Drama as a Powerful Tool to Enrich Socio-scientific Argumentation

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Abstract
Socio-scientific argumentation (SSA) is increasingly being recognized as a key aspect of scientific literacy. Much of the reason for this is that this skill is crucial for helping students to become active participants in twenty-first-century democratic societies in which the construction of informed and critical views of socio-scientific issues (e.g. climate change, COVID-19 vaccination, genetic testing) plays a fundamental role. The problem is that instructors rarely give students explicit and research-based opportunities to enrich their SSA skills. Therefore, the aim of this study was to provide evidence that drama can be used as a platform to enrich argumentation in genetic testing. The data were derived from the written responses and the audio recordings of seventy-six university students (37 females and 39 males, 16–29 years old) in Colombia during a complete drama-based teaching–learning sequence (TLS) supervised by the same instructor. The outcomes suggest that the sequence can be used to enrich argumentation in genetic testing as it effectively provided participants with explicit opportunities to produce both arguments and counterarguments about the controversy whether the use of genetic tests among people should be encouraged. This study contributes to the literature on SSA in science education by demonstrating that drama is a promising tool to enhance argumentation about science-based social issues.

Keywords Drama · Genetic testing · Higher science education · Scientific literacy · Socio-scientific argumentation
Introduction

Climate change (Powell, 2021), COVID-19 vaccination (Giubilini et al., 2021), and genetic testing (Zimmermann et al., 2021) are examples of socio-scientific issues (SSI) for which there is no straightforward solution, and thus, citizens’ socio-scientific argumentation (SSA) becomes fundamental to make informed and critical decisions. This largely explains why SSA is increasingly being recognized as a key aspect of scientific literacy (Christenson & Chang Rundgren, 2015; Namdar & Namdar, 2021). It may, therefore, be obvious to point out that in university science education, promoting SSA is important if students are to become active participants in twenty-first-century democratic societies. However, evidence corroborates that argument and debate are virtually absent from university science education (Archila et al., 2020; Wieman, 2017). Moreover, Chen and Xiao (2021) and Evagorou et al. (2014) maintain that there is a clear instructors’ lack of training about how to use research-based strategies for the promotion of SSA. Thus, it is hard to imagine that undergraduates could enrich their SSA skills when instructors rarely implement research-based activities to explicitly engage them in meaningful SSA practices.

Educators and researchers in science education agree that scientifically literate individuals should be able to evaluate (counter) arguments and make decisions about science-based social issues (Dawson, 2011; Dawson & Carson, 2020). Undoubtedly, this agreement is a step in the right direction. Nonetheless, Capkinoglu et al. (2020) remind us that science “classrooms do not promote argumentation in the absence of dedicated [and prepared] teachers and a supportive learning environment” (p. 832). Hence, there is still much work to be done to effectively move towards the constitution of the promotion of SSA as a representative practice of science education rather than a sporadic one.

For all the reasons just mentioned, it makes sense to take into account Namdar and Namdar’s (2021) reflection that the promotion of SSA is a challenging goal that requires the exploration of effective, pragmatic, and realistic possibilities to pass from rhetoric to concrete actions as a way to provide students with explicit opportunities to enrich their SSA skills. Namdar and Namdar (2021) also observe that within such exploration, the use of drama—“plays considered as a form of literature” (Oxford English Dictionary, 2021)—to foster SSA is an under-researched possibility in science education, since there is not much empirical evidence in this respect. This lack of research evidence is unfortunate because it has been demonstrated that drama can be a powerful and versatile pedagogical resource in science education (Archila, 2017, 2018; Karman, 2019; Verhoeff, 2017).

This study aimed to provide evidence that drama can be used as a platform to enrich argumentation concerning the socio-scientific issue: genetic testing—a type of test where the purpose “can be diagnosis and/or risk assessment for symptomatic and asymptomatic cases, population screening, and reproductive decision-making” (Rédei, 2008, p. 778). With this in mind, we proposed and implemented a drama-based teaching–learning sequence (TLS). Specifically, the research question guiding this study was to what extent does the drama-based TLS give undergraduates explicit opportunities to enrich their argumentation in genetic testing?
Conceptual Framework

In this section, we discuss the two conceptual constructs present in our work. The first construct concerns SSA. Before referring to SSA, it is important to stress that in this article, argumentation is defined as “the justification of claims with reasons and/or evidence” (Erduran et al., 2022, p. 655). Additionally, it is important to reiterate that science-based social issues “tend to have multiple plausible solutions” (Sadler, 2011, p. 4). This means that strong arguments and counter-arguments may be formulated for the same issue. Here, we define SSA as the construction and evaluation of reason-based and/or evidence-based (counter) arguments related to issues that involve scientific content placed in a social context. SSA is widely promulgated as a legitimate and desirable possibility to cultivate democratic principles, such as respect for alternative points of view and seeing both sides of an issue (Dawson, 2011; Zeidler, 2014).

According to Archila et al. (2022a), a key reason to consider the promotion of SSA in science education is that students who can construct and evaluate SSI-related (counter) arguments are better equipped to make decisions about SSI. They also maintain that instructors are expected to explore research-based strategies to foster SSA. As part of this process of exploration, the SSI selection becomes a vital stage. In other words, the issue selected should be conceptually and/or procedurally linked to science, controversial, ill-structured, relevant to students; connected to economic, ethical, moral, political, and/or social factors; and allow for argumentative interaction (e.g. small-group debate, whole-class debate) (Dawson & Carson, 2020; Sadler, 2011; Zeidler, 2014). The pedagogical tool to engage students in SSA is another aspect to be considered within this type of exploration. Recently, Namdar and Namdar (2021) invited us to see drama as a powerful tool to enrich SSA. In the next section, we summarize the attributes of drama that make it a good alternative to engage students in SSA.

As stated earlier, a crucial feature of science-based social issues is their ill-structured nature which means that these problems do not have clear-cut solutions. In this sense, Acar et al. (2010) and Jafari and Meisert (2021) claim that decision-making intimately connects with SSA. In other words, they explain that decision-making about SSI requires the consideration of various nuances beyond mere scientific content knowledge, such as economic, ethical, moral, political, and/or social factors. This explanation is useful to help understand that SSA is a complex process as it requires the construction and evaluation of reason-based and/or evidence-based (counter) arguments taking into account different factors.

