



A Case Study on the Use of Contexts and Socio-Scientific Issues-Based Science Education by Pre-service Junior High School Science Teachers in Indonesia During Their Final Year Teaching Internship

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This paper presents a case study looking at the use of daily life contexts and socio-scientific issues by pre-service science teachers (PSTs) in Indonesia during their final year teaching internship. The study is based on a questionnaire distributed to 42 PSTs at a State University in East-Java after they took part in a teaching internship program. The questionnaire focuses on the contexts the PSTs used in their teaching and how the contexts were used. Additionally, eight of the PSTs who taught a unit on environmental pollution were interviewed to more deeply explore how deeply they referred to real-world contexts in their teaching practice and whether or not they presented the topics as socio-scientific issues (SSIs). Most of the PSTs stated that they had used daily life contexts quite often when teaching. The most frequent contexts the PSTs used were daily life objects and questions related to society and the environment. The contexts were mostly introduced at the beginning of the lesson, before the science content was taught. They suggested that the function of contexts was generally for motivational purposes and for student engagement with science concepts. The contexts were rarely used to provoke societal discussions, even though the PSTs acknowledged that many contexts can be used in the sense of socio-scientific issues and were considered to potentially provoke discussions beyond science.

Keywords: science education, teacher education, socio-scientific issues, pre-service teachers, context-based learning

INTRODUCTION

In the past, school science in many countries, such as in Sweden, England, and Australia, has been characterized as generally being structured around decontextualized content which is often perceived as difficult to learn by many students (Lyons, 2006). Traditional science curricula have been described as being overloaded with content (Gilbert, 2006). Many students find much of the science content to be irrelevant for their lives (Gilbert, 2006; De Jong and Talanquer, 2015) and not in line with their interests (Oscarsson et al., 2009). As a result, interest in learning science

has declined over time in many of these countries (Jonathan et al., 2003; Barmby et al., 2008), such as in Western European countries (OECD, 2007). Science education has a great role in enhancing the awareness of and positive attitudes toward science related carriers (Vaino et al., 2015). The perceived irrelevance and difficulty of learning science is believed to be worsened, if teachers do not connect science learning to students' daily lives (Childs et al., 2015). There has been many attempts to address students' lack of interest in learning science through context based science education, such as the Science-Technology-Society movement, which highlight societal issues to enhance students' critical thinking skills and social responsibility (Holbrook and Rannikmäe, 2010). It has further been suggested that science teaching needs to be better connected to societally relevant questions (Hofstein et al., 2011) and to be tied to the use of socio-scientific issues (SSIs) in order to make science curricula relevant (Sadler, 2011a; Stuckey et al., 2013). A recent study of Indonesian educational context found that to date most experienced junior high school teachers rarely implement SSIs in their teaching (Nida et al., 2020). This is why the current study explored whether pre-service Indonesian science teachers choose to use SSIs when asked to gather first-hand teaching experience during the final year of their teaching internship program. This study investigates the use of contexts and socio-scientific issues-based science education among pre-service science teachers (PSTs) attending a State University in East-Java.

THEORETICAL FRAMEWORK

Constructivist learning theory suggests that when contexts are integrated with science learning the outcomes are more meaningful to students (Greeno, 1998). Childs et al. (2015) have suggest numerous ideas for merging everyday life contexts with school science curricula, including a focus on everyday life objects, everyday materials, everyday activities, everyday issues, and other areas. All of these contexts can serve different functions in science learning. They can be used to open lessons, frame a whole lesson plan, or illustrate science content by highlighting its function and applications in everyday life, technology, their environment, and society (Gilbert, 2006; Eilks et al., 2013b).

Contexts may be used in science education in various ways. Contexts can be used before or after science content learning, or even both (De Jong, 2008). The more traditional approach is to start a lesson from the subject matter for later application to daily life questions. More recently, it has been suggested starting with students' daily lives in order to relate context to develop appropriate science understanding (Roberts, 2007; Childs et al., 2015). The theory of situated cognition (Greeno, 1998) has shown that the traditional approach, which introduces real world contexts only after teaching science concepts, may not be the best way to promote student learning (Overton et al., 2009). Nevertheless, many teachers still start with science content and some even finish there (Childs et al., 2015).

