





Research paper

Analysis of the Influence of Different Factors on the Attitudes Towards Science Among Veterinary Students

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ABSTRACT

Attitudes towards science can influence students' academic performance. Therefore, the objectives of this study are to assess attitudes towards science and the impact on them of metacognitive strategies, self-efficacy, learning processes, trust in science, understanding of the nature of science, and gender. Quantitative ex post facto research was carried out with 147 Argentine first-year veterinary students. Four previously designed and validated questionnaires were used to assess each of the study variables. The scores obtained and the correlation, multiple regression, and mediation analyses suggest that: a) attitudes towards science were mediocre, and neither gender nor knowledge about the nature of science had a significant effect on them; b) monitoring, evaluation and planning of learning, and trust in science were the variables that most influenced the variability of these attitudes; and c) constructivist connectivity, science learning self-efficacy, learning risks awareness, and control of concentration had significant indirect effects on attitudes towards science.

Keywords: attitudes towards science, learning processes, metacognition, self-efficacy, trust in science

According to Raved & Assarf (2011), the term attitudes typically refer to a construct that encompasses the orientation or relationship, whether positive or negative, towards a specific theme, subject, or issue. According to Osborne et al. (2003), in the specific case of attitudes towards science, this would include the set of feelings, beliefs, and values one holds about science in general, science in educational institutions, or the impact of science and scientists on society. Most researchers adhere to the model that distinguishes three basic components in attitudes: cognitive, affective, and behavioural (Potvin & Hasni, 2014). When discussing science, the cognitive component includes an individual's beliefs and knowledge about science, the affective component encompasses the emotional ties of the relationship with science, and the behavioural or conduct component corresponds to the way of acting with science (Xu et al., 2013).

The attitudes and perceptions of students towards science can influence their level of engagement and, ultimately, their conceptual learning and academic performance (Osborne et al., 2003). Studies by Mattern & Schau (2002), Papanastasiou & Zembylas (2002), and Xu et al. (2013) corroborate the positive and significant influence of attitudes towards science on academic outcomes. Balçın et al. (2018) found a high positive relationship between STEM attitude and interest in STEM professions. Attitudes towards science can be affected by various variables, including gender, learning environment, positive experiences with science,

perception of science, value of studying science, and laboratory use (Freedman, 1997; Şentürk & Özdemir, 2014). It has even been suggested that the construct attitudes towards science is formed by various subconstructs contributing in variable proportions to the attitudes one has towards science (Osborne et al., 2003). Murphy et al. (2006) consider interest, enjoyment, motivation, and perceived difficulty as the main subconstructs of attitudes towards science.

Numerous studies in secondary education have explored the effects of epistemological beliefs on attitudes towards science (Cairns, 2023; Kapucu & Bahçivan, 2015), with findings indicating positive and significant impacts. However, research on attitudes towards science in higher education is scarce, with links between epistemological beliefs and attitudes towards science similar to those identified in secondary education (Bayraktar, 2019; Fulmer, 2014).

It is worth noting that Edmondson & Novack (1993) revealed the positive impact of using metacognitive tools in learning on attitudes towards science and epistemological beliefs among university students. Similarly, Kapucu & Bahçivan (2015), working with secondary education students, discovered that self-efficacy in science learning was positively and significantly related to attitudes towards science. Lastly, the research conducted by Kayacan & Ektem (2019) with university students highlighted the significant effect of using self-regulated learning strategies (which include metacognitive, motivational, and behavioural processes) on improving their attitudes towards science.

A study conducted using a structural equation model with a sample of adults in Canada revealed that attitudes towards science decisively influence trust in science (Roberts et al., 2013). Trust in science can be considered a construct primarily made up of emotions, rational thinking, credibility perception, and reliability perception (Nadelson et al., 2014).

All this theoretical background leads to the conclusion that cognitive, metacognitive, motivational, and emotional factors can influence students' attitudes towards science. Furthermore, attitudes towards science are a good indicator of engagement in academic work and subsequent performance. Understanding these students' attitudes towards science is also important because it can help educators adapt and improve curriculum and science teaching in veterinary faculties. Given all these facts, the objectives of the present study were:

1. To understand the level of attitudes towards science among first-year veterinary university students.
2. To analyse the impact of self-efficacy, metacognitive strategies, learning processes, trust in science, knowledge about the nature of science, and gender on these students' attitudes towards science.