Additionally, Archila (2017) insists that poor knowledge of the reason-based and/or evidence-based arguments in favor of an issue may result in the development of naïve views about this problem. On the other hand, informed views may be consolidated when there is a sufficient knowledge of the arguments in favor of an issue. Most importantly, knowing the arguments in favor and against an issue becomes sine qua non for developing critical views. Clearly, the fact that students find very few opportunities to cultivate their SSA skills exacerbates the difficulties they have in developing critical views of SSI. Recently, Namdar and
Namdar (2021), for example, noted that biased SSA is a difficulty that deserves more attention. Biased SSA is typically characterized by the exclusive use of arguments in favor of a claim and omission of possible counterarguments. This is a serious matter if it is acknowledged that open-mindedness is fundamental to productively engage in SSI-related argumentation (Zeidler, 2014). In relation to this point, Archila (2018) expressly recommends presenting students with solid arguments for and against a dilemma as a way to help them to consider alternative viewpoints and avoid biased opinions in their evaluation of arguments and counterarguments. He also emphasizes that open-minded individuals are expected to value the merit of a counterclaim when the arguments are rational and reasonable.

Moreover, it is worth mentioning that the development of SSA skills enables students to assume critical views towards the SSI-related information communicated in the media (newspapers, radio, television, the Internet). This point is of paramount importance since media channels may expose people to numerous accounts of false and/or inaccurate information related to science-based social issues (Archila et al., 2021a; Archila et al., 2019). Of late, the most popular illustration of this is the way the media have influenced COVID-19 literacy (Archila et al., 2021c).

The second construct of our conceptual framework concerns drama. The idea of implementing drama-based activities for science education is not new (Alban Metcalfe et al., 1984). Nevertheless, the use of drama to foster SSA is an under-researched possibility. The reason for this is that drama often receives little attention, although it may be a promising tool available to instructors (Braund, 2015). There are actually several attributes of drama that can be explored in the practice of science education in multiple ways. We briefly summarize these attributes and specify how they guided our drama-based TLS as follows:

1. Drama-based activities may be introduced in a specific course (e.g. geoscience) as well as in various articulated courses (e.g. economics-geoscience-philosophy) (Braund, 2015). In our case, we implemented our sequence in a specific course. Much of the reason for this is that the coordination of the implementation of a sequence in only one course is easier than in two or three. Of course, the introduction of drama-based activities in various articulated courses would provide students with a wider multidisciplinary view of a SSI.

2. Students can be involved in diverse roles, such as authors, actors, and/or spectators (Archila, 2015; Archila et al., 2022a; Dawson et al., 2009; Verhoeff, 2017). In the implementation of our TLS, two students spontaneously dramatized the roles of the two characters of the play, while the rest were spectators. A key point to stress here is that each student had a copy of the play script to which s/he could refer during the drama-based TLS, thus facilitating students’ deep analysis of the (counter) arguments of each character.

3. Drama can recreate fictional argumentative interactions and serve as a catalyst to engage students in small-group debate and whole-class debate (Archila, 2017; Archila et al., 2022a; Begoray & Stinner, 2005; Dawson et al., 2009). The participating students were engaged in both types of debate. To be clear, both were created as scenarios for argumentative interaction in which students could not only argue their points of view and counterargue against the standpoints.
of others with a view to making a group decision but to cultivate their spirit of critical debaters.

(4) Through drama, students are provided with opportunities to experience a broad spectrum of emotions and thus realize that SSI has a human side. This is possible because as Begoray and Stinner (2005) point out, drama uses both expository (also known as informational) and narrative text forms. These two were considered in the creation process of the playscript used in this study. Specifically, the expository nature of our script is explained by the fact that each paragraph presents information about the genetic testing controversy. Moreover, this script was constructed as a narrative as this relates the argumentative interaction between two characters that revolves around this type of controversy.

(5) Drama may present students with situations that have no defined ending (Dawson et al., 2009; Fontichiaro, 2007). This is useful to help them make sense of the complex nature of science-based social issues. Our playscript revolved around the controversial question, “Should the use of genetic tests among people be encouraged?” This is clearly a question for which there is no straightforward response but rather arguments in favor and against this type of testing. It is, therefore, rational to consider that this question is able to create a great opportunity for students to acknowledge alternative points of view and see both sides of this SSI.

(6) Drama enables students to feel involved and reflect on situations based on fictional contexts that would not otherwise be available to them (Wieringa et al., 2011). The playscript used in this study recreated a fictional argumentative interaction between two friends. This is a particularly valuable aspect of our script as it enabled students to step into the shoes of each of the two characters. And perhaps more important is the fact that instead of the play recreating a discussion between two enemies, the characters of this play are close friends who hold different points of view.

(7) Plays may be adapted for specific educational purposes and/or scripted by the instructor and/or students in advance (Karman, 2019; O’Toole, 2009). Here, we report on a play scripted by the authors in advance. This decision was motivated by the lack of literature addressing the use of drama to enrich genetic testing argumentation. The play was written by an expert in science education (the first author) with previous experience in the use of drama in educational settings and an expert in genetic testing (the last author). More details about the writing process of this play are provided in the following sections.

**Significance of the Study**

This study is significant for three reasons. First, it sought to explore the possibility of using drama as a tool to enrich SSA. Even though SSA has been the focus of various studies over the last two decades (e.g. Acar et al., 2010; Dawson & Venville, 2020), using drama to provide students with explicit opportunities to craft SSI-related (counter) arguments is a legitimate and desirable possibility that has received very little recent attention (Namdar & Namdar, 2021). Second, in theory, as the
review by Chen and Xiao (2021) shows, instructors recognize that SSA is important. In practice, however, university science courses are often stuck in outmoded ways of teaching that rarely promote argumentation (Archila et al., 2020; Wieman, 2017). Therefore, a drama-based TLS can be an authentic, pragmatic, and realistic way to foster SSA and thus contribute to moving from theory to practice in university science education. And third, our TLS centers on an issue which is relevant to undergraduates (Forbes Shepherd et al., 2021; Siani & Assaraf, 2015, 2016), controversial (Strohmaier et al., 2019), and current (Bracewell-Milnes et al., 2021; Zimmermann et al., 2021), namely, genetic testing. There are few studies focusing on the promotion of argumentation in relation to this issue at tertiary level, despite the fact that several organizations maintain that today’s citizens need to develop critical views towards the economic, ethical, moral, political, and social factors involved in making decisions about genetic testing (Genetic Alliance, 2009; Organization for Economic and Cooperative Development [OECD], 2007; United Nations Educational, Scientific and Cultural Organization [UNESCO], 2005; World Health Organization [WHO], 2011). Because of the serious socio-scientific implications of genetic testing, there is a need for research on how to enrich university students’ argumentation about this issue.

