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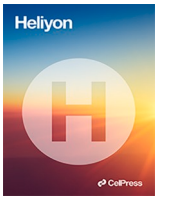

Research article

High school physics teachers' pedagogical discontentment: The effect of curriculum improvement and professional development programs

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ABSTRACT

Pedagogical discontentment refers to the feeling of dissatisfaction or frustration that teachers experience with the current state of their teaching. The purpose of this study is to explore high school physics teachers' pedagogical discontentment within the Kazakhstani context. A survey was administered to 126 physics teachers from urban and suburban areas. This quantitative research using Bayesian factor analysis was carried out to analyze the data. The results indicated that teachers are slightly discontented about their teaching and there were no relationships between gender and discontentment, qualification, and discontentment, as well as location and type of the school and discontentment. The results of our study indicate that the professional development programs for physics teachers should prioritize enhancing their abilities to teach using an inquiry-based approach. Furthermore, based on our findings, it can be inferred that the recent educational reforms aimed at improving physics education in secondary schools in Kazakhstan have been effective.

1. Introduction

A high-level of professionalism and a proper attitude among educators towards their subjects can act as a catalyst for advancing and enhancing the teaching process while preserving the potential already established in this field. Therefore, exploring different factors that contribute to improving the quality of education, such as pedagogical discontentment, is crucial, as Leu and Price-Rom [1] noted.

Pedagogical discontentment is a relatively new term introduced by a group of authors [2] who have studied teachers' satisfaction or dissatisfaction with their practice in the classroom. In other words, "pedagogical discontentment" refers to the situation where each teacher sets certain goals and objectives for their lesson but may not always achieve them in practice. When teachers find a discrepancy between their pedagogical beliefs, goals, and their actual classroom practice, pedagogical discontentment may arise [3]. In essence, pedagogical discontentment occurs when teachers are dissatisfied with their previous practical theories and find new ones to be reasonable, useful, and instructive [4].

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In the recent decade, pedagogical discontentment has been actively researched worldwide to define teachers' calls for professional development or educational reforms. Our review of the relevant literature in the field shows that pedagogical discontentment gained researchers' attention more after the vast contribution of Southerland et al. [2]. Since then, the number of publications devoted to pedagogical discontentment of science teachers has increased [5].

Even though research on pedagogical constructs, such as discontentment, is gaining momentum in developed countries, research on pedagogical discontentment for the population of science teachers in Kazakhstan is limited. A search on Google Scholar with the search term "pedagogical discontentment, Kazakhstan" yielded no relevant results. Therefore, in this study, we aim to explore pedagogical discontentment among Kazakhstani physics teachers in terms of several variables, including gender, qualifications, school types, and school locations, and introduce it to a global readership. Moreover, we explained the level of pedagogical discontentment among Kazakhstani physics teachers in terms of professional development programs and curriculum reforms in Kazakhstan.

2. Literature review

The term "discontentment" initially was mentioned by Feldman in 2000 [4]. Later, Saka et al. [6] identified pedagogical discontentment as a key factor that needed to be addressed to ensure the enactment of inquiry teaching in science. Then, Southerland et al. [7] used Feldman's term discontentment to carefully disentangle contextual (dis)satisfaction from pedagogical (dis)satisfaction. In the same year, Southerland et al. [2] published their work, where they developed a tool to investigate science teachers' pedagogical discontentment. The Southerland et al. [2] instrument has served as a critical measurement source for the study of pedagogical discontent. After the conceptualization of the term pedagogical discontentment by Southerland et al. [2], various researchers applied this concept to curriculum, teacher development, and educational reform studies, publishing numerous articles, books, and book chapter [8–10].

Reviewing the mentioned above and other literature, we have identified several factors, such as the teacher's skill level, work experience, personal qualities (teaching self-efficacy, character), gender, and others, which are particularly relevant in studying pedagogical discontentment [2,11,12]. Research on pedagogical discontentment suggests that a balance between pedagogical discontentment and self-efficacy is necessary for professional development to encourage teachers' openness to alternative teaching concepts and practices [2]. Science teachers with higher self-efficacy in teaching believe they have the capability to successfully complete the intended purpose of the lesson. A teacher with low teaching self-efficacy is less likely to imagine successfully completing specific goals of the subject and, therefore, less likely to find a high probability of achieving that goal [11,12].

In a study by Kahveci et al. [13], two-thirds of science teachers in Saudi Arabia reported high levels of pedagogical discontentment. The researchers also found that science teachers (in physics, chemistry, and biology) had higher levels of discontentment than social science teachers, such as language teachers. However, they did not find any significant differences between gender, school location, and years of experience groups. Higher educational qualifications were associated with significantly lower levels of discontentment. In another study by Qablan et al. [14], science and vocational student teachers in Jordan reported high levels of pedagogical discontentment, but there were no significant differences between male and female teachers. Similarly, Keklikci and Yavuz [15] found no significant differences between gender and school location groups in terms of pedagogical discontentment. Nadelson et al. [16] showed that participants who took more science courses had lower levels of pedagogical discontentment. However, they did not find any association between discontentment and gender.

As mentioned earlier, maintaining the level of pedagogical discontentment among teachers requires a focus on their professional qualifications and participation in teacher development programs [12].

Japashov et al. [17]described the different types of schools in Kazakhstan, including public schools, lyceums, gymnasiums, and Nazarbayev Intellectual Schools. These schools differ in their aims, the number of science teaching hours, study programs, and student learning. Nazarbayev Intellectual Schools are newly established modern schools that primarily use the Cambridge educational program. They are an experimental and exemplary platform for public schools, aimed at introducing the best foreign educational practices. Teachers of all subjects regularly attend advanced teacher training courses, and the curriculum is adjusted annually to meet the needs of teachers and students. In order to maintain a high quality of teaching, Nazarbayev Intellectual Schools use a three-stage selection process to recruit new teachers: a qualification test, an essay, and an interview [18]. Lyceums in Kazakhstan are motivated by the fact that they have the right to adjust the general educational program of the country and can formulate their educational trajectory based on the original requirements of education [19]. They are primarily focused on science, so more hours are allocated to science subjects, and lyceum teachers are required to have higher qualifications in these subjects than teachers in gymnasiums and public schools. These factors are favorable for teachers and reduce the risk of pedagogical dissatisfaction [20]. Gymnasiums in traditional Kazakhstan schools mainly focus on the study of languages and humanities, paying little attention to science subjects, particularly physics. Teaching science subjects in Kazakhstani public schools falls somewhere between lyceums and gymnasiums. Many public schools have sufficient material and technical resources, and their teachers participate in teacher development courses to some extent.