METHOD

Research design

The study employed a quantitative methodology with an ex post facto design. Attitudes towards science were taken as the dependent variable. Trust in science, knowledge about the nature of science, and each of the dimensions that make up the questionnaire by Thomas et al. (2008) on metacognitive strategies, self-efficacy, and learning processes (constructivist connectivity; monitoring, evaluation, and planning; science learning self-efficacy; learning risks awareness; and control of concentration) were taken as independent variables. Gender was also considered an independent variable. Data were collected during the last months of 2022.

Participants

A total of 147 students voluntarily participated in the study, 59 men and 88 women from the first year of the Veterinary Sciences program at the Universidad Nacional del Litoral (Republic of Argentina). They belonged to different complete groups of said university, and their selection followed a non-probabilistic sampling method. In any case, there were no indications to suggest that the student profile differed from that of other Argentine universities.

Instruments

Four instruments were employed: one to assess attitudes towards science, one to determine trust in science and scientists, one to estimate knowledge about the nature of science, and finally, a self-report to reveal the use of certain learning processes and metacognitive strategies, as well as their level of self-efficacy in learning. All of them were translated into Spanish, adapted to the characteristics of the participants in this study, and reviewed and improved by two university professors. The characteristics of these instruments are provided below.

To measure attitudes towards science, a questionnaire based on the one validated by Kind et al. (2007) was used. It consists of 44 items and uses a Likert scale from 1 (strongly disagree) to 4 (strongly agree). It aims for students to disclose their degree of agreement (i.e., their self-perception) on various statements related to: self-concept in science (7 items), practical work in science (8 items), science outside the university (6 items), future

participation in science (5 items), the importance of science (5 items), and general attitude towards the university (8 items). There are direct and inverse items (in the latter, the score was reversed). It should be noted that a higher score indicates better attitudes towards science. The following are two examples of items from the questionnaire:

Studying science and doing science is boring (Inverse item)

I would like to engage in scientific activities outside the university (Direct item)

The total score of the attitudes towards science questionnaire was obtained by adding the scores of the 44 items (minimum score 44 and maximum score 176 points).

Trust in science and scientists was determined using the questionnaire validated by Nadelson et al. (2014). This questionnaire focuses on aspects of science and the work of scientists that people may question in terms of trust. It consists of 21 items, with a Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). High scores on the questionnaire indicate high trust in science and scientists. As in the previous questionnaire, there are both direct and inverse items:

We must trust that scientists are honest in their work (Direct item)

Scientists will protect each other even when they are wrong (Inverse item)

The final score for the questionnaire on trust in science and scientists was obtained from the sum of all items (minimum score 21 and maximum score 105 points), after transforming the scores of the inverse items.

In order to examine the level of knowledge about the nature of science, the questionnaire proposed by Dogan and Abd-El-Khalick (2008) was used. This questionnaire consists of 14 items, each presenting a proposition related to science, and one must select one of the presented options. Following the authors' guidelines, there are "naive" options (0 points), "informed" options (1 point), and "meritorious" options (2 points). An example item is provided:

The best scientists are those who scrupulously follow the steps of the scientific method. Your position, basically, is:

1. (Naive) I agree. The scientific method ensures valid, clear, logical, and precise results. Thus, most scientists should follow the steps of the scientific method.
2. (Naive) I agree. Applying the scientific method has to work well for most scientists, according to what we learned in secondary education.
3. (Meritorious) I disagree. The scientific methodology is useful in many cases, but it does not guarantee results. Therefore, the best scientists also use originality and creativity.
4. (Informed) I disagree. The best scientists are those who use any possible method (provided it is reproducible and rigorous) that allows obtaining adequate results (methods based on imagination and creativity would be included).
5. (Meritorious) I disagree. Many scientific discoveries were made by accident, not by following the scientific method step by step.

The final score of the questionnaire was obtained by adding the scores earned on the 14 items (minimum score 0 and maximum score 28 points).

The different variables related to the use of metacognitive and learning skills and self-efficacy in learning were evaluated using the SEMLI-S questionnaire (Thomas et al., 2008). Each of the 30 items in the questionnaire was rated on a Likert scale from 1 (never) to 5 (always). These items examined students' self-perception across five dimensions or subscales: constructivist connectivity; monitoring, evaluation, and planning; science learning self-efficacy; learning risks awareness; and control of concentration. Constructivist connectivity (7 items) explores students' perceptions regarding the establishment of connections between information and knowledge in different learning situations. Monitoring, evaluation, and planning (9 items) could traditionally be related to metacognition. Science learning self-efficacy (6 items) explores students' perceptions of their orientation to organize and execute the actions necessary to achieve science learning goals. Learning risks awareness (5 items) probes students' perceptions of their levels of awareness in situations that may be detrimental to their learning. These 5 items and the 3 items in the control of concentration dimension could also be considered related to the monitoring and evaluation of learning. The following are examples of items from the questionnaire:

(Constructivist Connectivity) I try to connect the content taught in science with the knowledge I already have.