The Drama-Based TLS

The drama-based TLS proposed in this study is presented in Appendix 1. As mentioned before, it is pragmatic and realistic to begin with the one-session class TLS and then explore progressively the TLS option spread over several weeks (Archila, 2015, 2017). Therefore, our sequence was designed as a single 105-min class session and was based on the five-step TLS structure proposed by Archila (2015, 2017). One reason for this is that this structure enables the instructor to provide students with concrete opportunities (five in total) to make decisions about a controversial question throughout the complete sequence. Moreover, a key feature of this five-step TLS structure is that students are free to modify their decisions if and whenever they want to. Another reason is that the five steps in this structure are deliberately sequenced to present students with reason-based and/or evidence-based arguments in favor of and against an issue in different ways and thus contribute to the improvement of their argumentation.

At the heart of our drama-based TLS was the controversial question, “Should the use of genetic tests among people be encouraged?” This was chosen for a variety of reasons. These include (1) this question is widely recognized as a fundamental one within the current genetic testing controversy (Forbes Shepherd et al., 2021; Wedderburn & McVeigh, 2021); (2) the WHO (2011) insists that critical reflection on this question is indispensable to foster awareness of the importance of respecting the voluntary nature of genetic testing; (3) there are no clear-cut answers to this controversial question, but rather arguments in favor and against genetic testing (Majumder et al., 2021; Sharpe & Carter, 2006); and (4) Botkin et al. (2015), Giarelli (2001), Nurmi et al. (2021), and Strohmaier et al. (2019) observe that a desirable decision-making process about this question requires the consideration of diverse aspects (e.g. economic, ethical, social)
related to genetic testing. In the subsequent section, we discuss the play used in our sequence and explain how it is related to the thought-provoking question.

The Playscript Presented to the Students

The seven attributes of drama previously mentioned give us an idea of the great variety of ways in which this resource can be used for educational purposes. As O’Toole (2009) maintains, drama can be used in the form of a play scripted by the authors in advance. Thus, we decided to write the play Talking about Genetic Testing at The Country Museum (Appendix 2). To ensure the quality of the content of this play, we based it on some of the main ideas about genetic testing presented in the manual How to understand genetics (Genetic Alliance, 2009). We chose to use this manual as the basis of our play since this (1) presents concisely well-documented arguments in favor and against this issue; (2) recognizes genetic testing as a socio-scientific issue rather than a merely scientific one; and (3) is in essence an “educational resource” (Genetic Alliance, 2009, p. 3). Additionally, there are two valuable characteristics of the play Talking about Genetic Testing at The Country Museum that make this a pragmatic possibility to be used in university science courses. First, the playscript is written in a way that requires no special background in genetics. This is an appropriate characteristic because, unfortunately, students usually have low levels of genetics literacy (Osman et al., 2017). Second, this play is about 2350 words in length. Archila (2017, 2018) observes that undergraduates commonly show favorable willingness to read playscripts between 2000 and 3000 words because of their extension, which is not too long.

Talking about Genetic Testing at The Country Museum dramatizes a fictional argumentative interaction between two friends: Tamara and Bruno. Tamara (around 38) is a future shareholder of MassGen®—a fictional genetic testing company. Bruno (around 40) is a creator of podcasts about science-based social issues. This interaction occurs while Tamara and Bruno walk by The Country Museum—a fictional museum. Tamara talks to Bruno about the reasons why she has decided to invest in MassGen®. She is in favor of encouraging the use of genetic tests among people, but Bruno is skeptical and questions many of the arguments she puts forth. In this play, Tamara is a character who defends the potential benefits of genetic testing. Nonetheless, she holds naïve and biased views of the role of genetic testing in society, focusing merely on the benefits and underestimating Bruno’s critiques. At this point, it is important to clarify that both Tamara and Bruno offer solid arguments throughout the play, even though they hold different views. This is a feature of the play that was purposely created to cultivate students’ ability to evaluate arguments as impartially as possible (Archila, 2018).

Research Design and Method

To recap, the current study posed the following research question: to what extent does the drama-based TLS give undergraduates explicit opportunities to enrich their argumentation in genetic testing? To answer this question, we employed a mixed methods approach. This approach is supported in the assumption that quantitative
data and qualitative data when combined result in a better understanding of a research question than either type by itself (Creswell, 2015). In our case, the primary data were the students’ written responses to closed-ended (e.g. “Should the use of genetic tests among people be encouraged?”; quantitative data) and open-ended questions (e.g. “Why did you make that decision?”; qualitative data). In particular, the quantitative outcomes could be useful to document students’ decisions about genetic testing throughout the five steps of the drama-based TLS, while the qualitative findings would favor description and interpretation of students’ genetic testing argumentation. Although students’ written responses in steps 1, 2, and 5 clearly provided us with sufficient information to answer our research question, we decided to collect audio recordings from the undergraduates’ small-group debates (step 3) and the whole-class debate (step 4) to offer just a brief idea of what occurred in steps 3 and 4. But, it is not the intention of this article to provide much detail about these steps.

Setting

We implemented the drama-based TLS (Appendix 1) in two university courses called Science, Genetics, and Society (Course 1) and Applied Genetics (Course 2). These courses were chosen by “convenience sampling” (Bryman, 2016, p. 187). Much of the reason for this is that the last author is the course instructor. Each one is a 16-week long course offered every year by the Department of Biomedical Engineering to undergraduates at a private university in Bogotá, Colombia. In both courses, syllabus contents include several socio-genetic issues. In particular, we decided to address the genetic testing issue for three reasons. First, university students represent a unique population as they are potential future users of genetic counseling and testing services (Siani & Assaraf, 2015, 2016). Second, in various universities, students’ personal genotyping results are used as pedagogical resources in genetic and pharmacogenetic classrooms—an educational practice that has raised questions about its ethical and legal implications (Burghardt et al., 2021). The third reason deals with the fact that genetic testing is in high demand worldwide and “direct-to-consumer (DTC) personal genetic testing (PGT) has become a global business” (Raz et al., 2020, p. 459). For instance, “genetic testing kits have become a popular gift: their marketing has been remarkably successful” (Chadwick, 2020, p. 222). The problem is that this contrasts with the lack of attention that the promotion of university students’ genetic testing argumentation receives in Latin American countries. Clearly, if students are not prepared to construct and evaluate reason-based and/or evidence-based (counter) arguments related to genetic testing, this facilitates the manipulation of their decision-making processes.

