

Method for Cultivating the “Inquiry-Mindset” Using the Information Access-Based Belief Bias Parameter

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Abstract. In today’s world, it is important to have an “inquiry-mindset”, i.e. the disposition to access information in a critical manner. There are several previous approaches that use discussion for cultivating an “inquiry-mindset”. However, it is not easy to cultivate an inquiry-mindset only by discussion. This study proposes a method for cultivating an inquiry-mindset that focuses on opening the learner’s eyes to the possibility of belief bias, that is the tendency to gather only agreeable information. This is a method for the quantification of belief bias based on three factors: accessing information, deciding the degree of importance, and viewpoint. Based on the evaluation experiment in which 38 students participated, the authors observed that accessing information and viewpoint are especially important for cultivating an inquiry-mindset. This result confirms the efficacy of the model and argues in favor of its combined use with other cultivating methods.

Keywords: Inquiry-mindset, Belief bias, Information access, Critical thinking disposition, Learning support.

1 Introduction

With the growing influence of science and technology on society, complex social problems appear, that cannot be solved only by science, and people are often required to reach social agreement [1]. It is necessary to critically gather multiphase information and to acquire a wide range of nonbiased information in order to achieve the appropriate mutual agreement. People need to acquire information critically through an attitude which is called critical thinking (CT) attitude [2]. The CT attitude can be further divided into four domains: awareness to logical thinking, inquiry-mindset, objectiveness and evidence based judgment [3]. The inquiry-mindset refers to the attitude of trying to acquire new information and different ideas, and is the most necessary factor for acquiring a wide range of nonbiased information. With the improvement of inquiry-mindset, the quality of social mutual agreement is also expected to improve.

There are some methods for cultivating the CT attitude using information technology as shown in related works [4] [5]. However, these studies have not yielded

the expected results in the cultivation of an inquiry-mindset, failing to address issues such as internalizing information indiscriminately or ignoring information that contradicts one’s standpoint. This study aims at proposing a method for cultivating the inquiry-mindset based on the advantages of both a discussion framework and information technologies. In addition, the factors that influence cultivating the inquiry-mindset are also analyzed by actually applying the proposed method to university students, and the further challenges for cultivating the inquiry-mindset are considered.

2 Method for Cultivating the Inquiry-Mindset by Stimulating Awareness to Belief Bias

2.1 Model for Cultivating the Inquiry-Mindset Using the Belief Bias Parameter

The inquiry-mindset has a great influence on people’s acquisition of information and, therefore, for cultivating the inquiry-mindset two sides must be taken into account: the side where information is acquired (learner) and the side where the information is conveyed (information media). It is known that these two sides have different types of bias. First, there is the bias on the learner side (where information is acquired), in other words, the belief bias. Belief bias means the tendency to collect information and judge the right or wrong of things based on the agreement with one’s own belief, not on the validity of logic [6]. Therefore, it is possible to suppose that there is a deep relationship between the inquiry-mindset and belief bias, and the authors assume that this can be the clue to cultivating an inquiry-mindset. On the other hand, there exists another type of bias, on the side that imparts information: media bias [7] [8]. Since the inquiry-mindset is the attitude of an individual towards information acquisition, it is more important to show the learner’s own tendency to gather information, rather than only the results after removing the media bias. Therefore, it would be more effective to focus on the belief bias on the learners’ side, and propose a mechanism that informs him/her of his/her own belief bias in order to cultivate an inquiry-mindset. Belief is variously defined according to each research field. In the field that focuses on the learner’s understanding of utterances, it is defined as the matters or things that the learner considers true and valid [9]. Thus belief bias might become a factor that obstructs the access to relevant information. However, the belief bias is something generally possessed by everyone. This study refers neither the good/bad of the bias, nor does it deny or support bias avoidance. Here, information refers to things and matters including someone’s intentions, hypotheses, and sense of values. Information access refers to the process by which someone tries to acquire information, and the awareness (or lack thereof) that information gathering is influenced by one’s own viewpoint.