(Monitoring, Evaluation, and Planning) I evaluate my learning processes with the goal of improving them.

(Science Learning Self-Efficacy) I know that I can assimilate all the content (conceptual and procedural) that is taught in sciences.

(Learning Risks Awareness) I am aware of when I do not understand an idea.

(Control of concentration) I am capable of adjusting my level of concentration according to the learning situation presented.

The total score for each dimension of the questionnaire is obtained by summing the scores of the items within that dimension (minimum score 30 and maximum score 150 points).

Procedure

The instruments were administered over three different regular class sessions. In the first session, the objective of the task they would undertake was discussed, emphasizing that participation was voluntary and

anonymous (although they were to use an identification code on all tests), and their collaboration in the research was appreciated. Then, the questionnaire on attitudes towards science was completed (up to 50 min). In the second session, the questionnaires on knowledge of the nature of science and trust in science were answered (up to 60 min). In the third and final session, the questionnaire on the use of metacognitive and learning skills and learning self-efficacy was carried out (up to 40 min).

All student scores on each of the items from the four questionnaires, with corresponding adjustments for inverse items, were entered into a spreadsheet. Subsequently, the data were processed using the SPSS statistical package, version 24.0. The reliabilities of the questionnaires on attitudes towards science, trust in science, and knowledge about the nature of science, calculated using Cronbach's alpha, were .87, .81, and .84, respectively, indicating a high reliability. As for the reliabilities of the five dimensions of the questionnaire on the use of metacognitive and learning skills and learning self-efficacy, they were: .79 in constructivist connectivity; .83 in monitoring, evaluation, and planning; .70 in science learning self-efficacy and learning risks awareness; and .58 in control of concentration. As can be seen, these range from low-acceptable to notable-high.

To determine the existence of mediating variables between predictors and criterion in the regression analysis, the procedure proposed by Hayes (2013) was applied. To assess the significance level of the mediation effects, the Sobel test (1982) was used.

RESULTS AND DISCUSSION

The mean scores of all study variables and their standard deviations, according to gender, are presented in **Table 1**.

Table 1

Descriptive statistics of the various variables involved in the study

Variable	Gender	Mean	SD
Attitudes Towards Science (Max score 176)	Male	125.88	9.82
	Female	125.13	11.75
Constructivist Connectivity (Max score 35)	Male	23.17	5.75
	Female	21.65	5.92
Monitoring, Evaluation, and Planning (Max score 45)	Male	29.93	6.44
	Female	29.94	6.30
Science Learning Self-Efficacy (Max score 30)	Male	20.41	4.09
	Female	19.53	4.17
Learning risks Awareness (Max score 25)	Male	17.95	3.23
	Female	19.26	4.10
Control of Concentration (Max score 15)	Male	10.78	2.60
	Female	11.45	2.40
Knowledge of the Nature of Science (Max score 22)	Male	7.83	2.88
	Female	8.63	3.06
Trust in Science (Max score 105)	Male	74.61	8.84
	Female	75.80	7.45

It is noteworthy that the attitudes towards science correspond to an average item score of 2.85 on a 1-4 scale, which does not reach the high-very high scoring range (between 3 and 4 points). This result is quite consistent with the findings of Jeffery et al. (2016) with first-year university biology students. These students showed a low level of attitudes towards science that improved after the introduction of an inquiry-based teaching methodology (Suryani et al., 2025; Acar et al., 2025; Gupta, 2025).

Table 2 presents the product-moment correlation coefficients between the study variables.