Participants

The University’s Ethics Committee granted permission to conduct the study. Among a total of 91 eligible students, 76 (83.5%) participated in this study. Out of these 76 participants, 37 (48.6%) were females and 39 (51.3%) were males. The average age
was 20.1 years (SD = 1.89). Ethical considerations (anonymity, confidentiality, and consent) were observed in accordance with the guidelines of the American Psychological Association. Hence, informed consent was obtained from all participants. As recommended by Bryman (2016), we avoided asking students for their educational major as a way to help them feel confident and be spontaneous during the participation in our pedagogical intervention. Moreover, the instructor informed the students that their personal opinions would have no influence on their final course grade and that data would be completely confidential. In order to protect participants’ anonymity, they were assigned codes, for instance, 1U12 means Class 1, undergraduate number 12.

These 76 university students were grouped into two classes. The drama-based TLS was carried out in the following order:

1. Class 1: undergraduates taking Science, Genetics, and Society during the spring semester (average age 19.6 years), 46 students (25 females and 21 males)
2. Class 2: undergraduates taking Applied Genetics during the fall semester (average age 21 years), 30 students (12 females and 18 males)

Data Collection

To answer our research question, we collected data from steps 1, 2, and 5 of the sequence. In these steps, students completed a ten-item questionnaire (Appendix 3). The questionnaire and the script of the play *Talking about Genetic Testing at the Country Museum* were distributed to the students at the beginning of the drama-based TLS. The playscript (~2350 words) was piloted with forty-five undergraduates (external to the study) so as to ensure its readability. All forty-five students mentioned that, on the whole, the information presented in the playscript was understandable for them. Moreover, audio recordings were obtained from the undergraduates’ small-group debates (step 3) and the whole-class debate (step 4). Each small-group debate (in total 15 in class 1 and 10 in class 2) was composed of three or four participants. The debate of three small groups (selected randomly) of each class was audio recorded. Additionally, the whole-class debate (step 4 in Appendix 1) was audio recorded in both classes.

Finally, as recommended by Archila (2015, 2017), we complemented the corpus, asking students for their impressions about the sequence. Undoubtedly, valuing students’ opinions is necessary to continuously enhance our drama-based TLS and is coherent with Guisasola et al.’s (2021) idea that a TLS is in nature an unfinished and open educational resource. With this in mind, at the end of the TLS, participants who could stay for an extra 5–10 min were asked to answer a nine-item survey (Appendix 4). Forty-six out of the 46 students in class 1 and 29/30 participants in class 2 answered the survey. We chose to use these items because they ask for students’ previous instruction in argumentation (question 1), argument identification (question 2), argument evaluation (question 3), opinions about the usefulness of the playscript (questions 4 to 6), the small-group debate and the whole-class debate (questions 7 and 8), and frequency with
which they have the opportunity to explicitly reflect on the genetic testing issue in other university courses (question 9).

It is important to clarify that this survey was not piloted. We assumed that “the individuals in the sample [were] capable of completing the survey and [could] understand the questions” (Creswell, 2015, p. 393), for two reasons. The first is that the nine items were taken from intervention feedback surveys created and administered by Archila et al. (2020, 2021b) with students from very similar demographic profiles to the participants in our study. The second is the fact that we did not change the purpose of each question since its adaptation was solely nominal. For instance, the item, “Apart from the Food Microbiology course, have you ever received instruction in argumentation?” (Archila et al., 2022a, p. 31), was adapted to “Apart from the Science, Genetics, and Society course, have you ever received instruction in argumentation?” (Question 1 in Appendix 4).

**Study Questionnaire**

The questionnaire (Appendix 3) was organized in five sections: parts 1, 4, and 5 dealt with the controversial question, “Should the use of genetic tests among people be encouraged?”, while parts 2 and 3 addressed the identification and the assessment of arguments put forth in the play, respectively. Parts 2 and 3 were created to facilitate students’ understanding of the argumentative interaction between Tamara and Bruno (the findings pertaining to these parts are not discussed in this article).

Parts 1, 4, and 5 of the questionnaire are based on the following principle: (1) make a decision (“Should the use of genetic tests among people be encouraged?”) and (2) support it (“Why did you make that decision?”). This principle has been used in the questionnaires of previous TLS (Archila et al., 2021a, b). As explained in the Conceptual Framework section, SSA implies that students need not only to be able to make decisions about SSI, but also to produce arguments (informed decisions) and anticipate counterarguments (critical decisions). Thus, the importance of parts 1, 4, and 5 is that they allowed us to collect valuable information to be able to classify the type of decisions made by the students, namely, naïve, informed, or critical decisions. The differences between these will be detailed in the next section (Appendix 5).

Students were given 30–40 min to read the playscript and answer the questions. As recommend by Archila (2017), during reading time, the instructor asked for two volunteer students who spontaneously dramatized the roles of Tamara and Bruno while reading aloud *Talking about Genetic Testing at The Country Museum* to the whole class. Each student had a copy of the text to which s/he could refer during the drama-based TLS. This was particularly important to reduce any influence of the performance of the two volunteer students (e.g. fluency, mood, spontaneity) in the students’ responses.

**Data Analysis**

Frequency counts were used to analyze the undergraduates’ responses to questions 1, 7, and 9 of the questionnaire (Appendix 3). In addition, responses to questions 2, 8, and 10 were coded according to three criteria (codes) (Appendix 5). The
framework about SSA discussed in the Conceptual Framework section was the basis for the construction of these criteria. The first and last authors worked independently to code the students’ responses, and they then got together to discuss their outcomes. Cohen’s kappa coefficient (Cohen, 1960) calculated was 0.76 for question 2 (step 1 in Appendix 1); 0.88 for question 8 (step 2 in Appendix 1); and 0.67 for question 10 (step 5 in Appendix 1). As Bryman (2016, p. 276) notes, “a coefficient of 0.75 or above is considered very good; between 0.6 and 0.75, it is considered good” inter-coder agreement. Any discrepancies were discussed, and a consensus was reached after further examination of the coded corpus. Furthermore, Cohen’s $d$ effect size is reported to evaluate the magnitude of participants’ gains in steps 2 and 5 of the sequence. More tangibly, effect size was calculated using students’ responses to step 1 (question 2 in Appendix 3) as the “control” condition and responses to steps 2 (Question 8 in Appendix 3) and 5 (question 10 in Appendix 3) were treated as the “experimental” condition. Besides, we adopted Cohen’s (1988, pp. 25–26) benchmarks for interpreting effect size: small ($d=0.2$), medium ($d=0.5$), and large ($d=0.8$).