Based on the above, the authors assume that “Urging awareness to belief bias might lead to cultivating the inquiry-mindset”. It is necessary to show that information access can be biased, in order to provide the learners with awareness to their belief bias. The determinism model, the probability theory, and the set-theoretical relation of Inami [10] can function as a theory connecting the elements concerning information and a person’s sense of values. In this model, it is shown that the tendencies of

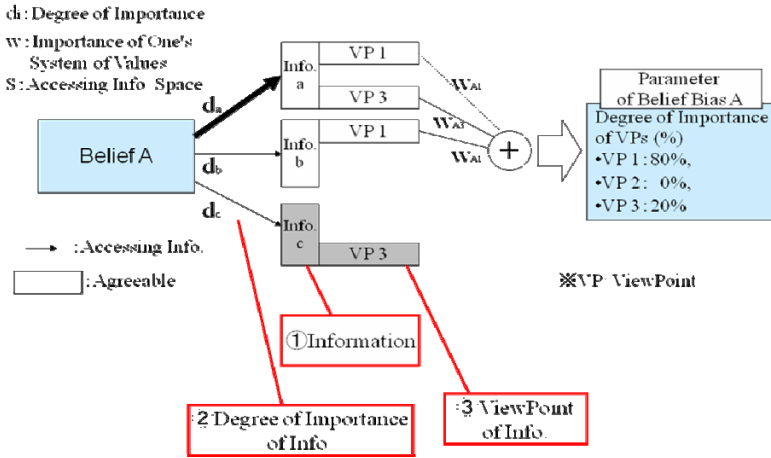


Fig. 1. A Model for the Quantification of Belief Bias

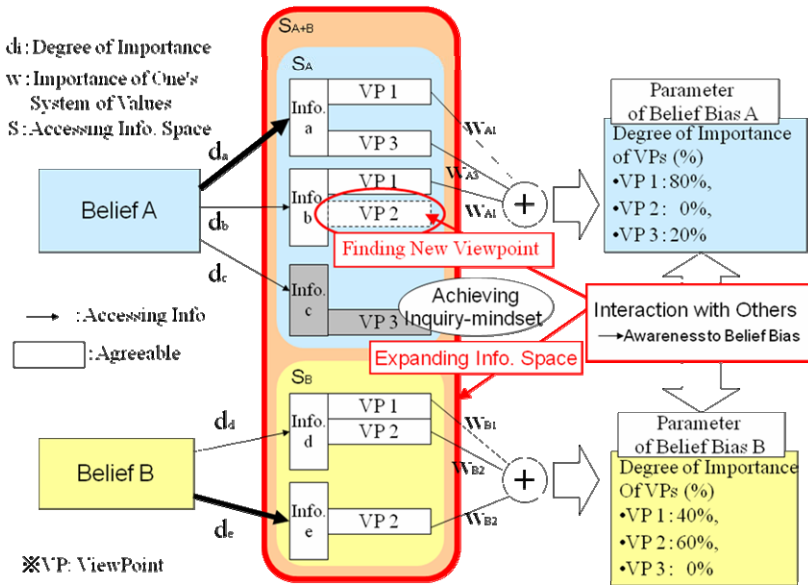


Fig. 2. A Model for Cultivating Inquiry-mind based on Belief Bias Parameter

attaching importance to information according to each learner's viewpoint can be quantified using the linear harmony of the values extracted from the weight and the viewpoint regarding a certain piece of information, on the one hand, and the way a person attaches importance to the topic, based on his/her sense of values, on the other. In addition, it is said that the information access bias appears not only for information acquisition but also as far as the priority level of information and the interpretation of

information are concerned. Our challenge is to extract the information access bias by using three elements; information (itself), the degree of importance of the information, and the viewpoints from which the information are acquired.

In this study, the authors attempt to quantify the belief bias in connection with the influence of the information access bias and the role played by one’s sense of values. The belief bias is quantified from the above-mentioned consideration points, aiming at cultivating an inquiry-mindset; also, the way it is used in the interaction with others is modeled. The belief bias quantification model is shown in Figure 1.