Gordienko [21] showed that pedagogical discontentment among post-Soviet Union countries' teachers is an integrated psychological characteristic of individuals' attitudes toward various aspects of labor activity, such as their profession, the working atmosphere, and working conditions. It initially arises as a psychological result and later acts as a factor stimulating the development of individuals in their professional activities [22].

In their recent research, Baisalova et al. [23] attempted to identify the factors that influence the increase or decrease of teachers' personal interest in self-development and to suggest ways to solve this problem. They compared the motivations for self-development of teachers in private and public schools and found that job dissatisfaction and motivation from administrative support were highly

correlated with the eagerness of teachers for self-education.

Another significant indicator of teachers' pedagogical discontentment in Kazakhstan is the location of the schools and socio-economic factors [24]. Beymisheva and Arǵynbayeva [24] claim that in remote regions from cities, there may often be a shortage of schools or their remote location, creating significant barriers to education for the local population. Socio-economic development of the regions of Kazakhstan reveals a relationship between the quality and accessibility of local school education. At the first level, socio-economic development determines the availability of quality employment, which ensures the education and employment system which includes a modern building, a library, a laboratory, access to the Internet, and advanced educational technologies, science laboratories and equipment. More developed regions have opportunities to create such infrastructure, facilitating teachers with professional growth and development opportunities. In addition, qualified teaching staff prefer to work in more favorable and prosperous areas, which also helps improve education quality in such places. During the annual Republican Educational Conference in 2019, the President of Kazakhstan emphasized the importance of overcoming the inequality between urban and rural schools' education quality [25]. This issue is still relevant, and Kazakhstan's governmental educational policymakers are currently working on it.

2.1. Pedagogical discontentment leads to a conceptual reform in teaching

Pedagogical discontentment usually leads to conceptual reform in teaching a particular subject. If a teacher experiences some discontentment, they may delve more carefully into and process the idea of reform, making them more likely to adopt the new practice as they consider themselves potentially capable of successfully implementing it [2].

One of the goals of understanding pedagogical discontentment among science teachers is to define their affective states before they participate in professional development activities, thereby helping coaches better plan the trajectory of professional development [6, 26]. Professional development should include central components such as enabling teachers to understand the role that pedagogical discontentment can play in shaping their own learning as teachers, followed by attempts to allow teachers to reflect on their own practice and promote the development of pedagogical discontentment to some extent, which increases the effectiveness of such experiments [7].

Thus, determining the level of pedagogical discontentment is necessary to improve the teaching of a particular subject through correct professional development or reforms. In terms of Kazakhstan's educational sphere, conceptual reform in teaching and professional development programs have been happening from the late 1990s until now. This has attracted this paper's attention to study the Kazakhstan population in terms of pedagogical discontentment and whether during these long-term reforms, physics teachers in Kazakhstan have been experiencing pedagogical discontentment or not.

2.2. Educational reforms in Kazakhstani secondary schools

Previously, the Kazakh educational sector was based on the Soviet Union's education system [27]. After the collapse of the Soviet Union, Kazakhstan launched a continuous reform of the entire educational system, which continues to this day [28]. The Kazakhstani educational system is currently undergoing a period of intense change, and below are some of the changes that have occurred: In 2000, a pilot program was initiated to transition from an 11-year to a 12-year compulsory education system. Although secondary school education in Kazakhstan currently covers an 11-year program, a 12-year education system has been introduced in some schools as an experiment. A national system for assessing the quality of education was established, and the Unified National Testing was introduced for admission to universities. In 2008, a network of Nazarbayev Intellectual Schools was created throughout the country to serve as an experimental platform for implementing modern models of educational programs and translating the best experience into the educational process of the country's public schools. In 2017, the State Compulsory Education Standard and the programs of primary and basic secondary education were updated in Kazakhstan to shift from a knowledge-based model to a competency-based one working to develop 21st-century skills in schoolchildren. Currently, a transition plan to teaching in three languages is underway in schools: Kazakh, Russian, and English. Additionally, a criteria system for assessing students' educational achievements is being introduced [29]. The adoption of modern teaching methodologies, such as lesson study, action research, CLIL (Content and Language Integrated Learning), and peer instruction, have made Kazakhstani teachers flexible in adapting to changes in the education system.

2.3. Teacher training program in Kazakhstan

In our study of Kazakhstani content, we chose to provide a brief description of teacher training programs in Kazakhstan because, as defined by Kahveci et al. [13], teachers with higher educational qualifications had significantly lower levels of pedagogical discontentment.

Chernobay and Tashibaeva [29] conducted a comprehensive study on teacher training and professional development for Kazakhstani secondary education teachers as part of the "Teaching and Learning International Survey 2018" project, which involved more than 6000 teachers and principals from 331 secondary schools. The purpose of the study was to identify the level of training and assistance provided to young teachers in Kazakhstan and to identify barriers that hinder the professional development of teachers. The study found that Kazakhstani secondary education organizations run teacher preparation programs, assign mentors to new teachers, and provide professional support to teachers through school methodological associations. This support includes training on modern methodologies, using technology during classes [30], and class management. According to the results of the study, most teachers participate in induction programs in the following formats: cooperation with other new teachers (93 %), scheduled meetings with the principal and/or more experienced teacher (92 %), and external guidance mentor (91 %).

One aspect of the "Teaching and Learning International Survey 2018" is teacher professional development. The study found that teacher professional development programs in Kazakhstan are primarily aimed at studying student assessment practices (98 %), studying the school curriculum (96 %), enriching knowledge in the main subject area (92 %), and improving teaching methods (90 %). These same areas of study are provided in the programs for preparing teachers to teach updated content and use criteria-based assessment in schools. As part of professional development programs, Kazakh teachers most often observe the lessons of colleagues and participate in coaching (94 %), attend courses/seminars (89 %), participate in communities of teachers for professional development (78 %), read professional literature (77.3 %), participate in conferences (64.8 %), and attend other schools (62 %).

One practical example of teacher training and sharing of teaching experience in Kazakhstan is the implementation of Open Lesson (OL). OL is a type of demonstrative regular lesson, conducted by a qualified instructor to disseminate and demonstrate the most effective teaching methods, similar to the Japanese open lesson [31], Chinese open class [32], or European demonstration class [21]. The purpose of OL is to provide teachers with the opportunity to observe a lesson taught by one of their colleagues and discuss pedagogical practices implemented during the lesson, students' understanding of the given material, subject content, time management of the instructor during the OL, and more. In short, during OL, teachers learn pedagogical practices to implement in their classes [33]. According to the results of the "Teaching and Learning International Survey 2018," one of the main obstacles to teacher professional development in Kazakhstan is the lack of time (38.5 % of respondents cited this as an obstacle). Kazakhstani teachers have an average of 49 contact hours per week, which is significantly higher than the average in other countries [29].