In relation to the audio recordings, we used the software Transana® (Rush, 2019) to transcribe verbatim and then coded them. To make valid inferences from transcripts, we adopted the approach: verbal protocol analysis (Ruiz-Primo, 2015). Explaining in more detail, coding was guided by the decisions made by participants on the evidence and arguments ((1) naïve view; (2) informed view; (3) critical view) that they used to make a decision (yes/no) about the question, “Should the use of genetic tests among people be encouraged?” The most highly representative transcripts are commented on in the Results section. These are English translations of the verbatim Spanish transcripts, care having been taken not to change the meaning of the original Spanish. To this end, as in previous studies (Archila et al., 2021b, 2022a), a modified direct translation technique (Behling & Law, 2000) was adopted. Specifically, (1) a native Spanish bilingual (Spanish–English) individual (the first author) translated these transcripts from Spanish into English; (2) this translation was revised by a native English bilingual (English–Spanish) individual (the third author); (3) the native Spanish author created a modified (revised) version that was then (4) again revised by the native English author. Finally, students’ responses to the intervention feedback survey were analyzed using frequency counts. Some answers to open-ended questions are commented on in the Results section.

**Results**

The results presented in this section focus on the responses of the students to the questionnaire (steps 1, 2, and 5 of the drama-based TLS). Also, some transcripts were included just to offer a brief idea of how participants engaged in small-group debate and whole-class debate (steps 3 and 4 of the drama-based TLS). In addition, the results of the intervention feedback survey are presented throughout this section so as to provide a deeper context for our outcomes.
Responses of the Students to the Questionnaire

In steps 1, 2, and 5, students made individual decisions about the same controversy, namely, “Should the use of genetic tests among people be encouraged.” Undoubtedly, the way this question is formulated prompted students to decide between “yes” or “no.” Table 1 shows the decisions made by the participating students in each of these three steps. It is especially evident that in all these three steps, almost all the students were in favor of encouraging the use of genetic tests among people. It is important to clarify that these results only serve to provide a general picture of the students’ position about the genetic testing controversy; these cannot be labeled as positive or negative since our purpose was not to change, impose, influence, and let alone judge students’ “yes” or “no” decision but to enrich their argumentation about their decisions. That being said, the results presented in the next paragraphs will be crucial to discover whether such enrichment effectively occurred.

“Why did you make that decision?” (questions 2, 8, and 10 in Appendix 3). This was the question used to prompt each student to make explicit her/his argumentation about the decision s/he made individually in steps 1, 2, and 5. Table 2 presents the number of participants who, while answering this question, demonstrated having made a naïve, an informed, or a critical decision. We categorized as “non-classified answers” (NC) from undergraduates who did not base their responses on any of these types of decisions. Outcomes suggest that in classes 1 and 2, step 5 showed a large effect size ($d = 1.32$) in the category “Critical decision.” This is the main finding of our study as it demonstrates the potential effectiveness of the drama-based TLS in enriching students’ argumentation about genetic testing.

Table 2 also shows that many students made an informed decision in step 1 (36/46 in class 1; 21/29 in class 2), producing arguments but not counterarguments about their decision. These results should come as no surprise since Namdar and Namdar (2021) have observed a serious problem: students tend to use only arguments that support their viewpoints, ignoring possible counterarguments, which are a fundamental element to make critical decisions. Another point to emphasize here is that in step 1, the undergraduates had not yet read the play Talking about Genetic Testing at The Country Museum (Appendix 2). It is therefore very possible that they made a

| Table 1 | Decisions made: “Should the use of genetic tests among people be encouraged?” |
|---------|------------------|------------------|------------------|
|         | Step 1 ($N=76$) | Step 2 ($N=76$) | Step 5 ($N=76$) |
| Class 1 ($n=46$) |         |         |         |
| Yes     | 45       | 44       | 45       |
| No      | 1        | 2        | 1        |
| Class 2 ($n=30$) |         |         |         |
| Yes     | 29       | 29       | 29       |
| No      | 1        | 1        | 1        |
| Classes 1 and 2 ($N=76$) |         |         |         |
| Yes     | 74       | 73       | 74       |
| No      | 2        | 3        | 2        |
decision based on their previous knowledge. The results from step 1 are valuable as they show that even though students seemed to be supporters of the promotion of the use of genetic tests among people (step 1 in Table 1), they produced a biased argumentation. In other words, they did not anticipate any possible counterargument.

In step 2, students were asked to read the playscript and identify and evaluate Tamara and Bruno’s arguments. Before detailing the outcomes of this step, it is worth mentioning that a relevant number of the students who answered the survey, apart from the Science, Genetics, and Society course, had received instruction in argumentation (41/46 in class 1; 26/29 in class 2) and argument identification (41/46 in class 1; 24/29 in class 2) (questions 1 and 2 in Appendix 4), while more than half of the respondents, apart from the this course, had received instruction in argument evaluation (28/46 in class 1; 20/29 in class 2) (question 3 in Appendix 4).

