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## Virtual forum as a methodological strategy for the development of critical thinking at the university

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**Abstract.** Due to numerous complex changes that characterise life in the modern world, acquisition and improvement of high-quality thinking becomes one of the most crucial objectives for people all around the globe.

In this context, the demand for university development of critical thinking in future professionals requires not only to modernise the content of educational courses, but also to transform existing teaching and learning methodologies. In order to reach this objective, the university level pedagogy should redefine the roles of teachers and students in the learning process as well as provide correct methodological strategies.

This article focuses on the application of a virtual forum as a method of critical thinking development. The study provides a brief contextualisation of the topic and presents in part the results of the descriptive research that was conducted in the Costa Rica Institute of Technology.

The results demonstrate that, according to the students' opinion, a virtual forum as a teaching method has a positive effect on the critical thinking development. Moreover, the study clarifies the structure of the critical thinking concept, showing the preponderant roles of the attitudinal and self-regulatory dimensions and their ability to improve cognitive skills bringing them to the highest level of competence.

**Keywords:** critical thinking, virtual forum, information and communication technologies (ICT), university didactics, higher education, Costa Rica.

## Introduction

### *Higher education and the demand for critical thinking*

In the modern world which is rapidly and constantly changing the need for a new model of higher education becomes obvious. This new model must be focused on the student, which requires not only to modernise the content of educational courses, but also to transform existing teaching and learning methodologies that should stimulate the development of creative and critical thinking and be based on new types of collaboration (Betancourth Zambrano 2015; Bezanilla Albusua, Poblete Ruiz, Fernández Nogueira et al. 2018; Calle Álvarez 2014;

León 2014; Ilyin 2009; Novikova, Grevtseva 2015; Smirnova 2015; Fedorenko 2018).

The UNESCO report, prepared by a team lead by Jacques Delors, draws attention to the particular challenge that contemporary universities face trying to empower students' understanding, awaken their intellectual curiosity and stimulate acquisition of critical thinking and autonomy of judgment at the same time. Moreover, the report points out "encouraging cooperation in learning" as another key element of education (Delors, Al Mufti, Amagi 1996). Article 9 of the Declaration on higher education in the 21st century, which has become a guiding document for priority action for the change and development of universities, is dedicated to critical thinking and creativity and declares that:

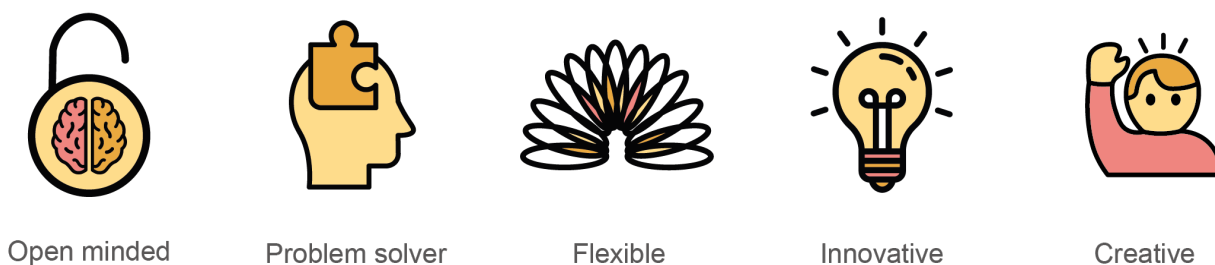


Fig. 1. Critical Thinker Profile. Source: own production

*Higher education institutions must train students to become well-informed and deeply motivated citizens, equipped with a critical sense and capable of analyzing society's problems, seeking solutions, applying them and assuming social responsibilities* (Documento de política... 1995).

These guidelines and demands are already taken into account in policies of many Latin American universities. Thus, the Costa Rica Institute of Technology (ITCR or TEC) points out in its academic model that the educational process should enhance creativity and encourage the student to question, investigate, create and develop ideas. Furthermore, as a guiding framework for teachers, the model encourages them to “permanently seek resources and methodologies to improve the teaching-learning process” (Modelo académico... 2003).

The ITCR Regulation of the Teaching-learning Regime determines that the use of methodologies which stimulate development of the critical, creative and responsible spirit in students must be encouraged in order to achieve excellence in the educational process. The same regulation establishes that teachers must use teaching methodologies that tend to develop involvement, creativity, analytical and critical skills of the student (Reglamento del régimen enseñanza-aprendizaje... 1986).

In other words, there is a very clear demand for the university education to switch the focus of the teaching process on the development of critical thinking. However, as it often happens, it is “easier said than done”. In order to convert educational policies and curriculum guidelines into everyday classroom experience, teachers should have, among other things, a clear awareness of their new role; they should understand the concept of critical thinking, value the possibility and importance of its development in students and possess methods and tools to put it into practice.

This article describes a discussion forum that is carried out online, asynchronously and called a “virtual forum” for convenience. The focus of the study is on the following two key objectives closely related to each other: a) to clarify the concept of

critical thinking; and b) to assess the virtual forum as an emerging methodological strategy able to contribute powerfully to the development of critical thinking.

### *Critical thinking*

In a way, everyone can draw inferences about the meaning of critical thinking (Bezanilla Albusua, Poblete Ruiz, Fernández Nogueira et al. 2018; León 2014). Facione comments that “it is a thought of quality, it is almost the opposite of an illogical or irrational thought” and it is based on the following six skills that a person should possess: analysis, inference, interpretation, explanation, evaluation and self-regulation (Facione 2007). Arango refers to the same phenomenon as follows:

*It is the type of thinking that is characterised by managing and mastering ideas from their review and evaluation, rethinking what is understood, processed and communicated. It is an active and systematic attempt to understand and evaluate the ideas and arguments of others and their own. It is conceived as a rational, reflective and inquisitive thought that decides what to do or believe, that is able to recognise and analyse the arguments in their constitutive parts* (Arango 2004).