In summary, as pedagogical discontentment has not been extensively studied in the Kazakhstan population, we believe that our study of this relatively new population will draw the attention of researchers, policymakers, and general readers. Therefore, to provide a wide range of information, we have chosen to conduct a comprehensive analysis of the factors affecting the pedagogical discontentment of physics teachers (as a part of science teachers), and have formulated the following research questions.

1. What is the level of discontentment among physics teachers in Kazakhstan?
2. How are the levels of discontentment among physics teachers in Kazakhstan related to their gender, qualifications, school types, and locations?

3. Methods

This is a quantitative survey research. Surveys are convenient instruments that allow for the evaluation of large populations with relative ease [34]. The aim of this research is to describe Kazakh physics teachers' pedagogical discontentment. Specifically, we measured the discontentment that arises in teachers as they observe a discrepancy between their own pedagogical views and objectives, and their authentic classroom practices. In other words, as we focus on teaching physics, this study aimed to describe one aspect of physics teachers' affective states as they engage in teaching and learning activities.

3.1. Participants

We employed a convenience sampling which is a non-probability sampling method in which researchers select participants who are readily available and easily accessible. The questionnaire was administered to teachers working at high schools in Almaty, Kazakhstan, during the 2022–2023 school year. The sample represents the population of physics teachers in Almaty because our sample is from four of the common schools in Almaty (See Table 1). These schools included both urban and suburban communities. 131 teachers consented to participate in this research, and data from 126 of them were used for analysis. The attrition occurred during data cleaning after the questionnaire was administered. Demographic variables including frequencies (f) and percentages (%) are presented in Table 1. Informed consent was obtained from all subjects involved in the study, and participation was voluntary. They were informed that they could withdraw from the study at any time.

There are varying degrees of population types at each school type that accurately represent the population of the nation. In the NIS and Lyceum strata, our sample demonstrated approximately 66.67 % and 68.75 % of the respective populations. However, in the

Table 1
Respondents' background information.

Variable	Dimension	N	%
Gender	Male	39	31
	Female	87	69
Degree	Undergraduate (Bachelor)	86	68
	Graduate (Master)	40	32
Location	Urban	76	60
	Suburban	50	40
School type	NIS	20	16
	Lyceum	22	17
	Gymnasium	21	17
	Public	63	50
Age: Ranged between 21 and 63 with an average of 37 years			
Work experience: Ranged from 0.6 up to 39 years with an average of 13 years			
Grades teaching: 7th up to 12th			

Gymnasium and Public strata, the representation levels were comparatively lower, with 31.82 % and 37.06 % of the populations included in our study.

3.2. Instrument

The 21-item instrument, with six dimensions, used in this study was adapted from Southerland et al. [3]. For our study, items 8, 15, and 18 were removed from the original survey [3] because they were deemed inappropriate for our sample. Specifically, these items were about the nature of science (NOS), which unfortunately is not included in the Kazakhstani curriculum, and teachers are unfamiliar with NOS. After excluding the NOS items, the following dimensions were applied to our sample: a) Implementing inquiry instruction (five items); b) Ability to teach all students science (four items); c) Science content knowledge (four items); d) Balance of depth versus breadth of instruction (three items); e) Assessing science learning (three items). Teachers' level of discontentment was measured on a scale of 1–5, where 1 = no discontentment and 5 = very high discontentment.

Southerland et al. [3] originally developed the scale through an instrument development process, including validation through interviews, expert opinions, and factor analysis. They generated a scale of 21 items with six dimensions. Southerland et al. [3] measured the reliability of the original instrument with Cronbach's alpha internal consistency analysis and obtained the Cronbach's alpha value for the entire instrument as 0.93. In the current work we translated, validated, and then checked the instrument for reliability. The reliability for the dimensions and for the whole scale is as follows: Ability to teach all students science = 0.858, Balance depth versus breadth of instruction = 0.805, Implementing inquiry instruction = 0.768, Assessing science learning = 0.855, Science content knowledge = 0.825, All = 0.941.

All items were translated into Kazakh by the first and second authors using a cross-cultural translation procedure [35]. For this purpose, the first and the second authors (who are fluent Kazakh and English speakers) translated the instrument into the Kazakh language, and a professor of physics education evaluated the translated items and obtained the final version of the instrument, creating the scale format and instructions to match the original version.

Based on the Flesch-Kincaid Readability scores calculated for each sentence, our text has a readability score ranging from approximately 18 to 24. This range corresponds to a "college" reading level, which is often appropriate for academic content at the undergraduate level [36].

3.3. Data collection and analysis

Teachers completed the questionnaire online through Google Form. The questionnaire asked teachers for some demographic information, such as gender, qualifications, school type and location, and the grades they are teaching (see Table 1), as well as their level of pedagogical discontentment. Blank and illegible responses, such as all "5," were excluded from consideration. Overall, attrition was low (n = 126 useable responses out of 132 total teachers).

To analyze the data from the questionnaire, each item was first considered separately. Then, a Bayesian factor (BF01) was calculated to clarify any statistically significant differences. BF01 indicates the Bayes factor in favor of H_0 over H_1 [37]. It is known as the ratio of the number of cases that support the H_0 hypothesis to the number of cases that support the H_1 hypothesis [38]. A value of BF01 less than 1/100 significantly supports the H_1 hypothesis. Table 2 indicates the Bayesian factor interpretations. Prior and posterior plots are essential tools in Bayesian analysis, allowing researchers to gain a deeper understanding of the parameter of interest by incorporating both prior beliefs and new evidence from data [39].

Bayes factors provide a direct measure of the strength of evidence in favor of one hypothesis over another, which can be more intuitive than interpreting p-values. It allows researchers to quantify the likelihood of one hypothesis being true relative to another [40]. Bayesian Mann-Whitney *U* Test is used when the data is not normally distributed while Bayesian Independent Samples T-Test is used for normally distributed data.

4. Results

In this section, we provide detailed descriptions of each variable and their analyses through descriptive and inferential statistics. We first present the results on an item-by-item basis and then provide the results on a group basis. Fig. 1 indicates the level of discontentment reported by teachers for each item, which ranges from 1 to 5.

According to our findings (see Fig. 1), the average level of discontentment among the Kazakh physics teachers is 1.29, indicating a

Table 2
Bayesian factor interpretations.