There are numerous functions which contexts can take on in science teaching. Context can be used for motivation, orientation, illustration, or the application of science concepts (De Jong,

2008). Meaningful learning should begin with contexts which are related to students' lives, prior experiences, and personal interests. It should also be connected to actively applying the learned knowledge (Eilks et al., 2013b). However, not all contexts have the same characteristics, nor do they possess the same potential for challenging students in the different areas of learning (Stolz et al., 2013). It is also clear that we need to recognize that the contexts selected by teachers are not always perceived as interesting or relevant by students to the same degree (De Jong and Talanquer, 2015).

One special form of context that can challenge students consists of socio-scientific issues (SSIs) (Sadler, 2011a; Zeidler, 2015). SSIs have the following characteristics (Zeidler and Nichols, 2009; Zeidler, 2015): (1) They are controversial. (2) They present ill-structured problems faced by a society, which require not only scientific evidence-based reasoning, but also moral reasoning or ethic concern. (3) They have social ramifications which require students to engage in discussion, dialogue, debate and argumentation. (4) They are associated with character formation. SSIs need to be authentic, relevant, undetermined in a socio-scientific sense, open to debate, and related to science and technology (Stolz et al., 2013). SSIs have previously been suggested as representing suitable real-life contexts in which students can practice and achieve scientific literacy (Hofstein et al., 2011; Zeidler, 2015). This also holds true for a recently suggested critical vision of scientific literacy, which aimed at preparing students for responsible citizenry in their society (Sjöström and Eilks, 2018). SSIs are deemed appropriate for applying scientific knowledge and skills to societal participation. The skills entailed are necessary for a modern life in which humans, society and the environment are all strongly influenced by the ongoing developments in science and technology (Rundgren and Rundgren, 2010). But SSI-based science education is not only a specific form of context-based learning. SSI-based education also provides a framework for promoting general educational skills. Its focus is on preparing students to be actively involved in a democratic society in which all citizens are required to make decisions concerning the application of science and its associated effects (Sjöström and Eilks, 2018).

In previous studies of teachers' perception regarding SSI-based education in Indonesia, both in-service science teachers (ISTs) (Nida et al., 2020) as well as pre-service science teachers (PSTs) (Nida et al., in press) acknowledged the potential of SSI-based education. They saw it as a means to both enhance students' general educational skills and to broaden teachers' competencies. They also viewed it as a way to contribute to character formation among learners. However, the teachers also listed many perceived challenges when it comes to implementing SSI-based pedagogy. These included both a lack of estimated competencies among students and incomplete teacher experience and expertise when carrying out SSI-based science education. Many of the ISTs and PSTs expressed strong interest in implementing SSI-based instruction in their own teaching. There was, however, a quite large number of teachers who were hesitant to incorporate SSIs to a broader extent.

This paper explores Indonesian PSTs' experiences when it comes to utilizing contexts in their teaching practices. The study looks at their time in teaching internships in junior secondary schools as a part of their bachelor degree program in science education. The focus is on the way the PSTs used contexts in their teaching. Other aspects explored include how the PSTs included contexts in science education and whether or not they incorporated contexts in the sense of SSI-based education.

The research question in this study is: What types of daily contexts do PSTs use when they conducted their teaching internship and how are the contexts presented? Furthermore: How do PSTs use contexts in science education and whether or not do they incorporate contexts in the means of SSI-based education?

SAMPLE AND METHOD

Sample

The sample in this study was comprised of 42 pre-service junior secondary science teachers taking part in a 4-year science education program at a State University in East-Java, Indonesia. The student teachers were in their final year and had had teaching internships in schools during the 2 months prior to this study. The sample consists of 37 female (88.1%) and 5 male (11.9%) student teachers. This is a normal distribution for junior secondary education programs in Indonesia. Six student teachers (14.3%) carried out their teaching internships in private schools, whereas the other 36 (85.7%) taught in public schools.