It is highlighted that critical thinking is a person's ability to think, solve complex problems, be creative, produce discoveries and generate innovations (Betancourth Zambrano 2015; Gabdulkhakov 2019; Ilyin 2009). Furthermore, it is mentioned that educators typically identify at least three features of critical thinking: “1) it is done for the purpose of making up one's mind about what to believe or do; 2) the person engaging in the thinking is trying to fulfil standards of adequacy and accuracy appropriate to the thinking; 3) the thinking fulfils the relevant standards to some threshold level” (Hitchcock 2018).

It is possible to summarise a general profile of a critical thinker as follows: it is a person who appreciates creativity, is innovative, sees the future as flexible, believes that life is full of possibilities, raises questions and searches for their answers,

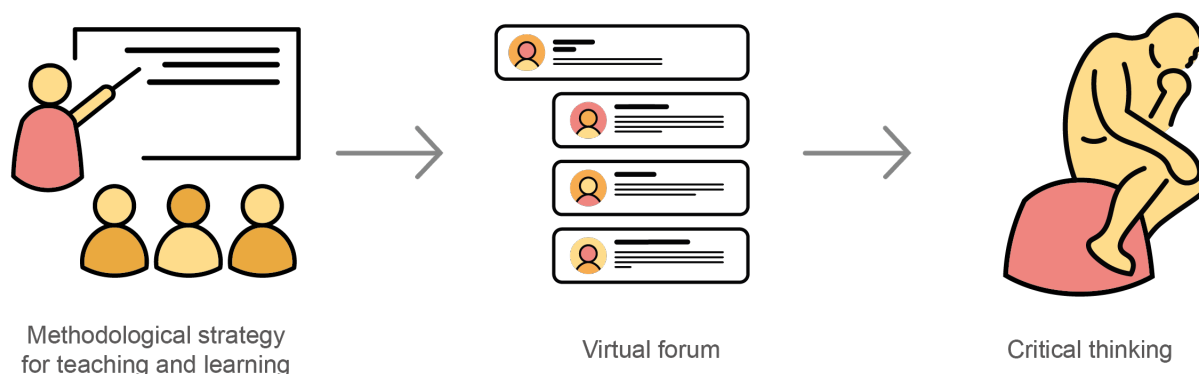


Fig. 2. Virtual forum as a methodological strategy for the development of critical thinking.  
Source: own production

generates and evaluates alternative options, is willing to reconsider his or her opinion, investigates the interrelationships between various real-life phenomena, uses problem-solving skills to improve the world, keeps an open mind and accepts different points of view, is objective, reasonable and honest to face his or her own weaknesses, persists in the search for results, is willing to take risks and challenges others to be critical thinkers (Betancourth Zambrano 2015; Bezanilla Albisua, Poblete Ruiz, Fernández Nogueira et al. 2018; Boisvert 2004; Facione 2007; Fulton 1989; Jones, Safrit 1994; León, 2014; Gabdulkhakov 2019; Ilyin 2009; Kubrushko, Bekbaeva 2018; Mushtavinskaya 2009; Smirnova 2015; Fedorov 2007). Figure 1 summarises the predominant components of the critical thinker profile.

### *Dimensions of the critical thinking concept*

It is possible to distinguish at least two main internal dimensions of the critical thinking concept.

One of them is a cognitive dimension which combines a range of high-level intellectual operations and abilities (such as analysis, inference, interpretation, explanation, evaluation and self-regulation), which support high-quality thinking. The cognitive dimension is characterised by being logical, rational, clear, transparent, synthetic, reflective, contextualised, appropriate, argued and self-regulated. These aspects take a form of intellectual, communicative, metacognitive or self-regulatory operations (Calle Álvarez 2014; León 2014; Kubrushko, Bekbaeva 2018; Fedorov 2007).

The other substantial dimension of the critical thinking concept concerns attitudes. This dimension combines qualities, dispositions, inclinations, motives, postures, actions and tendencies, contributing as guarantors for the generation of high-quality thought and its products. Within this di-

mension, it is possible to differentiate between the extrinsic attitudes which are oriented towards others and the intrinsic ones which are oriented towards themselves at a higher level (Calle Álvarez 2014; León 2014; Fedorov 2007).

### *Virtual Forum as a methodology for the development of critical thinking*

The development of critical thinking in students does not happen on its own. During a class where the teacher specifies the subject that the student has to copy it into his or her notebook and then reproduce it at the exam, there is practically no space left for such intellectual work as analysis, synthesis, collaboration or conception; therefore, neither the cognitive skills nor the attitudes that constitute a part of critical thinking are formed (Kubrushko, Bekbaeva 2018; Novikova, Grevtseva 2015; Fedorov 2007). The roles which are assumed, the conditions, the methods and the means which are used in the educational process can either limit the development of high-quality thinking or contribute to it. Jones, Safrit and other authors note in this regard that critical thinking requires creating conditions which empower students, give them responsibility for their own learning and enable them as autonomous individuals (Calle Álvarez 2014; Jones, Safrit 1994; Gabdulkhakov 2019).

As presented in Figure 2 regarding the didactic strategies favourable for the development of critical thinking, several authors recognise that asynchronous debates or virtual forums serve as excellent tools for the critical thinking development in any educational system due to the fact that they involve multiple cognitive and socio-affective aspects, such as: a thread of dialogues, considering and understanding interventions, discovering hidden gems, using messages to encourage conversation, allowing others to express themselves, respecting autonomy