Criteria	Interpretation of BF01	Criteria	Interpretation of BF01
>100	Extreme evidence for H0	1/3–1	Anecdotal evidence for H1
30–100	Very strong evidence for H0	1/3–1/10	Moderate evidence for H1
10–30	Strong evidence for H0	1/10–1/30	Strong evidence for H1
3–10	Moderate evidence for H0	1/30–1/100	Very strong evidence for H1
1–3	Anecdotal evidence for H0	<1/100	Extreme evidence for H1
1	No evidence		

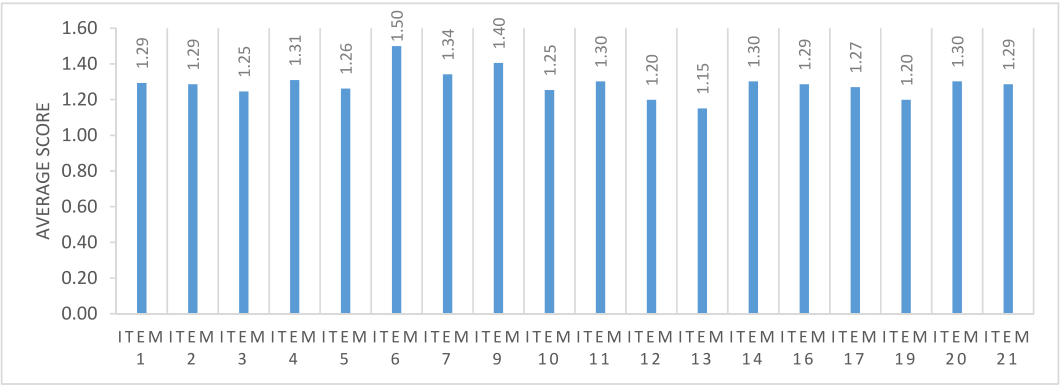

Fig. 1. Bar graph for teachers' discontentment on each item.

level somewhere between no discontentment and slight discontentment. This suggests that the level of pedagogical discontentment in our sample was quite low. Among the individual items, the highest level of discontentment (1.50) was reported for the sixth item, which pertains to the use of inquiry-based teaching across all content areas, while the lowest level of discontentment was reported for the thirteenth item, which relates to teaching science to students of higher ability levels.

The Bayesian statistical findings for the categorical variables (gender, qualification, school location, and school type) are presented below. Our data collection instrument has five dimensions (the NOS dimension was excluded) and teachers' average discontentment scores for each dimension are presented in Table 3.

Of all five dimensions, teachers have the highest level of discontentment in implementing inquiry instruction (1.33) and the lowest in science content knowledge (1.23). The average scores of male and female teachers on the dimensions of the pedagogical discontentment scale are presented in Table 4.

The scores of males are higher in "implementing inquiry instruction, ability to teach all students science, and science content knowledge" while that of females are higher in "balance depth versus breadth of instruction and assessing science learning" (See Table 4).

To locate if these differences are significant through Bayes factor, we constructed the null hypothesis: "There is no difference in discontentment scores across gender" and alternative hypothesis: "There is difference in discontentment scores across gender." The amount of data supporting each hypothesis was determined by Bayesian Mann-Whitney *U* Test. Our results for the gender differences on all dimensions of the discontentment scale is presented in Table 5.

Despite the differences between the means of the groups, our results did not support one hypothesis over the other. As the BF01 values change between 3.795 and 4.721, we found moderate evidence for H_0. In other words, Kazakhstani physics teachers' pedagogical discontentment level is not related to gender.

The visualization of the findings from the Bayesian test is shown in Fig. 2. The first five plots are for the scores on the dimensions of the discontentment scale, and the last one is for overall scores.

Several indicators in these graphs can be used to compare both hypotheses. For example, the pie charts on the top of the graphs display the percentage of evidence for the H_1 (red) and H_0 (white) hypotheses. Additionally, if the grey dot on the prior distribution is lower than the one on the posterior distribution, then the Bayes factor supports the null hypothesis. As a result, a two-sided analysis revealed a Bayes factor (BF01) indicating that the data were 4.721, 4.281, 4.201, 3.795, and 4.485 times more likely under the null than the alternative hypothesis for the five dimensions and the average discontentment, respectively.

We also analyzed teachers' discontentment according to their qualifications, i.e., those with only a bachelor's degree and those with a master's degree (Table 6). We constructed the null hypothesis: "There is no difference in discontentment scores across teacher qualifications" and the alternative hypothesis: "There is a difference in discontentment scores across teacher qualifications." The amount of data supporting each hypothesis was determined by the Bayesian Mann-Whitney *U* Test."

The discontentment scores of teachers vary between those who have only a bachelor's degree and those who have a master's degree. The scores of the bachelor group are higher in the dimensions of "science content knowledge," "balance depth versus breadth of instruction," and "assessing science learning," while those of the master's degree group are higher in "implementing inquiry instruction"

Table 3
Mean and standard deviation for the dimensions of the discontentment.

Dimension	Mean	Std
Implementing inquiry instruction	1.33	0.57
Ability to teach all students science	1.32	0.64
Science content knowledge	1.23	0.55
Balance depth versus breadth of instruction	1.29	0.62
Assessing science learning	1.27	0.63
Total	1.29	0.52

Table 4
Mean and standard deviation for gender variable.

Dimension	Gender	N	Mean	Std
Implementing inquiry instruction	Male	39	1.35	0.63
	Female	87	1.31	0.54
Ability to teach all students science	Male	39	1.33	0.65
	Female	87	1.31	0.64
Science content knowledge	Male	39	1.26	0.66
	Female	87	1.22	0.50
Balance depth versus breadth of instruction	Male	39	1.22	0.53
	Female	87	1.32	0.66
Assessing science learning	Male	39	1.26	0.57
	Female	87	1.28	0.66

Table 5
Bayesian Mann-Whitney *U* test – gender.

Dimension	BF_{01}	W	Rhat
Implementing inquiry instruction	4.721	1687.0	1.006
Ability to teach all students science	4.281	1751.0	1.010
Science content knowledge	4.201	1577.0	1.006
Balance depth versus breadth of instruction	3.795	1547.0	1.001
Assessing science learning	4.485	1674.5	1.002

Note. Result based on data augmentation algorithm with 5 chains of 1000 iterations.

and "ability to teach all students science" (see Table 6). To test for significant differences between the qualification groups, we conducted a Bayesian Mann-Whitney *U* Test (see Table 7).

As shown in Table 7, the values of BF01 vary between 2.082 and 4.442, which indicates moderate evidence for H_0. In other words, regardless of qualification, all teachers have a similar amount of discontentment in teaching physics. The visualization of the findings from the Bayesian test for the difference between bachelor's and master's degree teachers is presented in Fig. 3. The first five plots are for the scores on the dimensions of the discontentment scale, and the last one is for the overall scores.