First, the bias about information (“Information”) accessed by belief (“Belief”) of learner A is expressed. Here, the arrows show that learner A is accessing information a, b, and c (“Info. a, b, c”) according to the belief (“Belief A”). When the learner is supporting a certain belief (in the case of information a, b), this fact is shown by the difference in the color of the box (white color). The person’s tendency is also expressed in the importance degree (“Degree of Importance”) of the accessed information, where the importance degree is shown by the thickness of the arrow. For instance, “Info. a” is shown as having a higher degree of importance than “Info. b” by making the arrow to “Info. a” thicker. Moreover, “Viewpoint (ViewPoint)” shows the person’s view about the information, that is, their interpretation of the accessed information. For instance, the fact that “Info. a” is interpreted from viewpoints 1 and 3 (VP1, VP3) is shown at the right side of the piece of information. For m number of pieces of information, the importance degree vector of information is \mathbf{d} ($d_i = [d_{i1}, d_{i2}, \dots, d_{in}]$ (n : the number of viewpoints)), which is calculated by using the importance degree of the i -th information. The viewpoint vector is \mathbf{v} ($v_i = [v_{i1}, v_{i2}, \dots, v_{in}]$ ($v_{ij} \in 0,1$)), which shows whether the information has a viewpoint or not. Since the sense of values from one individual to the other differs, the vector for the degree of importance of information is corrected linearly by the weight of each viewpoint determined by the individual’s sense of values. Here, the weight of the viewpoint is \mathbf{w} ($w = [w_1, w_2, \dots, w_n]$). The belief bias parameter is \mathbf{b} ($b = [b_1, b_2, \dots, b_n]$) as the total sum. The belief bias parameter shows, based on each learner’s sense of values, what is the value of each viewpoint and what is his/her tendency regarding the access to information, as well as how much importance each learner attaches to the viewpoint. When the parameter value of the viewpoint is large, the viewpoint is emphasized. The vector \mathbf{b} is regularized, the sum total is assumed to be one, and the ratio of the emphasized viewpoints is shown as a parameter (Parameter of Belief Bias A). The vector \mathbf{b} is calculated as follows:

$$b'_j = w_j \sum_{i=1}^m d_{ij}, b = (1 / \sum_{i=1}^n b'_i) [b'_1, b'_2, \dots, b'_n] = [b_1, b_2, \dots, b_n].$$

Next, the model for cultivating the inquiry-mindset in two learners, A and B, is shown in Figure 2 as an example. The information space that the learners A and B are accessing is shown as S_A and S_B in Fig. 2. The difference in the size of information space means the difference in the quantity, the degree of importance and the viewpoints of information accessed.

2.2 Flow of the Method for Cultivating the Inquiry-Mindset

The method for cultivating an inquiry-mindset proposed in this study consists of the following steps:

- (a) Calculation of each learner’s belief bias parameter,
- (b) Group discussion referring to the presentation based on the calculation results of the belief bias parameter of each learner.

The following work is needed so that the method for cultivating the acquiring of an inquiry-mindset might progress appropriately:

- Calculations of the setting of each learner’s tendency regarding access to information (information, degree of importance of information, and selection and evaluation of viewpoint of information),
- calculation of the setting of each learner’s sense of values, and
- presentation of the belief bias parameter during group discussion.

ID: 1

Title: Going Ahead with Underground Nuclear-waste Disposal

Source: NEA RWMC
http://www.nea.fr/html/rwm/RWMC_moving_flyer_A4_JP_Feb09.pdf

Content: Positive opinion about underground nuclear-waste disposal.

Other:

ViewPoint: technology convenience economy nature globalization

Agree of Importance: 1 2 3

Fig. 3. Design for Information Evaluation Screen

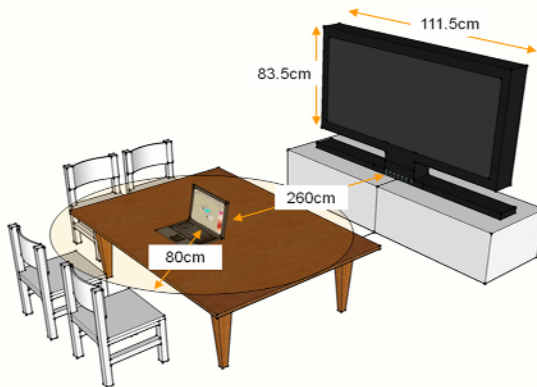


Fig. 4. Experimental Setting for Group Discussion

A supporting tool for the method of cultivating an inquiry-mindset is developed, because it is expected that the above-mentioned calculations and the presentation can be conducted more smoothly using a computer. The screen design for information input and belief bias parameter output during group discussion are shown in Figure 3 and Figure 4, respectively.