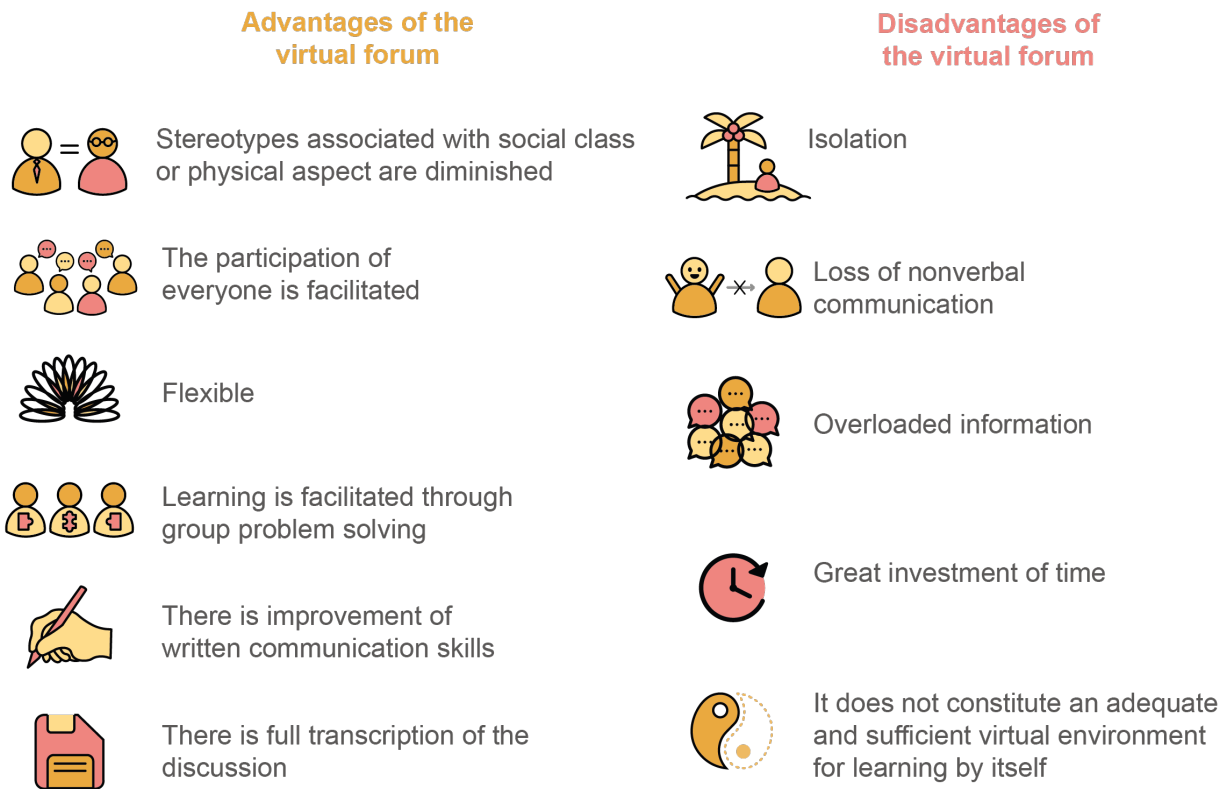


Fig. 3. Advantages and disadvantages of a virtual forum. Source: own production

of the participants and leaving the obvious to explore other alternatives, etc. (Arango 2003; Calle Álvarez 2014; Domínguez Figaredo, Alonso Díaz, 2004; Markel 2001).

Some of the most frequently noted advantages of a virtual forum include the following: a diminished role of stereotypes associated with social classes or physical aspects; facilitated interaction even among the most introverted students; greater flexibility and independence, which make no limits to the students' contributions in terms of time and place and allow students to express their most profound thoughts; facilitated learning through the group problem solving; improvement of students' written communication skills; fully transcribed discussions, which give users the opportunity to store, retrieve and correct ideas (Wilkins 2002).

It is shown that virtual forums can have different approaches and their educational value varies depending on the prevailing dialogue form. According to this criterion, it is important to develop forums according to the "pragmatic dialogue" model, in which everyone's knowledge is brought into play to build from different perspectives "in order to strengthen and foster the argumentative and reflexive capacity of the participants" (Arango 2004).

On the other hand, it should be mentioned that several authors not only highlight the positive potential of virtual forums, but also warn about the

implications and disadvantages entailed through the incorporation of these strategies into the methodological arsenal of university teaching. Such limitations include student isolation, the loss of nonverbal communication, the information overload and the great time investment that they demand. Moreover, a forum can be used for educational improvement; however, it does not constitute by itself an adequate and sufficient virtual environment for learning (Arango 2004; Gros, Adrián 2004; Markel 2001). Figure 3 shows key advantages and disadvantages of a virtual forum.

Therefore, a technological tool alone will not contribute significantly to the development of critical thinking in students if it is not applied in the context of a pedagogical model that defines the roles and the rules of the game.

## Methodology

This paper has a descriptive scope, but also a quantitative nature. The aim of the present research is to check whether the usage of virtual forums as a methodological strategy influences critical thinking development and, furthermore, to clarify the structure of the dimensions that make up the concept of critical thinking as well as the relationship between them. The conclusions are made based on

the perception of these matters held by a group of ITCR regular students.

In order to achieve the research aim mentioned above, the following objectives were set: 1) to identify how students perceive the influence of a virtual forum on the development of critical thinking; 2) to establish forms and cognitive and attitudinal aspects of critical thinking that are fostered by the application of this methodology; 3) to clarify the structure of the dimensions that underlie this concept; 4) to draw justified conclusions about the interrelations between the dimensions that constitute the phenomenon of critical thinking.

The research participants are an entire group of students (22 people in total) majoring in Mathematics Teaching with Technological Environments and enrolled during the recent semester to the course of Psychopedagogical Theories at the TEC. Half of the group are first-year students and almost three-quarters of them (16 people or 73 %) are male.

According to the course curriculum, this group had two classroom sessions during the sixteen weeks of the semester. The virtual forum was used as one of the methodological and evaluative pillars of this course; face-to-face lessons were supplemented with extra work hours during which each student must, among other things, participate in about three asynchronous and consecutive forums. Virtual debates had clear and defined rules and covered the most important topics of the course. They lasted about three weeks each and followed the lines of thought outlined in a collaborative way among all the participants.

Asynchronous debates took place on a digital platform of virtual learning environment (VLE) called Virtual TEC. This VLE has been used in the ITCR since 1998 and is considered as a complementary service for face-to-face teaching.