The pie charts at the top of the graphs display the percentage of evidence for H_1, which is much less than that for H_0 for all dimensions as well as for the total scores. Moreover, all the grey dots on the prior distribution are lower than the ones on the posterior distribution, which means that the Bayes factor supports the null hypothesis. As a result, a two-sided analysis revealed that the data were 4.267, 4.385, 3.191, 2.080, 4.442, and 4.67 times more likely under the null than the alternative hypothesis for five dimensions and the average discontentment, respectively.

We then analyzed teachers' discontentment according to the location of the school (Table 8). For this, we constructed the following hypotheses: "There is no difference in discontentment scores across the location of the schools" and "There is a difference in discontentment scores across the location of the schools."

The scores of teachers whose schools are in urban area are higher in implementing inquiry instruction," and "ability to teach all students science," while those scores of the village areas are higher in "science content knowledge, balance depth versus breadth of instruction, and assessing science learning" (See Table 8). Bayesian Independent Samples T-Test is used to locate any statistically significant differences between teachers from urban and rural areas.

As seen in Table 9 no significant differences are detected between groups. As the values of BF01 vary between 2.964 and 4.737 we found moderate evidence for H_0. In other words, regardless of the location of the school all teachers have similar amounts of discontentment in teaching physics.

The visualization of the findings from Bayesian test for the difference between teachers from urban and rural areas is shown in Fig. 4. The first five plots are for the scores on the dimensions of the discontentment scale and last one is for the overall scores.

The pie charts on the top of the graphs display that the percentage of evidence for the H_1 are much less than and H_0 hypothesis for all dimensions as well as for the total scores. Moreover, all the grey dots on the prior distribution are lower than the one on the posterior distribution which means the Bayes factor supports the null hypothesis.

As a result, a two-sided analysis revealed a Bayes factor (BF01) that the data were 4.456, 4.737, 3.971, 2.964, 3.062, and 4.867 times more likely under the null than the alternative hypothesis for five dimensions and the average discontentment, respectively.

Finally, we used Bayesian ANOVA test for each dimension to test the hypotheses H_0: "There is no difference in teachers' discontentment across school types" and H_1: "There is difference in teachers' discontentment across school types." Table 10 represents mean and standard deviation for school type variable.

Bayesian ANOVA analysis provides an analysis based on model comparisons. "Null model" was preferred in comparisons (Table 11).

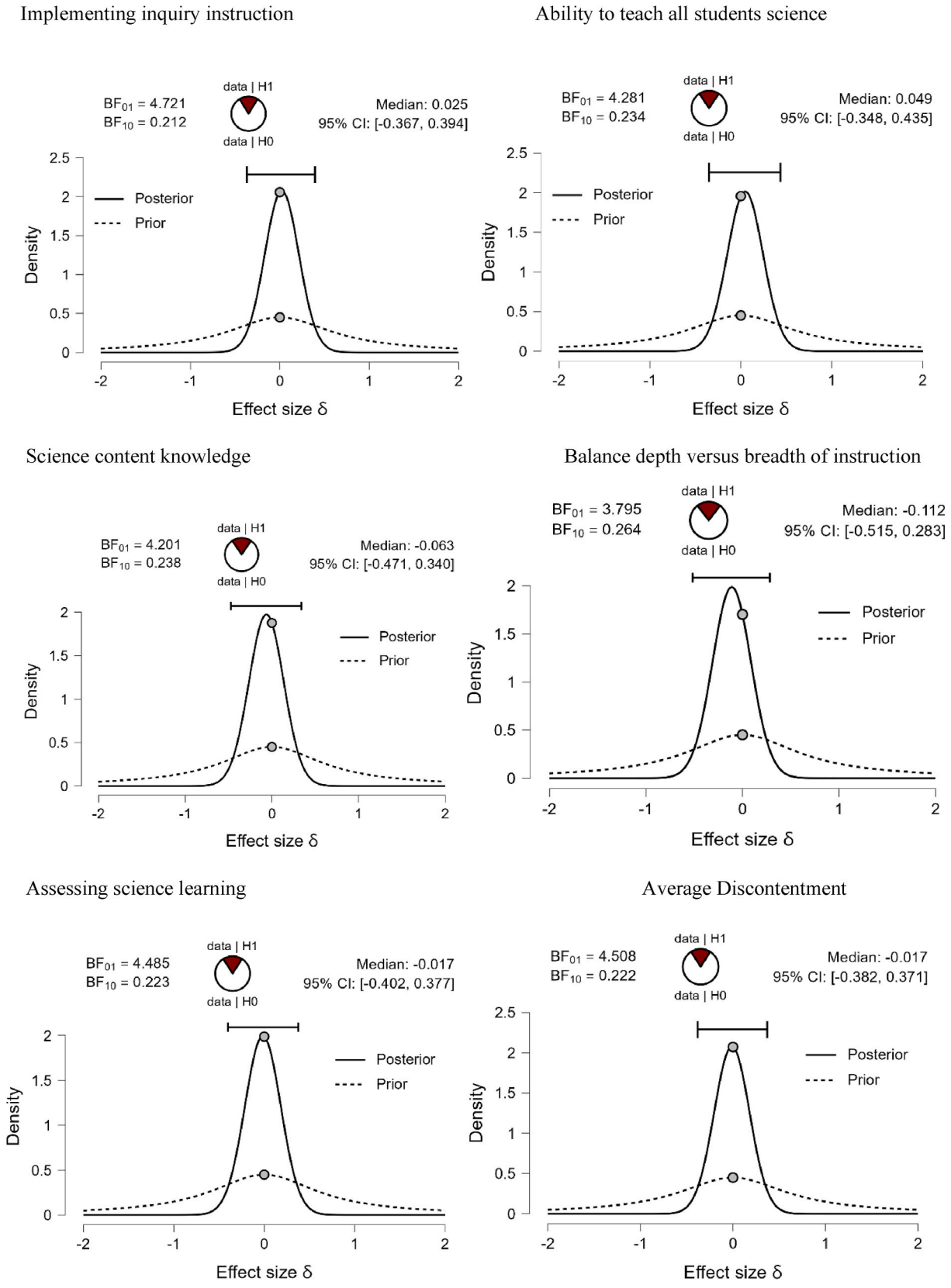

Fig. 2. Prior and posterior plots for the males and females scores on the dimensions of the scale.

Table 6
Mean and standard deviation for qualification variable.