3 Evaluation Experiment

3.1 Purpose

The authors focus on information access bias based on the contents of information, importance degree of information and viewpoints of information, in order to quantify the belief bias and provide the learner with awareness about it. Therefore, the influence of these three elements on cultivating an inquiry-mindset is analyzed in the evaluation experiment. Because the place where the proposed method was applied and the measurement of the changes in the inquiry-mindset and the awareness to the belief bias are necessary for the analysis, the following conditions are required for the evaluation experiment:

- A place where evaluation of information and group discussion can be conducted,
- measurement of the inquiry-mindset before and after group discussion, and
- measurement of the awareness to belief bias before and after group discussion.

3.2 Method

Setting

- Participants: 38 people (undergraduate and graduate students, divided into ten groups of 3 or 4 persons).

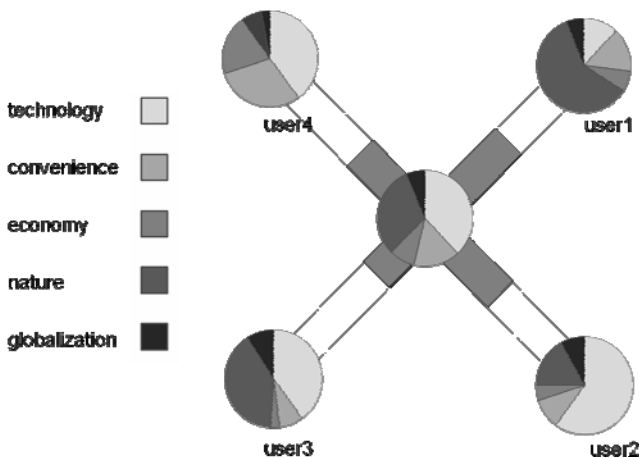


Fig. 5. Design for Belief Bias Parameters Output Screen

- Condition: “Approval or disapproval on underground disposal of high-level radioactive wastes” as a theme of controversial discussion.
- Five viewpoints (technology, convenience, economy, nature, and globalization) [11] are used for the evaluation of the viewpoint of information, known as a necessary framework for considering the environmental problems.

Procedures

- The flow of the task is shown below as the procedure of the experiment:
 1. Setting one’s sense of values (each participant)
 2. Collection of information (each participant)
 3. Sharing the collected information with the group and evaluating the degree of importance and viewpoints (each participant)
 4. Group discussion

“1. Setting of one’s sense of values”, “2. Collection of information” and “3. Sharing and evaluation” take 65 minutes in total, and “4. Group discussion” takes 60 minutes.

Figure 5 shows the experimental setting for group discussion. Group members can use one personal computer, and each member can operate the screen displaying belief bias parameters of all group members (as seen in Fig.4).

Measurements

As for the measurements of the inquiry-mindset and the awareness to belief bias, the authors focused on changes in the situation before and after the experiments; a total of three measurements are conducted in the beginning of the experiment (pre-test), immediately before group discussion (middle-test), and immediately after group discussion (post-test). Questionnaires are used in pre-, middle- and post-tests.

Ten items (A1-A10) from the critical thinking attitude test (consisting of a total of 33 all items) [8] are used for the measurements of the inquiry-mindset, and evaluated on the Likert scale (seven point scale of +3: true to -3: not true). The test is executed three times (pre-, middle- and post-) and the changes in the inquiry-mindset are measured. The measurements of awareness to belief bias are divided into two parts: “Questions concerning information received in daily life (B)” and “Questions concerning the task of the experiment (C).” (B) includes three items (B1-B3) evaluated on the 7 point Likert scale. The tests are applied three times (pre-, post- and middle-) to evaluate the change to awareness of belief bias. (C) includes three items (C1-C3) evaluated on the 7 point Likert scale. The tests are applied once (middle) to evaluate the existence or non-existence of awareness to belief bias concerning the task of the experiment.