The instrument used to collect data, which was applied in the last classroom session of the course, is a Likert-type opinion scale of verified technical qualities, made up of twenty statements which represent the large dimensions of the concept. Eleven of the statements deal with aspects of cognition, communication and self-regulation while nine other statements are devoted to intrinsic and extrinsic attitudes. All the statements that make up the scale are presented both in their original Spanish version and translated into English in the appendix of this paper.

After the experiment about twenty students completed the survey that registered their appreciation and assessment regarding the virtual forum. The information collected was subjected to the statistical analysis (descriptive and factorial), nec-

essary for the characterisation of the phenomena corresponding to the objectives of this study.

## Results and discussion

### *Descriptive statistics*

It should be noted that only 3 % of all valid answers given by the students to the twenty questions of the survey correspond to the scales such as “very little” or “not at all” in relation to the statements that qualify the influence of the virtual forum on the development of different critical thinking aspects. On the contrary, 75 % of responses point to the positive effect of the forum. In addition, it should be noted that in almost 41 % of the answers respondents agreed with the option “completely” regarding the effect of this methodological strategy on the development of critical thinking. It is highlighted that the mean of the average values of the twenty items is high and is located at 4.13 (on the scale of 1.00 to 5.00), accompanied by a low deviation between the scores of the 20 individual means (equal to 0.2955).

The minimum value of the averages is equal to 3.70 (of item No. 6 — “Clarity of expression”), while the averages of the highest scores (between 4.30 and 4.85) characterise the responses of the subjects to items no. 5 (“Opportunity to use critical thinking”), no. 8 (“Respect for the free opinion of others”), no. 12 (“Awareness of rethinking opinions before expressing them”), no. 15 (“Confrontation of different ideas”), no. 18 (“Ability to generate one’s own opinion”) and no. 20 (“Need to stay well informed”). These six items have the highest average scores and represent all the original dimensions of the concept, which allows us to take and interpret it as a convincing sample that the virtual forum exerts a high influence, both on the cognitive and metacognitive aspects, as well as on the attitudinal (extrinsic and intrinsic) and communicative critical thinking.

The analysis of the data grouped according to the previously established dimensions reveals that the average of the items no. 1, 3, 4 and 15, which refer to the cognitive aspects of the concept, is quite high and is equivalent to 4.15, which is slightly above the general average for the whole scale and indicates that the students feel that their skills of understanding, analysis and, above all, reflection and dealing with diverse and complex ideas increased significantly due to their participation in the virtual forum.

The average score of items no. 6, 9 and 18, which are related to the communicative aspects of critical thinking, corresponds to 4.02, which is still high despite being slightly lower than the total average of the scale. These data together with the standard

Table 1. The six main factors of the critical thinking concept, obtained in the initial factorial analysis

Factor	Description of the component and % of the variance (Varimax rotation) explained by it	Likert scale items that make up each component with their respective factor load
1	The willingness, tendency or intellectual ambition of a person to generate their own critical and timely opinion; 19 %.	N° 13 (.579); N° 14 (.540); N° 18 (.888); N° 20 (.905).
2	Predisposition or desire to learn and negotiate ideas intelligently—intelligent and collaborative learning; 16 %.	N° 2 (.522); N° 7 (.809); N° 10 (.790); N° 15 (.661); N° 17 (.625)
3	High-level cognitive processes, backed by a persistent attitude towards an intellectually challenging theme; 15 %.	N° 1 (.858); N° 3 (.799); N° 4 (.746); N° 11 (.594)
4	Metacognitive or authoritative regulatory features that provide a better quality of both the process and the products of critical thinking; 15 %.	N° 5 (.651); N° 12 (.830); N° 16 (.662); N° 19 (.732)
5	Value of respect for the critical and intelligent opinion of others; 9 %.	N° 8 (.917)
6	Clear and argued communication or expression; 9 %.	N° 6 (.784); N° 9 (.496)

deviation, which is slightly lower than the scale average, reveal that the students share an opinion that the virtual forum method has a very positive impact on the ability to generate, express and defend their own opinion.

In the group of self-regulation aspects we find some of the maximum values of the individual average (items no. 5 and 12), which are also reflected in the high level of the general average (equivalent to 4.30) of the four items that make up this dimension. This fact and the summation frequencies of the options “completely” and “considerably”, selected by the respondents at the time of answering the questionnaire and equivalent to 48 % and 39 %, respectively, indicate that, according to the students, the virtual forum has greatly encouraged them to be alert when using critical thinking, improved their understanding of the need to rethink their opinions before expressing them and their consideration of contextual factors before forming their own opinion.

Regarding the aspects of attitudes and values, it is important to mention that this dimension is presented in the Likert scale with two subgroups: one of them (constituted by items no. 2, 7, 11, 13, 16 and 20) refers to the personal attitudes to critical thinking projected inwards, while the other subgroup (made up of items no. 8, 10 and 17) deals predominantly with attitude aspects projected

outwards. The average sum of the first subgroup is equal to 4.01, while the second subgroup is equal to 4.25. The total average of both subgroups is exactly equal to the general of the 20 items (4.13).

The averages corresponding to the intrinsic attitudes are located in the range between 3.75 and 4.42 and illustrate that, according to the students, the virtual forum has a significant impact on the development of the motivation to learn, the persistence in dealing with a difficult topic, and the honesty to face one’s own weaknesses. This influence is even more significant in terms of the promotion of intellectual curiosity, strengthening of the investigative spirit and the need to remain well informed.