Dimension	Qualification	Valid	Mean	Std
Implementing inquiry instruction	Bachelor	86	1.31	0.54
	Master	40	1.35	0.63
Ability to teach all students science	Bachelor	86	1.31	0.66
	Master	40	1.33	0.61
Science content knowledge	Bachelor	86	1.27	0.57
	Master	40	1.17	0.51
Balance depth versus breadth of instruction	Bachelor	86	1.38	0.73
	Master	40	1.10	0.20
Assessing science learning	Bachelor	86	1.29	0.70
	Master	40	1.23	0.45

Table 7
Bayesian Mann-Whitney *U* test - qualification.

Dimension	BF_{01}	W	Rhat
Implementing inquiry instruction	4.267	1667.000	1.004
Ability to teach all students science	4.385	1639.000	1.006
Science content knowledge	3.191	1943.000	1.005
Balance depth versus breadth of instruction	2.082	2008.000	1.001
Assessing science learning	4.442	1616.000	1.006

Note. Result based on data augmentation algorithm with 5 chains of 1000 iterations.

5. Discussion

The aim of this study was to reveal physics teachers' pedagogical discontentment and analyze the discontentment in terms of gender, qualifications, school types, and school locations. In response to the first research question ("What is the level of discontentment among physics teachers in Kazakhstan?"), we found a low amount of discontentment in our sample. This result contradicts the findings of Kahveci et al. [13] who found high discontentment for science teachers in Saudi Arabia. Similarly, our results contradict that of Qablan et al. [14] from Jordan.

The low level of discontentment in our sample can be explained in two ways. First, the reforms through professional development programs on the physics teaching is Kazakhstan are successful. In recent years, Kazakhstan has implemented several curriculum reforms related to physics and science education. The Ministry of Education and Science of the Republic of Kazakhstan have introduced a range of initiatives aimed at improving the quality of science education, increasing student engagement, and preparing students for future careers in science and technology. For example, the adoption of the competence-based approach is a key reform in Kazakhstan's science education system. This approach aims to move away from a traditional, content-focused model of science education and emphasizes the development of students' practical skills and ability to apply scientific knowledge to real-world problems. The approach also aims to develop students' critical thinking and problem-solving skills [41]. To support these initiatives, the Ministry of Education and Science of the Republic of Kazakhstan has introduced new curriculum standards for all subjects, including physics education. The new standards emphasize the integration of science subjects and the development of critical thinking and problem-solving skills. They also include a focus on the use of technology in science education [42]. Moreover, Kazakhstan has introduced a STEM education program to promote interdisciplinary learning and the integration of science and mathematics education. The program includes initiatives such as teacher training, curriculum development, and the provision of laboratory equipment to schools [43].

Another possible explanation for the above findings is that the level of discontentment may depend on other factors. Thus, the teacher discontentment appears to be complex and multifaceted. Additional research is needed to better understand the factors that contribute to teacher discontentment across different contexts and populations.

The relationships between discontentment and gender, qualifications, school type, school location were assessed as a response to the second research question ("How are the levels of discontentment among physics teachers in Kazakhstan related to their gender, qualifications, school types, and locations?"). The statistical analysis conducted in this study indicates that gender has no significant influence on teachers' pedagogical discontentment in Kazakhstan. This finding is in congruent with findings of Qablan et al. [14] from Jordan, Keklikci and Yavuz [15] from Turkey, and Nadelson et al. [16] from USA. As there is not much research on the link between discontentment and gender this finding extends what we know in the field.

One interesting result of this study is that we did not find any significant difference in discontentment between teachers with bachelor's degrees and those with master's degrees. As Flores and Day [44] suggest, teacher qualifications may not be a significant predictor of pedagogical discontentment, and that factors such as teacher autonomy, support from colleagues, and access to professional development may be more important. While having a master's degree may provide teachers with additional knowledge and skills, it may not necessarily lead to lower discontentment if other factors contributing to discontentment are present. Thus, further research is needed to clarify the relationship between discontentment and qualification.

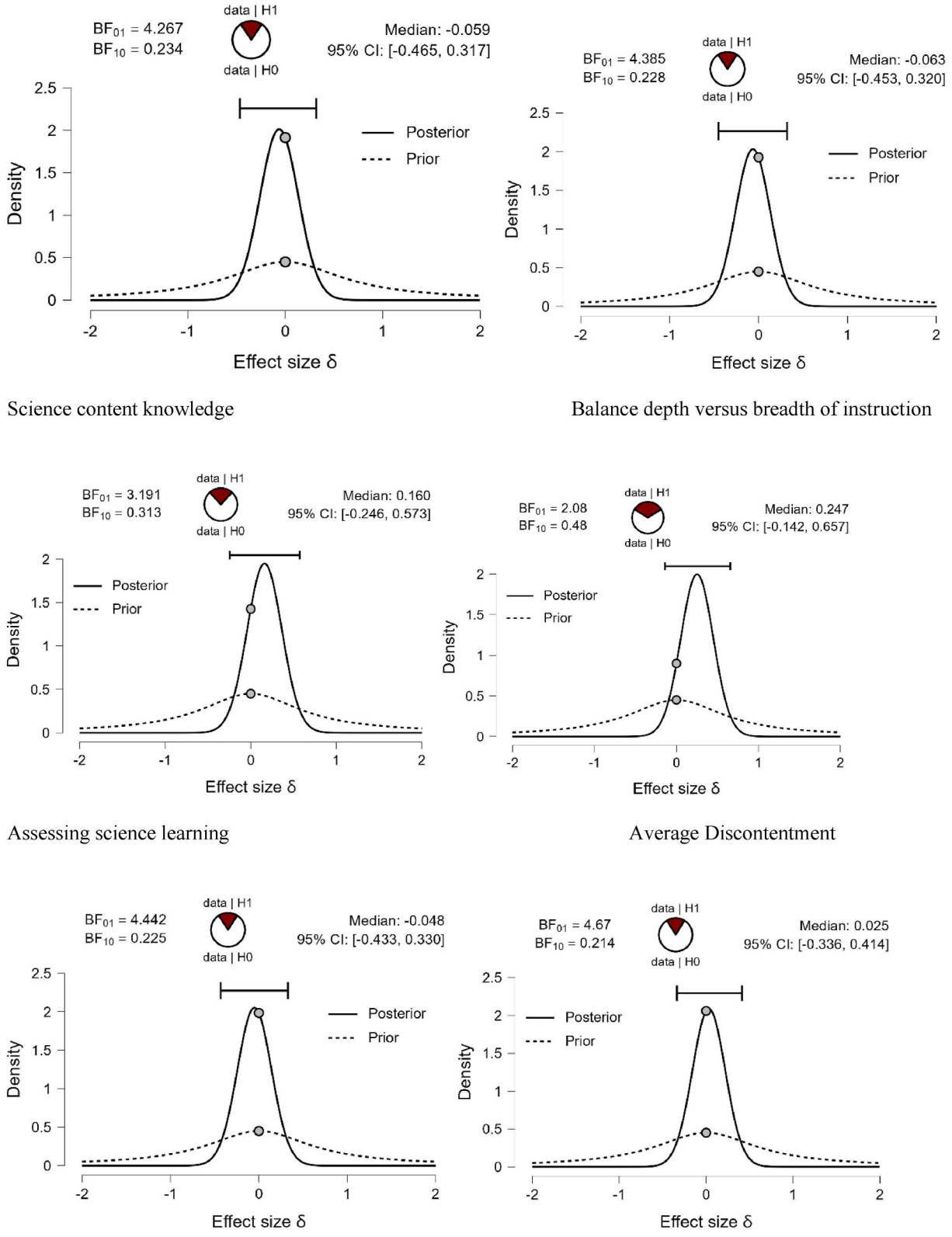

Fig. 3. Prior and posterior plots for the bachelor's and master's degree teachers scores on the dimensions of the scale.

