undermining fairness of assessment. Other ways of encouraging participation in an online environment without grading for participation could be further investigated.

References

Acar, Ö. & Azaklı, Z. (2023). The effect of online argumentation and reflective thinking-based science teaching on sixth graders' cognitive abilities. *Journal of Baltic Science Education, 22*(2), 192-203. https://doi.org/10.33225/jbse/23.22.192

Akbaş, Y. (2021). The effects of argumentation-based teaching approach on students' critical thinking disposition and argumentation skills: "population in our country unit". *International Journal of Psychology and Educational Studies, 8*(1), 51-74. https://doi.org/10.17220/ijpes.2021.8.1.195

Allamnakhrah, A. (2013). Learning critical thinking in Saudi Arabia: student perceptions of secondary pre-service teacher education programs. *Journal of Education and Learning, 2*(1). https://doi.org/10.5539/jel.v2n1p197

Amiri, D. (2018). The relationship between critical thinking, epistemological beliefs, and learning strategies with the students' academic performance. *Journal Of Educational and Psychological Researches, 15*, 572-587.

Arslankara, V. B. & Usta, E. (2020). Virtual risk perception in high school students: A research in the context of problematic internet usage and critical thinking. Journal of *Ahmet Keleşoğlu Education Faculty, 2* (1) , 134-153. https://dergipark.org.tr/en/pub/akef/issue/55203/759147

Baş, G. & Beyhan, Ö. (2017). Effect of social-constructivist learning environment design on learners' academic achievement and attitudes towards course. *Mehmet Akif Ersoy University Journal of Education Faculty, 1*(41), 137. https://doi.org/10.21764/efd.35974

Bermejo-Luque, L. (2004). Toulmin's Model of Argument and the Question of Relativism (J. A. Blair Prize, 2005). Informal Logic, 24.

Bromme, R., Pieschl, S., & Stahl, E. (2010). Epistemological beliefs are standards for adaptive learning: a functional theory about epistemological beliefs and metacognition. *Metacognition and Learning, 5*, 7-26.

Casiraghi, B. (2017). Fundaments of critical thinking evaluation in high education. *Journal of Education and Human Development, 6*(3). https://doi.org/10.15640/jehd.v6n3a11

Çetinkaya, F. (2018). Dialogic reading and vocabulary. *Journal of International Social Research, 11*(60), 705-715. https://doi.org/10.17719/jisr.2018.2825

Chan, N., Ho, I.T., & Ku, K.Y. (2011). Epistemic Beliefs and Critical Thinking of Chinese Students. *Learning and Individual Differences, 21*, 67-77.

Chua, A., Pal, A., & Banerjee, S. (2020). "This will blow your mind": Examining the urge to click clickbaits. *Aslib Journal of Information Management, 73*(2), 288-303. https://doi.org/10.1108/ajim-07-2020-0214

Creswell, J. (2003). *Research design: Qualitative, quantitative and mixed methods approach* (2nd ed.). SAGE.

Donnelly, R. (2018). Potential impacts of an academic writing and publishing module on scholarship and teaching: a qualitative study. *Double Helix a Journal of Critical Thinking and Writing, 6*(1), 1-22. https://doi.org/10.37514/dbh-j.2018.6.1.04

Dweck, C. S. (2017). *Mindset: Changing the way you think to fulfil your potential*. Robinson.

Dyer, K.D., & Hall, R. (2018). Effect of Critical Thinking Education on Epistemically Unwarranted Beliefs in College Students. *Research in Higher Education, 60*, 293-314.

Eğmir, E., & Ocak, G., (2016). Developing an achievement test towards evaluating critical thinking skills. *International Periodical for the Languages, Literature and History of Turkish or Turkic, 11*(19), 337-360.

Erduran, S., Ozdem, Y., & Park, J. (2015). Research trends on argumentation in science education: a journal content analysis from 1998–2014. *International Journal of STEM Education, 2*(1). https://doi.org/10.1186/s40594-015-0020-1

Gülen, S., (2019). Development of critical thinking skills scale for science lesson. *European Journal of Education Studies, 6*(4), 161-176.

Gülen, S., & Yaman, S., (2019). The effect of integration of STEM disciplines into Toulmin's argumentation model on students' academic achievement, reflective thinking, and psychomotor skills. *Journal of Turkish Science Education 16* (2), 216-230

Gündüzalp, C. (2021). The effect of activities based on web 2.0 tols on students' reflective and critical thinking and problem solving skills in an online lesson. *e-Kafkas Journal of Educational Research, 8*(2), 137-156. https://doi.org/10.30900/kafkasegt.936736

Gündüzalp, C. & Göktaş, Y. (2022). Trends in Master's and Doctoral Theses Conducted related on Project-Based Learning in Turkey Between 2000 and 2019. *Bolu Abant Izzet Baysal University Journal of Faculty of Education, 22*(2), 687-707. https://doi.org/10.17240/aibuefd.2022..-879197

Hyytinen, H., Holma, K., Toom, A., Shavelson, R.J., & Lindblom-Ylänne, S. (2014). The complex relationship between students' critical thinking and epistemological beliefs in the context of problem solving. *Frontline Learning Research, 2*(5), 1-25.