In addition to the above, the averages of the items that circumscribe the extrinsic attitudes also demonstrate the great usefulness of the virtual forum as a tool to improve the negotiation capacity (item no. 17, average of 3.84), the ability to value the consensus (item no. 10, average of 4.05). Moreover, it serves as an outstanding method to foster respect for opinion of others (item no. 8, average of 4.85). In fact, the average score of statement no. 8 is the highest of the whole scale. This item stands out because about 90 % of the respondents agree “completely” with the statement that the methodology of the virtual forum “promotes respect for the opinion of others”. This can be considered

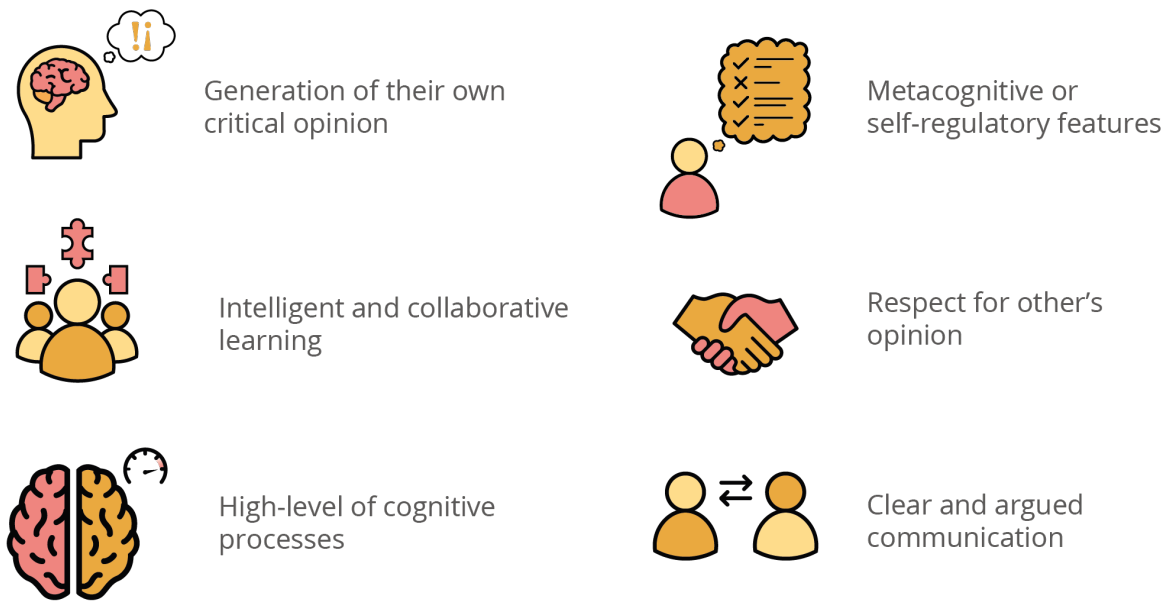


Fig. 4. The six main factors underlying the concept of critical thinking. Source: own production

an advantage of a virtual forum as a methodological strategy that can contribute to the general competence development of a future professional who is required to perform in a polyvalent and multicultural environment.

To sum up, the most prominent interpretations from the descriptive statistics data show that, according to the perception of the students who participated in the virtual forum carried out within this project, this methodology exercises a significant positive impact on the development of cognitive, metacognitive, attitudinal and communicative aspects of critical thinking. Thus, the great didactic usefulness of the virtual forum is confirmed within the methodological framework of the critical university pedagogy.

### Factor analysis

The data acquired in this investigation are submitted for factor analysis in order to verify the concept validity as well as to highlight the dimensions of critical thinking and make conclusions about their interrelations.

According to the routine procedure, six factors with characteristic roots greater than 1,000 are initially extracted with the support of the SPSS; together they manage to explain about 83 % of the variance. Then, the rigorously identified factors are interpreted in combination with the prior knowledge of the concept and a reasonable level of scientific intuition.

Thus, the six main factors underlying the critical thinking concept according to the rotation matrix analysis of the main components are detailed in Table 1, which presents their description, relative weight (in terms of percentage of variance explained rotated), the composition and saturation corresponding to the components of the six main factors obtained in the factorial analysis initially.

It is necessary to highlight that the great importance of the attitudes and dispositions that are affiliated with the cognitive and metacognitive processes is demonstrated in the model of the concept derived from the solution of six main components, also presented in Figure 4. In combination with communicative and value traits they end up forming complex structures or competences that underlie critical thinking.

However, it might be necessary to explore the possibility to further reduce the number of dimensions underlying the concept. Thus, after the reduction of the components up to three, it should be possible to explain almost 63 % of the variance, which is taken as an acceptable level. Taking into account that existing theoretical frameworks consider up to five dimensions of the phenomenon, reducing the number of main components to three can help to reconsider and simplify the concept model, contributing to the valid, clear and justified presentation of critical thinking. Table 2 summarises the results of the rotation matrix analysis of the three main components.

In regards to the congruence and relationship between both factorial solutions, it can be asserted

Table 2. The results of the rotation matrix analysis of the three main components

Factor	Description of the component and % of the variance (Varimax rotation) explained by it	Likert scale items that make up each component with their respective factor load
I	The attitudinal dimension: a broad and complex set of attitudes and mental dispositions, necessary to stay well informed, investigate and learn, generate one's opinion, demonstrate critical sense and negotiate ideas in an intelligent and timely manner; 28 %.	N° 2 (.581); N° 7 (.598); N° 11 (.525); N° 13 (.687); N° 14 (.687); N° 15 (.801); N° 16 (.514); N° 17 (.746); N° 18 (.921); N° 20 (.825)
II	The cognitive dimension: high-level cognitive ability or ability to understand, analyze, reflect, debug, synthesize and argue complex ideas; develop a value judgment about one's own ideas and those of others, which are confronted in the midst of a search for an intelligent consensus; 21 %.	N° 1 (.826); N° 3 (.432); N° 4 (.737); N° 9 (.669); N° 10 (.713)
III	The self-regulatory and metacognitive dimension: qualities that seek ethics and the quality of critical thinking. For example: the consideration of context, awareness of rethinking ideas, of seeking clarity of expression and the opportunity to use critical thinking and respect for the critical and intelligent opinion of others; 14 %.	N° 5 (.801); N° 6 (.690); N° 8 (.724); N° 12 (.452); N° 19 (.539)

that with the exception of a few small details the new factor I in the rotation matrix of three components represents a kind of sum of the first two factors in the rotation matrix of six components. The fundamental structure of the factor II is similar to that of the third factor of the rotation matrix of six components. While the III factor absorbs the vast majority of the same items as the fourth, fifth and sixth factors of the rotation matrix of six components.