Participants were prompted to evaluate arguments through the question, “Are Tamara and Bruno’s arguments solid?” (questions 5 and 6 in Appendix 3). As previously mentioned, Tamara is in favor of the encouragement of the use of genetic tests among people; however, she holds a biased view of their role in society, while Bruno is skeptical, holding a critical view. Particularly interesting is the fact that even though they hold different views, both Tamara and Bruno present us with solid arguments. Our results (Table 3) show that after evaluating Tamara’s arguments, the great majority of the students assessed them as solid (43/46 in class 1; 27/30 in class 2). Moreover, 28 and 12 undergraduates in classes 1 and 2, respectively, considered that Bruno’s arguments were solid. Thus, an important question to ask is whether students’ assessment of Tamara and Bruno’s arguments (Table 3) was influenced by the decisions the participants made (“Should the use of genetic tests among people be encouraged?”) in step 1 (Table 1). Accordingly, chi square tests were performed.

|                      | Step 1 \((N=76)\) | Step 2 \((N=76)\) | \(d\) | Step 5 \((N=76)\) | \(d\) |
|----------------------|------------------|------------------|-------|------------------|-------|
| **Class 1 \((n=46)\)** |                  |                  |       |                  |       |
| Naïve decision       | 3                | 2                | 0.09  | 1                | 0.20  |
| Informed decision    | 36               | 18               | 0.86  | 12               | 1.22  |
| Critical decision    | 7                | 26               | 0.94  | 33               | 1.37  |
| **Class 2 \((n=30)\)** |                  |                  |       |                  |       |
| Naïve decision       | -                | -                | -     | -                | -     |
| Informed decision    | 21               | 16               | 0.35  | 5                | 1.29  |
| Critical decision    | 9                | 12               | 0.21  | 25               | 1.26  |
| NC                   | -                | 2                | 0.33  | -                | -     |
| **Classes 1 and 2 \((N=76)\)** |            |                  |       |                  |       |
| Naïve decision       | 3                | 2                | 0.05  | 1                | 0.12  |
| Informed decision    | 57               | 34               | 0.66  | 17               | 1.26  |
| Critical decision    | 16               | 38               | 0.63  | 58               | 1.32  |
| NC                   | -                | 2                | 0.11  | -                | -     |

\(NC\), non-classified answers; \(d\), effect size
We found that the relation between undergraduates’ decisions and the evaluation of the arguments put forth by Tamara was not significant in classes 1 ($X^2 (1, N = 46) = 0.07, p = 0.78$) and 2 ($X^2 (1, N = 30) = 0.11, p = 0.73$). Additionally, chi square test reveals that the relation between students’ decisions and the evaluation of Bruno’s arguments was not significant in classes 1 ($X^2 (1, N = 46) = 0.65, p = 0.41$) and 2 ($X^2 (1, N = 30) = 1.55, p = 0.21$). This is a key result as it demonstrates that students evaluated Tamara and Bruno’s arguments in an unbiased as possible way.

In step 2, after having identified and evaluated Tamara and Bruno’s arguments, students were asked to decide whether the use of genetic tests among people should be encouraged. Table 1 shows that participants continued to be in favor of genetic testing as in step 1. Additionally, the results demonstrate that step 2 had a positive effect as the number of students who made a critical decision increased when comparing to step 1 (Table 2). Moreover, the results of the survey indicate that almost all the respondents (44/46 in class 1; 29/29 in class 2) considered that the script of the play *Talking about Genetic Testing at The Country Museum* was easily understandable for them (question 4 in Appendix 4). Also, a significant number of the undergraduates (41/46 in class 1; 29/29 in class 2) felt that they had had sufficient time for reading (question 6 in Appendix 4). A key finding here is that nearly all the respondents (44/46 in class 1; 26/29 in class 2) asserted that the playscript was useful for them in making a decision (question 5 in Appendix 4). They gave reasons such as “I found it useful that the script of the play showed the two sides of the coin in a concise and friendly way, giving valid arguments, and helping me to feel identified with a position”; “I could get to know both well-supported arguments in favor and against genetic testing. They helped me to get an overview of this issue”; and “I used information from this play to better develop points of view about genetic testing.”

With respect to step 5, we found that the number of participants who made a critical decision increased from steps 1 to 5 ($d = 1.32$). Arguably, the drama-based TLS seems to be a promising strategy to enrich genetic testing argumentation, as more than half of the undergraduates switched from using only arguments that supported their views (informed decision) to take into account possible counterarguments (critical decision). The contribution of our study is even more evident if we bear in mind that that many of the students (36/46 in class 1; 28/29 in class 2) never (19/46 in

|               | Tamara ($N = 76$) | Bruno ($N = 76$) |
|---------------|------------------|------------------|
| Class 1 ($n = 46$) |                  |                  |
| Yes           | 43               | 28               |
| No            | 3                | 18               |
| Class 2 ($n = 30$) |                  |                  |
| Yes           | 27               | 12               |
| No            | 3                | 18               |
| Classes 1 and 2 ($N = 76$) |      |                  |
| Yes           | 70               | 40               |
| No            | 6                | 36               |
class 1; 13/29 in class 2) or infrequently (17/46 in class 1; 15/29 in class 2) had the opportunity to explicitly reflect on the genetic testing dilemma in other university courses (question 9 in Appendix 4).

Participants’ Engagement in Small-Group Debate and Whole-Class Debate

In step 3, each group consisted of three or four students. In class 1 (46 participants), 15 small groups were organized (14 triads, 1 tetrad), while in class 2 (30 participants), the discussion was carried out in ten groups of three students. We found that the vast majority of the small groups (14/15 in class 1; 10/10 in class 2) decided that the use of genetic tests among people should be encouraged. Nevertheless, students seemed to have some concerns. The following excerpt illustrates this (see Appendix 6).

This excerpt shows that despite the fact that 1U10, 1U21, and 1U8 were in favor of genetic testing (lines 1, 3, and 5), the small-group discussion served as an oral scenario for them in which they made explicit their concerns about the (1) conception of this technology as a business (line 1), (2) the importance of guaranteeing confidentiality (lines 3 and 12), (3) the adoption of rigorous regulations (line 21), and (4) the necessity of medical professional assistance (line 26). It is interesting to note that these concerns have also been reported by several scholars (e.g., Botkin et al., 2015; Bracewell-Milnes et al., 2021; Forbes Shepherd et al., 2021; Giarelli, 2001; Wedderburn & McVeigh, 2021). It is therefore plausible to suggest that the fictional argumentative interaction between Tamara and Bruno recreated in the play Talking about Genetic Testing at The Country Museum appears to be a useful resource to introduce students to the main aspects of concern about genetic testing. The following example corroborates this (see Appendix 7).

This excerpt gives us an idea of the way 1U30, 1U37, and 1U41 construct their own views by using information from the play (lines 11, 19, 24, and 32). This is a feature of drama that has been documented by Archila (2017). He maintains that drama is a powerful resource that can be used to help students to familiarize themselves with multiple elements of a science-based social issue and thus move from a black and white view of the issue to a more nuanced opinion. In this sense, it is worth adding here that even though 1U37 seemed to highlight the benefits of genetic testing (line 1), they recognized that discussing with her/his partners allowed her/him to explore some aspects of this technology that deserve more attention (lines 15 and 24). Likewise, it is valuable to find that 1U41 (line 32) became aware of a crucial point recently stressed by Thiebes et al. (2020), namely, the importance of a critical understanding of “DTC genetic testing service business models” (p. 3).