Johnsen, D., Lipp, M., Finkelstein, M., & Cunningham-Ford, M. (2012). Guiding dental student learning and assessing performance in critical thinking with analysis of emerging strategies. *Journal of Dental Education, 76*(12), 1548-1558. https://doi.org/10.1002/j.0022-0337.2012.76.12.tb05418.x

Kahlke, R. & Eva, K. (2018). Constructing critical thinking in health professional education. *Perspectives on Medical Education, 7*(3), 156-165. https://doi.org/10.1007/s40037-018-0415-z

Kapshuk, Y. & Alt, D. (2022). Using digital concept maps in conflict resolution studies: implications for students' argumentative skills, domain-specific knowledge, and academic efficacy. *Frontiers in Psychology, 13*. https://doi.org/10.3389/fpsyg.2022.882370

Kettler, T. (2014). Critical thinking skills among elementary school students. *Gifted Child Quarterly, 58*(2), 127-136. https://doi.org/10.1177/0016986214522508

Kılıç Çakmak, E., Karaoğlan Yılmaz, G., & Yılmaz, R., (2015). Adaptation of internet-specific epistemological belief scale. *Educational Technology Theory and Practice, 5*(1), 55-71.

Kızkapan, O., & Bektaş, O. (2021). Enhancing seventh-grade students' academic achievement through epistemologically enriched argumentation instruction. *International Journal of Science Education, 43*(10), 1600-1617.

Ku, K. Y., Lai, E. C., & Hau, K. T. (2014). Epistemological beliefs and the effect of authority on argument–counterargument integration: An experiment. *Thinking Skills and Creativity, 13*, 67-79.

Lee, M. & Tsai, C. (2005). Exploring high school students' and teachers' preferences toward the constructivist internet-based learning environments in Taiwan. *Educational Studies, 31*(2), 149-167. https://doi.org/10.1080/03055690500095522

Lukitasari, M., Ristanti, R., Handhika, J., Murtafiah, W., Sukri, A., & Hasan, R. (2022). *Identification of student's critical thinking skills on cryptogamic based on digital argumentation performance through online learning*. https://doi.org/10.2991/assehr.k.220103.060

Lytzerinou, E. & Iordanou, K. (2020). Teachers' ability to construct arguments, but not their perceived self-efficacy of teaching, predicts their ability to evaluate arguments. *International Journal of Science Education, 42*(4), 617-634. https://doi.org/10.1080/09500693.2020.1722864

Mason, L., & Scirica, F. (2006). Prediction of students' argumentation skills about controversial topics by epistemological understanding. *Learning and Instruction, 16*, 492-509.

Nazila, L., Rosidin, U., Distrik, I., Herlina, K., & Hasnunidah, N. (2019). The effect of applying argument driven inquiry models to the critical thinking skills of students based on gender differences. *Scientiae Educatia, 8*(1), 35. https://doi.org/10.24235/sc.educatia.v8i1.4145

Ning, Y. & Dan, L. (2017). Critical thinking applied in case teaching of professional master degree, *Advances in Social Science, Education and Humanities Research, 119*, 1948-1953. https://doi.org/10.2991/essaeme-17.2017.396

Nussbaum, E. (2020). Critical integrative argumentation: toward complexity in students' thinking. *Educational Psychologist, 56*(1), 1-17. https://doi.org/10.1080/00461520.2020.1845173

Nussbaum, E. M., & Bendixen, L. D. (2003). Approaching and avoiding arguments: The role of epistemological beliefs, need for cognition, and extraverted personality traits. *Contemporary Educational Psychology, 28*, 573-595.