Thus, with the reduction of the number of components to three, the model of the concept is simplified without loss of the initial dimensions and the profiled dimensions following the analysis of the rotation matrix of six components.

Finally, it can be summarised that factor analysis revealed three large dimensions of the concept: a predominant attitudinal dimension, a prevalent cognitive dimension and an important self-regulatory dimension that guarantees the relevance and quality of the synthesis of the two previous ones within the complex phenomenon of critical thinking.

## Conclusion

It is possible to conclude the following regarding the first two objectives mentioned in the "Methodology" section: the majority of the

participants (close to 96 %) perceive the virtual forum as a method that promotes development of critical thinking.

It is established that the virtual forum significantly stimulates the development of various cognitive, metacognitive and communicative aspects of critical thinking in students. This method improves the ability to confront ideas that differ from one's own, develops skills of reflection, makes students consider contextual factors and stimulates their ability to generate personal opinion, increases their awareness in usage of advanced reasoning, emphasises the necessity to rethink ideas before expressing them and encourages them to generate the most appropriate critical opinion.

It is concluded that the methodological strategy of asynchronous debates also promotes critical thinking attitudes. According to the students, this method encourages respect for the free expression of opinion, emphasises the need to stay well informed, increases the motivation to learn, promotes the investigative spirit, reinforces persistence when dealing with complicated topics, awakens intellectual curiosity, increases honesty to face one's own weaknesses, makes students value consensus and improves their negotiation skills.

In conclusion, the opinion of the surveyed students confirms the great pedagogical and didactic usefulness of the virtual forum within



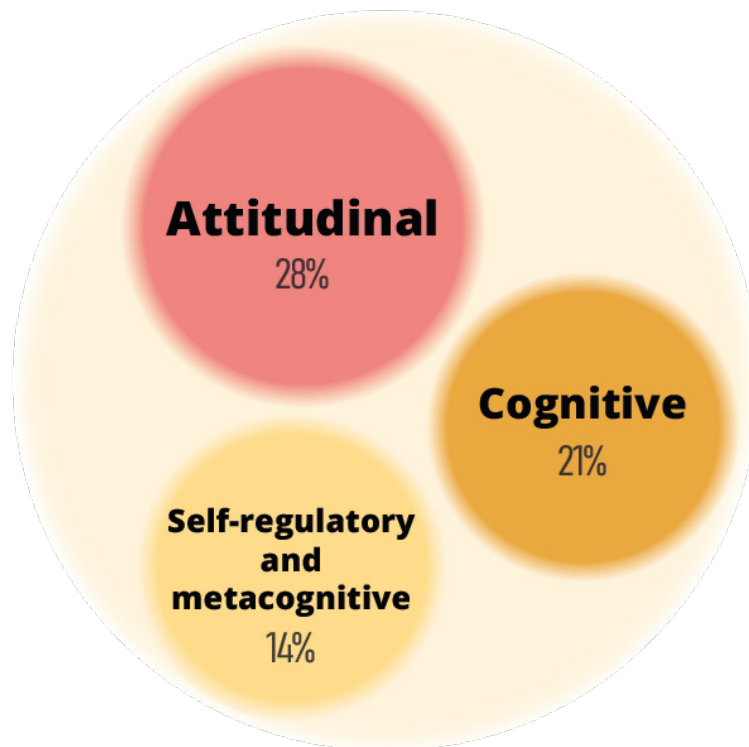


Fig. 5. The Model of the concept: main dimensions. Source: own production

the methodological framework of the critical university pedagogy.

In relation to objectives 3 and 4, it is possible to affirm the general structure of the critical thinking concept devised from the beginning of the investigation and to clarify the large dimensions and relationships between the elements that comprise it. In other words, it is verified that the critical thinking concept consists of three dimensions, which are coincident, congruent or symmetrical with those that were outlined in the theoretical framework.

It is revealed that there is a series of variables that represent the statistical quintessence of critical thinking, which include “the understanding of complex ideas”, “the argumentative capacity”, “persistence before a difficult topic”, “intellectual curiosity”, “the opportune critical sense”, “the confronting different ideas” and “the negotiation capacity”.

The study clarifies the model of the critical thinking concept, which is based on the interrelationships of the following three dimensions: I – Attitudinal (represented by a broad and complex set of attitudes and mental dispositions, such as perceiving the necessity to be well informed, to investigate and learn, generate one’s own opinion, identify critical meaning and negotiate ideas in an intelligent and timely manner); II – Cognitive (represented by high-level intellectual processes, backed by a persistent attitude) and III – Self-regulating and meta-cognitive (an essential element that ensures that

attitudes and cognition complement each other in order to achieve critical thinking of great ethical and intellectual value).

Figure 5 shows the predominant attitudinal dimension, the prevalent cognitive dimension and the important self-regulatory dimension. The last dimension guarantees the pertinence and quality of the processes and products of the previous two within the complex concept of critical thinking.

This fact provides significant evidence for the validity of the concept used in the research and contributes to the understanding of the phenomenon, especially regarding the interrelation and the functions of its main dimensions. It is likely that the attitudinal and self-regulatory elements alone are able to enhance cognitive operations to the highest level, where they merge into one complex competence, known as critical thinking and called by some as “mental watermark” (Boisvert 2004; Facione 2007).

Clearly, the conclusions of this investigation should not be regarded as final, but rather considered as references for further discussion on the matter. We hope that the present work will encourage our colleagues to investigate characteristics of the critical thinking as a complex concept. Similarly, it is intended to motivate university professors to implement an asynchronous forum in their classes as a methodological strategy capable of

promoting the development of critical thinking in students.

## Annexes

### *Items of the Likert scale used in the research*

It should be noted that this paper only presents statements of the questionnaire with their respective item numbers while instructions and the coding scale of the original survey are omitted. In the coding the score equal to 5 relates to the answer option "Completely"; score 4 relates to the option "Considerably"; 3 relates to the answer option "A little"; score 2 relates to the option "Very little"; and score 1 relates to the option "Not at all".