Table 8
Mean and standard deviation for school location variable.

Dimension	Location	Valid	Mean	Std
Implementing inquiry instruction	Urban	76	1.349	0.619
	Rural	50	1.290	0.477
Ability to teach all students science	Urban	76	1.336	0.633
	Rural	50	1.285	0.653
Science content knowledge	Urban	76	1.204	0.476
	Rural	50	1.280	0.646
Balance depth versus breadth of instruction	Urban	76	1.241	0.504
	Rural	50	1.367	0.769
Assessing science learning	Urban	76	1.224	0.512
	Rural	50	1.347	0.774

Table 9
Bayesian Independent Samples T-Test-school location.

Dimension	BF_{01}	error %
Implementing inquiry instruction	4.456	0.032
Ability to teach all students science	4.737	0.033
Science content knowledge	3.971	0.030
Balance depth versus breadth of instruction	2.964	0.026
Assessing science learning	3.062	0.026

In contrast to other studies, we found no relationship between pedagogical discontentment and school type. It is important to note that the relationship between school type and pedagogical discontentment is complex and may vary depending on a variety of individual and contextual factors. For example, a study by Chan and colleagues [45] found that the relationship between school type and pedagogical discontentment was influenced by factors such as teacher perceptions of school climate and leadership.

Another important finding is that teachers from urban and suburban schools show a similar level of discontentment in teaching physics, in contrast to the study of Baisalova et al. [23]. Similarly, in contrast to Moore [46], who found that teachers in rural schools experience higher levels of discontentment due to factors such as isolation, limited access to resources and professional development opportunities, and a lack of diversity among students and staff, we found no statistically significant differences between pedagogical discontentment and school location. This may be because our sample size regarding school location was limited to urban and suburban schools. We could not provide the research in schools located far from big cities. Therefore, we could not find a statistically significant difference between schools in different locations. The schools researched for this paper were geographically closely located and had equal professional development programs. For example, based on our observation, qualified teachers in Nazarbayev Intellectual Schools [47] regularly implement workshops, seminars, and lab work for teachers from suburban areas.

Additionally, we would like to highlight that among the individual items, the highest level of discontentment was reported for the items that belong to inquiry-based teaching across all content areas. This echoes the Kahveci et al. [13] findings, which most closely describe the discontentment issue of Kazakhstan teachers. Kahveci et al. [13] explained the high level of teachers' discontentment regarding inquiry-based teaching, stating the case that science teachers are highly challenged to teach inquiry-based science. This may be because most science teachers learned science in traditional classroom settings. Much of the professional development offered to teachers may not meet the demands of the inquiry-based science education standards [48,49] The initial preparation programs and ongoing professional development activities of in-service teachers should be also changed and linked to teachers' emerging needs to support inquiry-based teaching.

We prefer to highlight the findings of articles from other research on how successful programs have reduced the level of physics/science teachers' pedagogical discontentment. In this regard, Keklikci and Yavuz [15] conducted an experimental study about the relationship between science teachers' self-efficacy and pedagogical discontentment. Their findings were consistent with the results of Thompson [50], which state that reform-based, long-term, intensive professional development programs help increase teachers' self-efficacy, which leads to reduced teachers' pedagogical discontentment level. Keklikci and Yavuz [15] suggested that science teachers' educators and professional development designers should focus on opportunities for teachers to explore their pedagogical shortcomings and ineffective classroom applications to recognize their inadequacies in science teaching to reduce the level of pedagogical discontentment. Additionally, Enderle et al. [51] provided a five-year study with elementary, middle, and high school teachers to examine the effect of the Science Pedagogy Research Project Model on science teachers' self-efficacy, pedagogical discontentment, beliefs about teaching and learning, and Contextual Beliefs about Teaching Science. In the scope of the study, science teachers were involved in ongoing research projects in scientists' laboratories. The project aimed to engage teachers in scientific research and an in-depth, reflective study of the learning that occurred and how to translate that learning into classroom teaching practice. Their findings suggested that for all the constructs measured in the study, the most significant impact of the Science Pedagogy Research Project Model experiences may be reducing teachers' sense of pedagogical discontentment.