During their 4 years of study, student teachers must accrue 146 credits in a total of 66 courses. Most of these courses are related to science (chemistry, biology, and physics) and pedagogy. They include lessons in science teaching strategies, media use in teaching, science-technology-society (STS), student assessment, etc. In their sixth semester, student teachers are introduced to context-based learning in an STS course. However, the course does not explicitly focus on how to operate context-based learning in the sense of SSI-based education. Moreover, the latest curriculum changed STS education into STEM education, which still does not necessarily cover an explicit focus on SSI-based learning or the controversial nature of SSIs in society. By their final semester the student teachers have completed both a teaching internship and an undergraduate thesis. The internship require the PSTs to develop their lessons under the supervision of both a mentoring teacher and a teacher educator from the university. The supervisors decide whether the lesson plans are feasible or not with regard to implementing the curriculum. Educators and teachers usually agree on the lesson plan, as long as the targeted science concepts can be delivered within the specified time slot.

All of the PSTs taught in junior secondary schools in grades seven and eight. The teaching internship for pre-service junior secondary teachers usually occurs in these grades, since grade nine focuses on the pupils' final examinations. There is a total of 12 potential science topics to be taught during the second semester of grades seven and eight. On average, each topic is taught in six lessons of roughly 90–135 min. duration. The topic of environmental pollution, for example, receives a maximum

TABLE 1 | The topics taught by the pre-service science teacher.

No	Topics	Grade	Number of PST taught the topic	(%)
1.	Environmental pollution	7	18	43.9
2.	Global warming	7	17	41.5
3.	Earth structure	7	16	39.0
4.	Excretory system	8	9	22.0
5.	Vibration, waves, sound in daily life	8	7	17.1
6.	Respiratory system	8	5	12.2
7.	Light and optics	8	5	12.2
8.	Pressure	8	4	9.8
9.	Human interaction and environment	7	4	9.8
10.	Human organization system	7	3	7.3
11.	Solar system	7	2	4.9
12.	Energy in life systems	7	1	2.4

of seven lessons. This includes five lessons for teaching and learning, one for the test, and one meeting for remedial teaching (if necessary). Each pre-service teacher had taught at least one of the topics. The unit was based on the time slot in which the student teachers were scheduled to teach during their internship. The topics environmental pollution, global warming, and earth structure were the most frequent units taught by the pre-service science teachers (**Table 1**).

Instruments

The research consisted of a questionnaire and interviews. The questions in the questionnaire assessed how often the PSTs used daily life contexts during their internship, the type of context that they used, and the order of context and content learning in their classes (**Table 2**). The first question identified how often the PSTs integrated contexts in their teaching. The second question assessed the types of contexts they used with reference to Childs et al. (2015). The last question was on the order of using contexts, either before or after content learning, or both (De Jong, 2008).

The questionnaire study was followed by interviews of eight volunteer PSTs, who had taught the topic of environmental pollution. According to the PST answers, this was the most frequently taught topic. In addition, environmental pollution is a topic that easily can be carried out using an SSI-based education approach. The interviews focused on how the PSTs employed contexts in science teaching, whether or not the PSTs used contexts in the sense of SSI-based education, and how the PSTs integrated contexts as SSIs in their teaching. The interview guide is given in **Table 3**.

Data Analysis

The answers in the questionnaire were descriptively analyzed and percentage distributions were calculated for them. The interview responses were transcribed and analyzed following the tenets of qualitative content analysis according to Mayring (2014).

TABLE 2 | Description of the questions in the questionnaire.