1. I feel that my capacity for reflection has increased thanks to the forum.

2. I believe that my motivation to learn has been inspired by my experience with the forum.

3. I have noticed that the forum has facilitated my understanding of complex ideas.

4. I have discovered that my ability to analyse problems has increased due to the forum.

5. I feel that the forum encouraged me to be alert when using critical thinking.

6. I have noticed that my clarity of expression has improved due to my experience in the forum.

7. I feel that the investigative spirit has been stimulated by the forum.

8. I feel that the forum fosters respect for the opinion of others.

9. I have discovered that my argumentative ability has improved as a result of my participation in the forum.

10. I have learned to value consensus through participation in the forum.

11. I believe that I have improved my persistence towards investigating a difficult subject as a result of my participation in the forum.

12. I think that the forum made me more aware of rethinking my opinions before expressing them.

13. I think that the forum has inspired my intellectual curiosity.

14. I think that my critical sense has become more appropriate after my experience with the forum.

15. I think that I have learned to confront different ideas thanks to the forum.

16. I perceive that my level of honesty to face my own weaknesses has consolidated due to my participation in the forum.

17. My negotiation capacity has improved after my experience in the forum.

18. I think that my ability to generate my own opinion has strengthened due to the forum.

19. I feel that I have forced myself to consider contextual factors as the starting point of my opinion during my participation in the forum.

20. I think that the forum encouraged me to keep myself well informed.

The Spanish version of the Likert scale statements, validated and originally used in the investigation, is also attached below.

1. Siento que a través del foro mi capacidad de reflexión ha sido incrementada.

2. Estimo que mi motivación por aprender ha sido inspirada por lo vivido en el foro.

3. He notado que el foro me ha facilitado la comprensión de las ideas complejas.

4. He descubierto que mi capacidad de analizar problemas se ha incrementado a través del foro.

5. Siento que con el foro he sido estimulado a ser vigilante en las oportunidades de usar el pensamiento crítico.

6. He percibido que mi claridad de expresión ha mejorado a partir de mi experiencia en el foro.

7. Siento que el espíritu investigativo ha sido impulsado por medio del foro.

8. Siento que el foro fomenta el respeto por la libre opinión de los demás.

9. He descubierto que mi capacidad argumentativa se ha mejorado a consecuencia de mi participación en el foro.

10. He aprendido a valorar los consensos a través del foro.

11. Considero que con el foro he acentuado mi persistencia ante una temática difícil.

12. Creo que una de las consecuencias del foro es que ahora estoy más consciente de repensar mis opiniones antes de expresarlas.

13. Opino que el foro, en mi caso, ha despertado la curiosidad intelectual.

14. Después de mi experiencia con el foro, pienso que mi sentido crítico es más oportuno.

15. Opino que a partir del foro he aprendido a confrontar distintas ideas.

16. Percibo que mi nivel de honestidad para enfrentar mis propias debilidades se ha consolidado debido a mi participación en el foro.

17. Con la experiencia en el foro mi capacidad de negociación se ha intensificado.

18. Creo que con el foro mi capacidad de generar mi propia opinión ha sido fortalecida.

19. Siento que me he obligado a considerar los factores contextuales como el punto de partida de mis opiniones durante el desarrollo del foro.

20. Opino que la necesidad de mantenerme bien informado se ha fomentado a través del foro.

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## References

- Arango, M. M. (2004) Foros virtuales como estrategia de aprendizaje [Virtual forums as a learning strategy]. *Debates Latinoamericanos*, vol. 2, no. 2, pp. 85–105. (In Spanish)
- Betancourth Zambrano, S. (2015) Desarrollo del pensamiento crítico en docentes universitarios. Una mirada cualitativa [Development of critical thinking in university teachers. A qualitative approach]. *Revista Virtual Universidad Católica del Norte*, no. 44, pp. 238–252. (In Spanish)
- Bezanilla Albusua, M. J., Poblete Ruiz, M., Fernández Nogueira, D. et al. (2018) El pensamiento crítico desde la perspectiva de los docentes universitarios [Critical thinking from the perspective of university teachers]. *Estudios pedagógicos*, vol. 44, no. 1, pp. 89–113. DOI: 10.4067/S0718-07052018000100089 (In Spanish)
- Boisvert, J. (2004) *La formación del pensamiento crítico: Teoría y práctica [The training to critical thinking: Theory and practice]*. México: Fondo de Cultura Económica, 214 p. (In Spanish)
- Calle Álvarez, G. Y. (2014) Las habilidades del pensamiento crítico durante la escritura digital en un ambiente de aprendizaje apoyado por herramientas de la web 2.0 [The critical thinking skills for digital writing in a learning environment supported by Web 2.0 tools]. *Encuentros*, vol. 12, no. 1, pp. 27–45. (In Spanish)
- Delors, J., Al Mufti, I., Amagi, I. et al. (1996) *Learning: The treasure within. Report to UNESCO of the International commission on education for the twenty-first century*. Paris: UNESCO Publ., 46 p. (In English)
- Documento de política para el cambio y el desarrollo de la educación superior [Policy document for change and development of higher education]*. (1995) Paris: UNESCO Publ., 54 p. (In Spanish)
- Domínguez Figaredo, D., Alonso Díaz, L. (2004) *Metodología para el análisis didáctico de foros virtuales [Methodology for the didactic analysis of virtual forums]*. [Online]. Available at: <http://www.lmi.ub.es/edutec2004/pdf/46.pdf> (accessed 12.03.2018). (In Spanish)
- Facione, P. A. (2007) *Pensamiento crítico: ¿qué es y por qué es importante? [Critical thinking: What is it and why is it important?]*. [Online]. Available at: <http://eduteka.icesi.edu.co/pdfdir/PensamientoCriticoFacione.pdf> (accessed 15.03.2018). (In Spanish)
- Fedorenko, O. A. (2018) Formirovanie kriticheskogo myshleniya u studentov neyazykovogo vuza [The formation of critical thinking among students of a non-linguistic university]. In: S. D. Vaulin (ed.). *Nauka YuUrGU: Materialy 66-j nauchnoj konferentsii. Seksii sotsial'no-gumanitarnykh nauk [Science of South Ural State University: Proceedings of the 66<sup>th</sup> scientific conference. Sections of social and human sciences]*. Chelyabinsk: South Ural State University Publ., pp. 1711–1715. (In Russian)
- Fedorov, A. V. (2007) Razvitie kriticheskogo myshleniya v mediaobrazovanii: Osnovnye ponyatiya [The development of critical thinking in media education: Basic concepts]. *Innovatsii v obrazovanii*, vol. 4, pp. 30–47. (In Russian)
- Fulton, R. D. (1989) *Critical thinking in adulthood*. [Online]. Available at: <https://files.eric.ed.gov/fulltext/ED320015.pdf> (accessed 09.09.2019). (In English)
- Gabdulkhakov, V. F. (ed.). (2019) *Razvivayushchee obuchenie v usloviyakh sovremennogo informatsionnogo prostranstva [Developing education in the modern information space]*. Kazan: Otechestvo Publ., 330 p. (In Russian)
- Gros Salvat, B., Adrián, M. (2004) Estudio sobre el uso de los foros virtuales para favorecer las actividades colaborativas en la enseñanza superior [Study of the use of virtual forums to promote collaborative activities in higher education]. *Teoría de la educación: Educación y cultura en la sociedad de la información*, vol. 5. [Online]. Available at: [https://gredos.usal.es/bitstream/handle/10366/56472/TE2004\\_V5\\_%20estudiosobreel.pdf?sequence=1&isAllowed=y](https://gredos.usal.es/bitstream/handle/10366/56472/TE2004_V5_%20estudiosobreel.pdf?sequence=1&isAllowed=y) (accesses 09.09.2019). (In Spanish)
- Hitchcock, D. (2018) Critical thinking. In: E. N. Zalta (ed.). *The Stanford Encyclopedia of Philosophy*. [Online]. Available at: <https://plato.stanford.edu/archives/fall2018/entries/critical-thinking> (accessed 09.09.2019). (In English)
- Ilyin, E. P. (2009) *Psikhologiya tvorchestva, kreativnosti, odarenosti [Psychology of creativity, creativity, giftedness]*. Saint Petersburg: Piter Publ., 444 p. (In Russian)