3.3 Results

The average points on the pre-, middle- and post-tests about the inquiry-mindset are shown in Figure 6. The average for the pre-test (1.5) and the post-test (1.7) has significantly improved ($t(37) = -3.2, p < 0.01$). As for each item of A1-A10, the items A2, A3, A4, A6, A7, A8, A9 and A10 have higher average points in the post-test than

in the pre-test. The contents of the items are related to the participants’ motivation to study something new and the interest they expressed in different ideas. On the other hand, in the case of “A5: It is meaningful that we study how the foreigners think.”, the average points in the post-test are lower than in the pre-test. The cause might be that the discussion theme is on domestic problems and the group members are all Japanese.

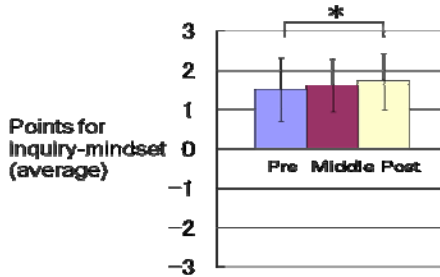


Fig. 6. Averaged Results of the Inquiry-mindset Evaluation (Evaluated on the 7 point Licker scale)

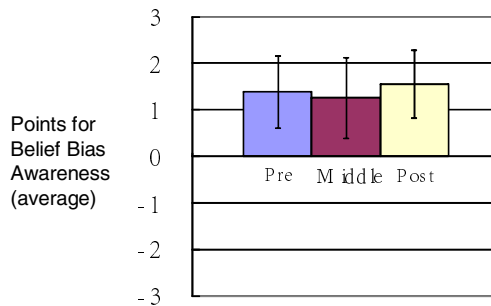


Fig. 7. Averaged Results of the Belief Bias Awareness Evaluation (B) (Evaluated on the 7 point Licker scale)

As for the correlation coefficients between the results about the inquiry-mindset and the awareness to belief bias, the latter are shown in Figure 7 and Figure 8. Fig. 7 shows the results pertaining to belief bias in the case of “Questions concerning information received in daily life (B)” (B1-B3) (seven point scale of +3: true to -3: not true) in the pre-, middle- and post-tests. Fig. 8 shows the results of belief bias on “Questions concerning the task of the experiment (C)” (C1-C3) (seven point scale of +3: true to -3: not true) in the middle-test.

The combinations with a positive correlation between inquiry-mindset and awareness to belief bias are A1 to A10 - B3, A4-B3, A10-B3, and A2-C1. On the other hand, the combination with a negative correlation is A9-B1.

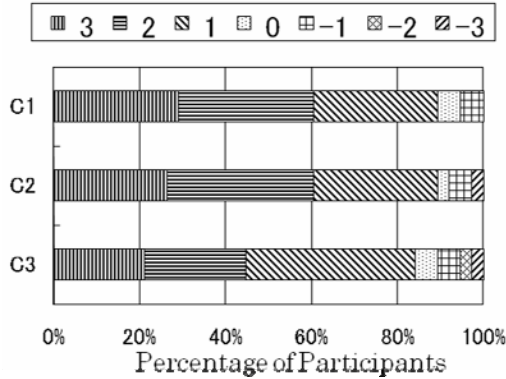


Fig. 8. Averaged Results of the Belief Bias Awareness Evaluation (C) (Evaluated on the 7 point Licker scale)

5 Conclusion

In this study, the authors aimed at proposing a new method for cultivating an inquiry-mindset focusing on the awareness to belief bias, in an attempt to solve problems that have not been tackled in previous research. The authors proposed a method for cultivating an inquiry-mindset using the belief bias parameter, the effectiveness of which was verified. The results suggested that it is possible for access to information and awareness to the bias of the viewpoint of information to influence the improvement of the inquiry-mindset.

Future challenges refer to developing the proposed method based on the results of the experiments. One of the practical challenges would be to use this method in universities and evaluate and analyze its efficiency in practice.

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