Table 2

Product-moment correlation coefficients between the study variables

	1	2	3	4	5	6	7	8	9
1. ATS	1	-.034	.415***	.297***	.345***	.235**	.271***	.356***	.055
2.GEN		1	.073	-.127	.001	-.104	.169*	.133	.131
3.TIS			1	.141	.058	.059	.156	.130	.097
4.CC				1	.418***	.479***	.297***	.461***	.046
5.MEP					1	.555***	.535***	.634***	.020
6.SE						1	.370***	.545***	.102
7.AW							1	.528***	.038
8.CO								1	.068
9.NOS									1

Notes: N = 147; Gender coded as female = 1, male = 0; ATS = Attitudes towards science, GEN = Gender, TIS = Trust in science, CC = Constructivist connectivity, MEP = Monitoring, evaluation, and planning, SE = Science learning self-efficacy, AW = Learning risks awareness, CO = Control of concentration, NOS = Knowledge about the nature of science; Significance level at *p < .05, **p < .01, ***p < .001

As can be seen, the variable attitudes towards science correlated positively and significantly with constructivist connectivity; monitoring, evaluation, and planning; science learning self-efficacy; learning risks awareness; control of concentration; and trust in science and scientists. These correlations are consistent with the links between the use of self-regulated learning strategies and improvement of attitudes towards science found by Kayacan & Ektem (2019), as well as with the relationship between attitudes towards science and trust in science found by Roberts et al. (2013; Chavez-Luque & Smith Q, 2025).

Neither gender nor knowledge of the nature of science were associated with attitudes towards science. In the case of gender, this seems to contradict the findings of Gokhale et al. (2015), who found that the attitudes towards science of female university students (in science and technology studies) were significantly lower than those of men. However, in the case of knowledge about the nature of science, it is consistent with the study by Verdugo-Perona et al. (2016), where primary education trainee teachers showed that having positive attitudes towards learning science did not guarantee having correct ideas about the nature of science (Natsi & Vitsou, 2025; Lee et al., 2023).

Finally, it must be emphasized that the gender variable produced significant differences in the learning risks awareness variable. Considering the gender coding and that the correlation coefficient between gender and learning risks awareness is positive, it can be inferred that women showed significantly higher learning risks awareness. This result is in line with the findings of the study by Baltaci et al. (2016), where women scored significantly higher than men on a Metacognitive Awareness Scale.

Subsequently, a multiple linear regression analysis was carried out, taking attitudes towards science as the dependent variable and those variables correlating significantly with attitudes towards science, namely: constructivist connectivity; monitoring, evaluation, and planning; science learning self-efficacy; learning risks awareness; control of concentration; and trust in science and scientists, as independent variables, or predictors. This analysis aimed to examine if the variability in attitudes towards science could be predicted by these variables. The regression analysis was performed step by step with the backward stepwise method. The regression model was statistically significant in explaining the dependent or criterion variable: $F(2, 144) = 27.36$; $p < .001$. **Table 3** shows the most notable data from the first and last step of the performed backward stepwise multiple regression analysis.

Table 3

Summary of the backward stepwise regression analysis

Step	Independent variable	Adjusted R2	β	p	VIF*
1		.271			
	Constructivist Connectivity		.108	.204	1.429
	Monitoring, Evaluation, and Planning		.200	.050	2.056
	Science Learning Self-efficacy		-.030	.742	1.710
	Learning Risks Awareness		.010	.909	1.550
	Control of Concentration		.143	.162	2.065
	Trust in Science		.370	.001	1.044
5		.265			
	Monitoring, Evaluation, and Planning		.322	<.001	1.003
	Trust in Science		.396	<.001	1.003

*Notes: N= 147; R= Multiple Correlation Coefficient; β = Standardized Regression Coefficient; *VIF = Variance Inflation Factor*

As observed in Table 3, in the first step of the regression analysis, the variables constructivist connectivity, science learning self-efficacy, learning risks awareness, and control of concentration were not significant predictors. Monitoring, evaluation, and planning, and trust in science and scientists were the only variables that contributed positively and significantly to explaining attitudes towards science ($p < .05$), predicting 26.5% of the variance in the dependent variable. On the other hand, the variance inflation factors (VIF) indicate that the levels of multicollinearity were high in the first step for the variables constructivist connectivity; monitoring, evaluation, and planning; science learning self-efficacy; learning risks awareness; and control of concentration. These values are the logical consequence of the high correlations between these variables that appear in Table 2.

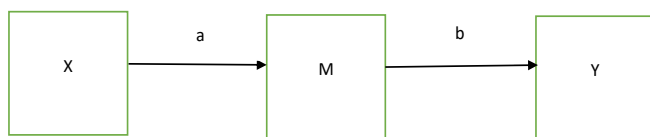
Considering the values of the standardized regression coefficients β , trust in science and scientists accounted for a slightly larger part than control, evaluation, and planning in the variability in attitudes towards science. In any case, both variables explaining a significant part of the variance in attitudes towards science is consistent with the mentioned findings of Roberts et al. (2013) and Kayacan & Ektem (2019).