No	Questions	Question type
1.	How often do you usually use daily life context when teaching science? <input type="checkbox"/> Never <input type="checkbox"/> Seldom <input type="checkbox"/> Sometimes <input type="checkbox"/> Often <input type="checkbox"/> Always	Likert
2.	What type of context do you use when you are teaching? (More than one answer is applicable) <input type="checkbox"/> Daily objects, either living or non-living objects, such as a laptop, smart phone, vehicle, plant, animal, planet, etc. <input type="checkbox"/> Materials/products used in daily life, such as medicines, cosmetics, water, detergents, soaps, oil, insecticides, etc. <input type="checkbox"/> Daily activities such as cooking, exercising, washing, etc. <input type="checkbox"/> Real life issues related to society and environment on the local/national/global level <input type="checkbox"/> Other contexts, such as those related to culture, ethics, economics, etc.	Multiple choice
3.	How do you usually use the contexts mentioned in question #2? <input type="checkbox"/> Contexts are introduced at the beginning, before science concepts are taught <input type="checkbox"/> Contexts are presented after teaching the science concepts <input type="checkbox"/> Contexts are presented before and after teaching science concepts	Multiple choice

The interview transcripts were coded by the first and second author. For the questions about what kinds of contexts the PSTs present to teach environmental pollution, categories were developed inductively from the interviews. For the questions about how the context was functioned, the category formation was based on De Jong (2008), that the function of context is either as motivation, orientation, illustration, or application. For the questions about how the PSTs use contexts in the class, the response was categorized into whether or not the teaching practice was conducted in means of SSI-based education according to Sadler (2011b). The initial agreement between the two coders was 91%. In those cases of disagreement inter-subjective agreement was reached by a joint re-coding until consensus was reached.

FINDING AND DISCUSSION

Most of the pre-service science teachers stated that they had used daily life contexts quite often in their teaching (46.4%). Another 25.0% described themselves as always using daily life contexts when they teach. The remaining 28.6% said that they sometimes use it. The contexts used in science teaching fall into all the five categories suggested by Childs et al. (2015). The most often used type of contexts the PST used (about 75%) were daily life objects, either living or non-living objects, such as plants, animals, vehicles, etc. (see **Table 4**), followed by real-life issues

TABLE 3 | Questions in the interview; leading question and potential impulses.

No	Questions
1.	This interview wants to know how you utilized contexts when teaching about environmental pollution. a. Which contexts did you use when you taught the topic of environmental pollution? b. How did you operate the contexts? (Was the context chosen to motivate students' learning? Was the context suggested as an orientation for learning?; Was the context used for the illustration of concepts previously learned? Was the context used for applying science concepts?) c. Do you think your use of the contexts fulfilled the characteristics of SSI? Namely: (1) Being presented as controversial and ill-structured problems that need scientific, evidence-based reasoning to make informed decisions; (2) Having societal ramifications of scientific topics that require students to get involved in dialogue, discussion, debate, and argumentation; (3) Tending to have implicit and explicit moral aspects and requiring moral reasoning to some degree; and (4) being associated with formation of virtue/character as a long-range pedagogical goal. d. Did you present any controversy on a context in your teaching?
2.	How did you use contexts in your teaching practice? Did you use it: - As a motivation to teach science concepts behind the context - As orientation for students to learn the science concepts behind the content - To show the inter-relatedness of science, technology, society and environment - To provoke discussion about the context from multiple aspects, not only from science, but also by considering ethical, moral, cultural, legal, or economic aspects - To provoke students to critically analyze the risks and benefits of different positions between the pro and cons - To direct the students to scientific reasoning - To provoke students making argumentation regarding the context - To let students make decisions and take positions - To ask students to propose win-win solutions by considering scientific aspects, as well as ethical concerns

TABLE 4 | Type of context used by the PSTs in their teaching practice.

No.	Context	Number of response	(%)
1.	Daily objects, either living or non-living objects, such as plants, animals, planets, vehicles, etc.	31	73.8
2.	Real life issues related to society and environment on the local/national/global levels	23	54.8
3.	Daily activities such as cooking, exercising, washing, etc.	18	42.9
4.	Other contexts, such as those related to culture, ethics, economics, etc.	16	38.1
5.	Materials/products used in daily life, such as medicals, cosmetics, water, detergents, soaps, oil, insecticides, etc.	14	33.3

related to society and environment (more than 50%). All the other three types of contexts were each named by about 30–40% of the participants.