- Jones, J. M., Safrit, R. D. (1994) *Developing critical thinking skills in adult learners through innovative distance learning*. [Online]. Available at: <https://files.eric.ed.gov/fulltext/ED373159.pdf> (accessed 07.09.2019). (In English)
- Kubrushko, P. F., Bekbaeva, Zh. S. (2018) Formirovanie kriticheskogo myshleniya studentov universiteta [Formation of critical thinking of students of the university]. In: O. B. Akimova (ed.). *Akmeologiya professional'nogo obrazovaniya: Materialy 14-j Vserossijskoj nauchno-prakticheskoy konferentsii [Acmeology of vocational education: Proceedings of the 14<sup>th</sup> All-Russian scientific and practical conference]*. Ekaterinburg: Russian State Vocational Pedagogical University Publ., pp. 364–367. (In Russian)
- León, F. R. (2014) Sobre el pensamiento reflexivo, también llamado pensamiento crítico [About the reflexive thinking, also called critical thinking]. *Propósitos y Representaciones*, vol. 2, no. 1, pp. 161–214. DOI: 10.20511/pyr2014.v2n1.56 (In Spanish)
- Markel, S. L. (2001) Technology and education online discussion forums: It's in the response. *Online Journal of Distance Learning Administration*, vol. 4, no. 2. [Online]. Available at: <https://www.westga.edu/~distance/ojdla/summer42/markel42.html> (accessed 12.03.2019). (In English)
- Modelo académico del Instituto Tecnológico de Costa Rica. III Congreso Institucional [Academic model of Costa Rica Institute of Technology. 3 Institutional Congress]. (2003) *Tecnológico de Costa Rica*. [Online]. Available at: [https://www.tec.ac.cr/sites/default/files/media/doc/modelo\\_academico\\_del\\_itr.pdf](https://www.tec.ac.cr/sites/default/files/media/doc/modelo_academico_del_itr.pdf) (accessed 05.09.2019). (In Spanish)
- Mushtavinskaya, I. V. (2009) *Tekhnologiya razvitiya kriticheskogo myshleniya na uroke i v sisteme podgotovki uchitelya [Technology for the development of critical thinking in the lesson and in the teacher training system]*. Saint Petersburg: KARO Publ., 140 p. (In Russian)
- Novikova, I. Yu., Grevtseva, G. Y. (2015) Razvitie kriticheskogo myshleniya studentov v protsesse poznavatel'noj samostoyatel'noj deyatel'nosti [Students' critical thinking development through cognitive independent activities]. *Vestnik Chelyabinskogo gosudarstvennogo pedagogicheskogo universiteta — Herald of the Chelyabinsk State Pedagogical University*, vol. 5, pp. 47–52. (In Russian)
- Reglamento del régimen enseñanza-aprendizaje del Instituto Tecnológico de Costa Rica [Regulation of the teaching-learning regime of Costa Rica Institute of Technology]. (1986) *Tecnológico de Costa Rica*. [Online]. Available at: <https://www.tec.ac.cr/reglamentos/reglamento-regimen-ensenanza-aprendizaje-tecnologico-costa-rica-sus-reformas> (accessed 05.09.2019). (In Spanish)
- Smirnova, I. V. (2015) Ponyatie kriticheskogo myshleniya v sovremennoj pedagogicheskoy nauke [The concept of critical thinking in modern pedagogical science]. *Sovremennye problemy nauki i obrazovaniya — Modern Problems of Science and Education*, vol. 5. [Online]. Available at: <https://science-education.ru/ru/article/view?id=22783> (accessed 26.08.2019). (In Russian)
- Wilkins, E. (2002) *Facilitating online learning: Training TA's to facilitate community, collaboration, and mentoring in the online environment. Master's thesis*. Provo, UT, Brigham Young University (as a manuscript), vii, 65 p. (In English)