The absence of four variables in the last step of the linear regression, despite their positive and significant correlations with attitudes, and the high VIF values of these variables pointed towards the possible mediation of the control, evaluation, and planning variable in the effects of these variables on attitudes towards science. Therefore, four simple mediation analyses were conducted, one for each of the variables.

Mediation implies a relational chain in which one variable (independent) X affects a second variable M (mediating variable) which, in turn, influences a third variable (dependent) Y. This could be represented as:

Figure 1

Relational chain in the mediation of a variable M



Paths a and b are called direct effects. The effect of X on Y through M is called the indirect effect (c'). The direct effects are determined through simple regression analysis. In fact, the values of "a" and "b" are the corresponding regression coefficients. The indirect effect c' is evaluated from a and b and the direct effect of X on Y (determined through a simple regression analysis whose regression coefficient is c): $c' = c - a \cdot b$. In the case at hand, the mediating variable M is control, evaluation, and planning. The different X variables, the values a, b, c', and the significance level of the mediation calculated from the Sobel test are shown in [Table 4](#).

Table 4

Values of direct and indirect effects and application of the Sobel test

X	a	b	c'	z (Sobel)	p-value
Constructivist connectivity	.450	.599	.287	3.467	<.001
Science Learning Self-efficacy	.847	.599	.117	3.844	<.001
Learning risks awareness	.888	.599	.248	3.839	<.001
Control of concentration	1.610	.599	.605	4.047	<.001

The significance level values from [Table 4](#) highlight the mediating role of the monitoring, evaluation, and planning variable between the four variables related to metacognitive strategies, self-efficacy, and learning processes, and attitudes towards science. That is, these four variables (constructivist connectivity, science learning self-efficacy, learning risks awareness, and control of concentration) had a significant indirect effect on attitudes towards science.

CONCLUSION

Regarding the first objective set, the first conclusion is that the values obtained for attitudes towards science in first-year Veterinary students can be considered mediocre; they are not what would be expected from first-year students in this field. This is important, as these attitudes can influence their engagement in their studies and academic performance. Consequently, educational programs should be designed to improve attitudes and promote a deeper appreciation of the relevance of science in their training as veterinarians.

From the second objective, and in accordance with the results obtained, several conclusions can be drawn. Firstly, and this would be the second conclusion, neither gender nor epistemological ideas about science affect attitudes towards science. Secondly, and as the third conclusion, the variables that most influence the variability of attitudes towards science are trust in science and scientists and monitoring, evaluation, and planning in learning. Thirdly and lastly, and as the fourth conclusion, the variables constructivist connectivity, science learning self-efficacy, learning risks awareness, and control of concentration have significant indirect effects on attitudes towards science. These conclusions highlight the complexity of the factors that influence the attitudes towards science of veterinary students and the importance of addressing specific factors such as trust in science and learning processes when designing interventions to foster positive attitudes towards science in this group.

Regarding the possible applications of this work, caution is necessary when generalizing these results due to its limitations both in the sample used and, in the instruments, employed. Future studies should be developed with the purpose of corroborating these findings and also analysing the attitudinal evolutions of students during their university studies.

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Ethical statement

Participation in this study was strictly voluntary and anonymous. All participants were informed of the research objectives before data collection. Formal IRB approval was not required as the study involved non-invasive, anonymous surveys that posed no risk to the participants.

Competing interests

The authors declare that they have no competing interests.

Author contributions

Rafael Althaus: Collection and/or assembly of data, data analysis and interpretation, writing the article, and critical revision of the article. Joan Josep Solaz-Portolés: Research concept and design, data analysis and interpretation, writing the article, critical revision of the article, and final approval of the article. Javier Verdugo-Perona and Yolanda Echegoyen-Sanz: Data analysis and interpretation, writing the article, and Critical revision of the article.

Data availability

All data used in this study are available upon request from the corresponding author.

AI disclosure

Artificial intelligence tools, ChatGPT (OpenAI, 2025), were used solely to assist with language-related tasks and improve the clarity of expression in this manuscript. The final version of the text was thoroughly reviewed and verified by the authors, who take full responsibility for the final content

Biographical sketch.

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