Özdemir, S. & Yalın, İ. (2007). The effects of individual and collaborative problem-based learning on critical thinking through a web based asynchronized learning tool. *Ahi Evran University Journal of Kırşehir Education Faculty, 8*(1), 79-94. https://dergipark.org.tr/en/pub/kefad/issue/59535/856315

Pariser, E. (2012). The filter bubble: how the new personalized web is changing what we read and how we think. *Choice Reviews Online, 50*(2). https://doi.org/10.5860/choice.50-0926

Pasquinelli, E., Farina, M., Bedel, A., & Casati, R. (2021). Naturalizing critical thinking: consequences for education, blueprint for future research in cognitive science. *Mind Brain and Education, 15*(2), 168-176. https://doi.org/10.1111/mbe.12286

Ryan, R. M., & Deci, E. L. (2000). Intrinsic and extrinsic motivations: Classic definitions and new directions. *Contemporary Educational Psychology, 25*(1), 54-67. https://doi.org/10.1006/ceps.1999.1020

Sampson, V. & Blanchard, M. (2012). Science teachers and scientific argumentation: trends in views and practice. *Journal of Research in Science Teaching, 49*(9), 1122-1148. https://doi.org/10.1002/tea.21037

Sengul, O., Enderle, P.J., & Schwartz, R.S. (2020). Science teachers' use of argumentation instructional model: linking PCK of argumentation, epistemological beliefs, and practice. *International Journal of Science Education, 42,* 1068 - 1086.

Setiansah, M., Novianti, W., Rahmawati, A., & Agustina, L. (2021). Knowledge sharing in peer group: an alternative of internet literacy education media for children. *Proceeding ICMA-SURE, 1*(1), 106. https://doi.org/10.20884/2.procicma.2021.1.1.4439

Soytürk, B. & Şahin, F. (2016). An analysis of the relationship between systematic thinking skills and academic achievement of middle school students. *Journal of Human Sciences, 13*(1), 1473. https://doi.org/10.14687/ijhs.v13i1.3644

Stassen, M., Herrington, A., & Henderson, L. (2011). Defining critical thinking in higher education. *To Improve the Academy, 30*(1), 126-141. https://doi.org/10.1002/j.2334-4822.2011.tb00653.x

Telenius, M., Yli-Panula, E., Vesterinen, V., & Vauras, M. (2020). Argumentation within upper secondary school student groups during virtual science learning: Quality and quantity of spoken argumentation. *Education Sciences, 10*(12), 393. https://doi.org/10.3390/educsci10120393

Telli, S. G. & Altun, D. (2020). The coronavirus and the rising of online education. *Journal of University Research, 3* (1), 25-34. https://doi.org/10.32329/uad.711110

Tinmaz, H., Fanea-Ivanovici, M., & Baber, H. (2022). A snapshot of digital literacy. *Library Hi Tech News, 40*(1), 20-23. https://doi.org/10.1108/lhtn-12-2021-0095

Tsai, C. (2004). Beyond cognitive and metacognitive tools: the use of the internet as an 'epistemological' tool for instruction. *British Journal of Educational Technology, 35*(5), 525-536. https://doi.org/10.1111/j.0007-1013.2004.00411.x

Tsai, C. and Chuang, S. (2004). The correlation between epistemological beliefs and preferences toward internet-based learning environments. *British Journal of Educational Technology, 36*(1), 97-100. https://doi.org/10.1111/j.1467-8535.2004.00442.x

Valanides, N., & Angeli, C. (2005). Effects of instruction on changes in epistemological beliefs. *Contemporary Educational Psychology, 30*, 314-330.

Walker, S. & Brown, R. (2020). *Critical thinking on technology use: higher education course design to promote personal, professional and societal change*. International Conference on Higher Education Advances (HEAd), Sixth International Conference on Higher Education Advances. https://doi.org/10.4995/head20.2020.11300

Widodo, A., Huda, I., Rochintaniawati, D., & Riandi, R. (2023). Effect of argumentation-based teaching on students' understanding, reasoning and decision-making concerning food preservatives. *Jurnal Penelitian Pendidikan Ipa, 9*(3), 1418-1424. https://doi.org/10.29303/jppipa.v9i3.2951

Xing, D. & Lu, C. (2022). Predicting key factors affecting secondary school students' computational thinking skills under the smart classroom environment: evidence from the science course. *Journal of Baltic Science Education, 21*(1), 156-170. https://doi.org/10.33225/jbse/22.21.156

Yang, W., Lin, Y., She, H., & Huang, K. (2015). The effects of prior-knowledge and online learning approaches on students' inquiry and argumentation abilities. *International Journal of Science Education, 37*(10), 1564-1589. https://doi.org/10.1080/09500693.2015.1045957

Yılmaz, F. & Çakmak, E. (2016). Internet-specific epistemological beliefs and online information searching strategies of pre-service teachers: gender and department differences. *Participatory Educational Research, 3*(2), 63-80. https://doi.org/10.17275/per.16.10.3.2

Yılmaz, R., (2016). *Investigation of teachers' epistemological beliefs about the internet*. 10th International Computer and Instructional Technologies Symposium (ICITS), 16-18 May.

Zimmermann, M., Engel, O., & Mayweg-Paus, E. (2022). Pre-service teachers' search strategies when sourcing educational information on the internet. *Frontiers in Education, 7*. https://doi.org/10.3389/feduc.2022.976346