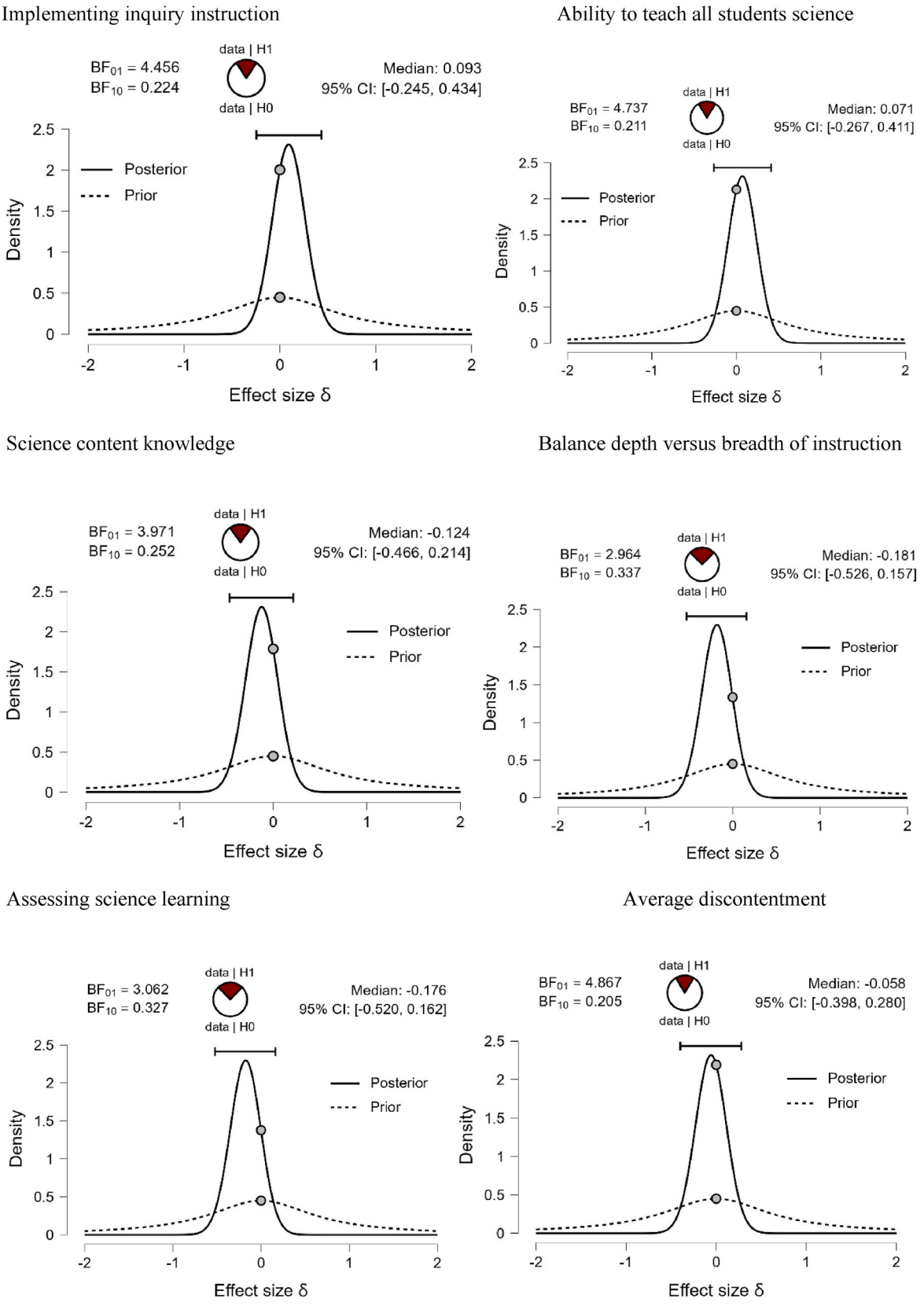

Fig. 4. Prior and posterior plots for the scores of teachers from urban and rural areas on the dimensions of the scale.

Table 10
Mean and standard deviation for school type variable.

Dimension	School	N Valid	Mean	Std
Implementing inquiry instruction	NIS	18	1.222	0.484
	Lyceum	20	1.363	0.576
	Gymnasium	19	1.500	0.786
	Public	69	1.293	0.511
Ability to teach all students science	NIS	18	1.194	0.379
	Lyceum	20	1.288	0.408
	Gymnasium	19	1.500	0.85
	Public	69	1.304	0.68
Science content knowledge	NIS	18	1.056	0.162
	Lyceum	20	1.188	0.371
	Gymnasium	19	1.289	0.774
	Public	69	1.279	0.581
Balance depth versus breadth of instruction	NIS	18	1.148	0.383
	Lyceum	20	1.217	0.394
	Gymnasium	19	1.281	0.641
	Public	69	1.353	0.716
Assessing science learning	NIS	18	1.019	0.079
	Lyceum	20	1.267	0.413
	Gymnasium	19	1.404	0.725
	Public	69	1.304	0.718

Table 11
Bayesian ANOVA model comparison.

Models	P(M)	P(M|data)	BF_M	BF_{01}	error %
Null model	0.500	0.878	7.197	1.000	
Type of school	0.500	0.122	0.139	7.197	9.728×10^{-4}
Null model	0.500	0.895	8.567	1.000	
Type of school	0.500	0.105	0.117	8.567	0.001
Null model	0.500	0.875	6.976	1.000	
Type of school	0.500	0.125	0.143	6.976	9.036×10^{-4}
Null model	0.500	0.898	8.813	1.000	
Type of school	0.500	0.102	0.113	8.813	0.001
Null model	0.500	0.826	4.748	1.000	
Type of school	0.500	0.174	0.211	4.748	4.468×10^{-4}

As seen from Table 11 in all dimensions of the discontentment scale the BF01 values are changing between 4.748 and 8.567 which indicates moderate evidence for H_0. In other words, teachers' discontentment is not dependent on the type of school that they work in.

6. Conclusions

The two main findings of this study were the low levels of discontentment in our sample and that there were no statistically significant differences between the pedagogical discontentment and the variables gender, qualifications, school types, and school locations. Unfortunately, existing literature does not provide sufficient research to discuss our results thoroughly. Further comparative analyses could be conducted to explore teachers' pedagogical discontentment in more depth. It is worth noting that the factors contributing to teacher discontentment may vary across different contexts and cultures, and so it is important to consider the specific conditions and factors that may be relevant in any given study. Overall, when our findings are assessed in the context of Kazakhstan, we can conclude that after the collapse of Soviet Union the educational reforms for science teachers in Kazakhstan at secondary schools are successful because low level of discontentment among teachers is a powerful indicator of teachers' quality [16,20] and well-organized professional development programs [12]. Still, further research is needed to observe similar findings for other subject teachers.

It is important to note that our sample, while demonstrating sufficient population representation within each school type, is not evenly distributed across school types. Specifically, the NIS and Lyceum strata exhibit strong representativeness, with approximately 66.67 % and 68.75 % of the respective populations included in our study. However, the Gymnasium and Public school strata are comparatively less represented, encompassing only 31.82 % and 37.06 % of their respective populations.

Finally, our analysis of the item-based results showed that the participants expressed the most discontentment (1.5 on a 5-point scale) with inquiry-based teaching in all content areas. Similarly, the dimension-based findings indicated that the participants reported the highest discontentment (1.33 on a 5-point scale) with the implementation of inquiry-based instruction. Although the discontentment levels are still relatively low, we recommend that future professional development programs for Kazakhstani teachers prioritize the enhancement of inquiry-based teaching skills.

Ethics statement

This study was approved by Ethical comity of South Kazakhstan State Pedagogical University on October 20, 2022 with protocol number 1.

Data availability statement

Data associated with our study is not deposited into a publicly available repository. Data will be made available on request from the corresponding author.

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CRediT authorship contribution statement

Nuri Balta: Writing - review & editing, Writing - original draft, Formal analysis. **Nursultan Japashov:** Writing - review & editing, Writing - original draft, Data curation. **Tannur Bakytkazy:** Methodology, Conceptualization. **Bagdat Abdikadyr:** Investigation, Conceptualization. **Kuralay Nurgaliyeva:** Writing - original draft, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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