The following (see Appendix 8) is an excerpt from 2U7, 2U18, and 2U22 small-group discussion. This shows that they held critical views about genetic testing (lines 4, 7, and 10). There are various crucial points of this issue in SSI that these students appeared to be aware of. 2U18, for example, noted that the emotional aspect should be considered in genetic testing processes (line 10). It is important that s/he has mentioned this as Nurmi et al. (2021) maintain that emotional guidance often receives little attention. Public genetic literacy (lines 24 and 28) and gradual
encouragement (line 30) are other examples of essential points of genetic testing that were referred to in the discussion between these participants. Once again, this demonstrates the great potential of step 3 of the TLS for engaging students in productive small-group debate.

In addition, the results of the survey show that many of the respondents (39/46 in class 1; 29/29 in class 2) reported that the small-group debate was useful for them in making a decision (question 7 in Appendix 4). Some of their reasons include the following: “Debating with my partners helped me to get to know other well-supported points of view,” “I contrasted my ideas with those of other people who have been presented with the same play,” and “this discussion helped me to better understand different aspects addressed in the play as well as to understand the reasons why my partners were in favor or against.”

In step 4, the whole-class debate was created as a second opportunity for participants to interact argumentatively with students from other small groups, interchanging the underlying arguments for the decision made. This was possibly and most importantly a scenario to make explicit both students’ agreements and disagreements. Consider the following excerpt as an example of this (see Appendix 9).

This excerpt shows that 1U13 realized how complex it is to reach a consensus about genetic testing (lines 1 and 8). Clearly, asking students to make a group decision forces them to critically evaluate the (counter) arguments of each member. This is also evident in the disagreement between 1U20 (line 14) and 1U36 (line 24) (on one side) and 1U7 (line 18) and 1U40 (line 26) (on the other side), about whether genetic testing should be encouraged in Colombia. A valuable point here is that the existence of this disagreement makes 1U45’s reflection about the inescapable and legitimate tension between trust and the lack of adequate regulation (line 31) more relevant. Additionally, this excerpt illustrates that, as planned (step 4 in Appendix 1), the instructor assumed as neutral an attitude as possible. Furthermore, a large number of participants (39/46 in class 1; 27/29 in class 2) mentioned that the whole-class debate was useful for them in making a decision (Question 8 in Appendix 4). Some comments include “I was able to develop a deeper understanding of this issue because of the multiple perspectives discussed”; “there were classmates that held views different from mine and it was interesting to get to know their opinions, especially on the subject related to whether this type of tests should be encouraged in Colombia or not”; and “I found many of the viewpoints interesting, they gave me a broader perspective on the possible advantages and disadvantages of genetic testing.”

Discussion

Archila et al. (2022b) define learning as constructing meaning and reflecting critically on this. Thus, much of the success of the promotion of SSA depends on the quality of the opportunities that students find to critically reflect on science-based social issues. Unfortunately, these opportunities are limited in university science courses (Wieman, 2017). Moreover, instructors are often interested in introducing SSA practices but lack the time and expertise to carry them out (Chen & Xiao, 2021;
Evagorou et al., 2014). Therefore, the contribution of this study is twofold. First, it provides research evidence that drama can be used as a platform to enrich argumentation in genetic testing. Second, we provide an effective and pragmatic drama-based TLS to help university students enrich their SSA skills. In this section, our research question (“To what extent does the drama-based TLS give undergraduates explicit opportunities to enrich their argumentation in genetic testing?”) guides the discussion of the results.

First of all, the findings of this study show that the great majority of the students decided “yes” in answer to the question whether the use of genetic tests among people should be encouraged. This question is commonly included in cross-sectional surveys interested in documenting public attitudes towards genetic testing (Bíró et al., 2020; Henneman et al., 2006). Our contribution here is that, for the first time, we dug deeper, examining the type of decision (naïve, informed, critical) made by the participating undergraduates. To be precise, at the beginning of the TLS (step 1), we found that even though students supported the use of genetic tests among people, the great majority of them held biased SSA, omitting possible counterarguments. One plausible explanation is the lack of opportunities to explicitly identify and assess alternative viewpoints. Previous work has argued that engaging students in the exploration of both sides of socio-scientific issues is an important but neglected aspect of science education (Dawson, 2011; Powell, 2021; Zeidler, 2014). More problematic is the fact that biased argumentation hampers the critical analysis of false or inaccurate information presented in the media (Archila et al., 2019, 2021a).

The results of step 2 demonstrate that the play Talking about Genetic Testing at The Country Museum can be used as a vehicle to present students with the main arguments and counterarguments of the genetic testing controversy in an expository and narrative manner. Arguably, this step was an opportunity for the students to explicitly identify and evaluate alternative viewpoints recreated in the fictional argumentative interaction between Tamara and Bruno. In particular, our outcomes demonstrate that students are more likely to develop unbiased genetic testing argumentation when they are explicitly presented while highlighting the advantages and disadvantages of this issue. The evidence of this is that participants were given the opportunity to explore the pros and cons of genetic testing by means of the play-script, and this helped them to evaluate Tamara and Bruno’s arguments as impartially as possible. Furthermore, this enriched students’ SSA, since in step 2, the number of students who made a critical decision increased when compared to step 1. Hence, these results reinforce the claim that students should be give opportunities to understand the importance of “identifying alternatives, weighing information regarding the alternatives, identifying and assessing the advantages and disadvantages of alternatives and finally reaching a decision” (Acar et al., 2010, p. 1196).

In the TLS, students were asked to make decisions individually (steps 1, 2, and 5) but also in small groups (step 3). The small-group discussions was an opportunity for the participants to interchange points of view. Excerpts from the transcripts suggest that the argumentative interaction between Tamara and Bruno recreated in the play served as catalysts for students’ engagement in argumentative interaction. This result can be attributed to the opportunity each student had to familiarize themselves individually with the main arguments and counterarguments recreated in the play.
in step 2. In this regard, this result supports the effectiveness of drama to involve students in small-group discussion, helping them to organize their thoughts and express them in a clear way as well as to consider, evaluate, and critique the (counter) arguments of others (Archila, 2017; Begoray & Stinner, 2005; Dawson et al., 2009). Excerpts also indicate that this interaction was productive since participants explored various concerns about genetic testing, such as confidentiality, privacy, and regulation. Importantly, some excerpts corroborate Majumder et al.’s (2021) reflection: “privacy continues to be a major concern related to genetic testing generally” (p. 159).

Genetic testing is an authentic socio-scientific issue as there are complex points to consider, such as economic, ethical, legal, moral, and psychosocial implications for which there are no clear-cut solutions. Excerpts from the whole-class debate (step 4) demonstrate this complexity. The reason for this is that this was a scenario for students to express the standpoint they had discussed in small groups with a view to making a group decision. Arguably, the whole-class debate was a second opportunity for students to engage in argumentative interaction and thus construct an unbiased view of this issue that enabled them to make critical decisions. This is a key contribution of the drama-based TLS if we acknowledge that “today’s students need opportunities to use their science knowledge to discuss, debate and practice making decisions about issues” (Dawson & Carson, 2020, p. 864). It is noteworthy that excerpts from the whole-class debate suggest that this was a pragmatic way for the instructor to assume not only the role of moderator, but also of facilitator, using students’ interventions to create an atmosphere conducive to robust participation by all members of the class. This is particularly valuable for various reasons: university science courses are widely criticized for (1) promoting instructor-centered learning; (2) overemphasizing details and rote memorization of facts and data; (3) and spending little empirical effort considering how to engage student in genuine and meaningful argumentation practices (Archila et al., 2020; Kampourakis, 2017; Wieman, 2017).

Finally, step 5 of the TLS emerged as an opportunity for students to make a final decision individually. The results of this step show that the small-group debate and the whole-class debate had a positive effect on the type of decision made by the students, as many of them were able to produce arguments and anticipate counterarguments individually. In other words, they made critical decisions. Christenson and Chang Rundgren (2015) remind us that the inclusion of counterarguments related to a socio-scientific issue implies the evaluation of alternatives to one’s own point of view. Accordingly, this “is considered to be an indicator of high quality” (p. 205) of argumentation about science-based social issues. Nevertheless, if the outcomes of this step are not sufficient to show the importance of out drama-based TLS, there are two points to bear in mind. The first is that the use of drama to foster SSA is an under-researched possibility in science education (Namdar & Namdar, 2021). The second is the call of Siani and Assaraf (2015, 2016) to prepare undergraduates to make critical decisions about genetic testing since “they are [commonly] at the relevant age for genetic counseling concerning birth defects and genetic diseases” (Siani & Assaraf, 2015, p. 82).
Conclusion

Through our research question, we explored the explicit opportunities provided by the drama-based TLS to the participating students to enrich their genetic testing argumentation. In the light of the results and discussion presented above, it is concluded that the sequence is a promising educational resource that can be used to enrich argumentation about the genetic testing controversy. It should be pointed out that this sequence is not a panacea to solve all obstacles to success in preparing students to make critical decisions about genetic testing. It is just one research-based contribution among many others that will be required to equip students with effective and pragmatic tools that enable them to deal critically with the current and complex tapestry of concerns of genetic testing, such as the introduction of genomic screening to detect a predisposition for cancer (Wedderburn & McVeigh, 2021), transparency, consent, and trust in the use of customers’ data by online genetic testing companies (Raz et al., 2020), the use of pre-implantation genetic testing for sex selection (Bracewell-Milnes et al., 2021), the balance between autonomy and responsibility to decide whether to undergo genetic testing (Nurmi et al., 2021; Strohmaier et al., 2019), the social influence of genetic testing decision-making (Zimmermann et al., 2021), conflicting emotions after knowing a person’s genetic status (Nurmi et al., 2021), and non-health-related uses of DTC genetic testing (e.g. investigative genetic genealogy) (Majumder et al., 2021).

Limitations and Scope for Future Research

A major limitation of this study is the impossibility of distinguishing as to whether the playscript, the small-group debate, or the whole-class debate was more crucial for the promotion of genetic testing argumentation. But this has never been the intention of this article. Another shortcoming is the small sample size (N=76) and the fact that our sequence was designed as a single class session. This is a relatively short time of implementation, although this shortcoming applies to nearly every study interested in testing methodologies for the development of SSA (Dawson & Venville, 2020). Moreover, Archila (2015, 2017) maintains that it is more likely that science instructors will be willing to introduce a TLS in their courses when this does not take up much class time. He also emphasizes that as instructors begin to realize the ways in which the implementation of TLS helps them construct meaningful educational practices, they will begin to feel confident to explore progressively the few-week TLS option, even if they are unfamiliar with the design of TLS. Furthermore, we should acknowledge the lack of information about participants’ previous knowledge of genetic testing. Clearly, previous knowledge could have influenced the decisions they made as well as the fact that the majority of the undergraduate students had received instruction in argumentation.

Drama is a versatile pedagogical resource (Archila, 2017, 2018; Karman, 2019; Verhoeff, 2017). Therefore, in order to successfully introduce drama-based
activities, it is necessary to help instructors become aware that “drama is anything more than acting out scripts like people do in a theatre” (O’Toole, 2009, p. 141). Here, students were presented with a play written for the purposes of this study, but there are multiple ways in which drama can be used as a “springboard” (Archila, 2017, p. 345) for enriching SSA that are still under-researched. Certainly, the playscript used in our sequence only accounts for a very small proportion of the possibilities that drama can reveal. Thus, more research is needed on the impact of drama on the enhancement of SSA, particularly where higher education is concerned. It would also be interesting to adapt the drama-based TLS to be used with different participants, such as undergraduates and graduates, in other parts of the world. Clearly, much work remains to be done to better understand the many ways in which drama-based educational strategies created to foster SSA can be successfully introduced in science education. With this in mind, we believe that future studies should be guided by Verhoeff’s (2017) reflection: “emerging technologies often involve uncertainties when it comes to their potential (medical, environmental or economic) benefits and risks, and drama seems especially apt to capture and articulate the ambivalence this entails” (p. 118).

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**Declarations**

**Ethics Approval** The University’s Ethics Committee granted permission to conduct the study. Ethical considerations (anonymity, confidentiality, and consent) were observed in accordance with the guidelines of the American Psychological Association. Hence, informed consent was obtained from all participants. Moreover, the instructor informed the students that their personal opinions would have no influence on their final course grade and that data would be completely confidential. In order to protect participants’ anonymity, they were assigned codes, for instance, 1U12 means Class 1, undergraduate number 12.

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