The contexts were used in all three potential orders (**Table 5**). Most of the PSTs (50.0%) used contexts at the beginning of the lesson, before addressing the science concepts. Only 9.5%

TABLE 5 | The order of using context in teaching.

No.	How the context is used	Number of response	(%)
1.	Context is introduced at the beginning of the lesson before teaching science concepts	21	50.0
2.	Context is presented after teaching the science concept	4	9.5
3.	Context is presented before and after teaching science concepts	17	40.5

of the PSTs provided contexts after the science concepts were approached. There were 40.5% of the PSTs who utilized contexts before and after teaching the science concepts.

In the interviews, there were a number of contexts named by the PSTs for teaching the topic of environmental pollution. Among them were pollution problems in Indonesian rivers, a cigarette company contributing to air pollution and health problems at the same time, old air conditioners and refrigerators which may release CFCs, and the increasing use of fossil fuels.

The intended function of contexts in the PST teaching practices varied. The most frequent answer given was to motivate students to learn the science concept behind the issue, as shown in the following quote:

I presented the issue at the beginning of the lesson using a video showing the polluted river, which is filled with waste. The issue is very close to their lives. They are very highly motivated by the issues arising from their daily lives; they are curious about the science concepts covered in the issue.

By starting with an interesting context, learning is viewed as more interesting for the students and should therefore enhance their motivation (Overton et al., 2009). Furthermore, the PST used the issue as an engagement or learning orientation to direct the focus to the science concepts:

Students tend to like discussing hot-button topics within the society, which are not only those covered in the textbook. I presented the issue to engage the students and to direct them to discuss the science concepts behind the issue. After teaching the intended science concepts, I usually reconnect the concepts with the issue presented at the beginning of the lesson.

Environmental contexts were mostly used to discuss the science concepts behind them. This included a polluted environment, the sources of pollution, types of pollution, human activities contributing to environmental pollution, the effects of environmental pollution, and ideas for decreasing pollution.

Although acknowledging that the environmental issues used were potentially controversial, none of the PSTs planned to use the controversial points of view to drive the lesson:

One of the source of environmental pollution and greenhouse gases is the poultry-based industry. On the one hand, the needs for daily food can be fulfilled. However, there is a concern from an environmental respect. I think that this is a controversial issue. But, I didn't address the controversy in my lesson plan, nor did I use it in the learning process.

Two PSTs, however, admitted that the controversy around the used issue was addressed by their students, although they had not included it in the scenario of their lesson plan:

I actually did not plan to provide the students with the controversies surrounding the cigarette issue. But during the discussion of the sources of pollution, such as human activity including the use of fossil fuels for factories, one student asked the question: "If cigarette factories can negatively affect the environment and cigarettes themselves have negative effects on health, why are people still allowed to consume cigarettes? Why have they not been banned?"

Another example of controversy which happens in society was addressed in the following quote:

[...] In one of the discussions, the student found herself in a dilemma, because she used a motorcycle to get to school every day [by using a gojek]. She admitted that she contributes to increase in air pollution. But, she didn't have any better choice. We know that we don't have good public transportation.

In Indonesia, the level of motorcycle and car usage is still increasing. Today, there is a number of online applications such as *gojek*, *gocar*, *uber*, *grab* in which cars/motorcycles can be ordered online for multiple purpose, such as for human transportation, the delivery of goods, ordering food, etc. This information technology-based transportation service is booming in Indonesia and has made life easier on the one hand. One can order these services anytime and anywhere at cheap prices, even when compared to public transportation. Such services allow people to save time and money. On the other hand, these services cause social problems such as tension between conventional traffic and information technology-based transportation service providers. They also increase the use of fossil fuels for transportation, hence contributing to increases in air pollution.

The PSTs seem to find it difficult to use controversies to engaging their students in societal discussions (e.g., to provoke discussion about the issue from multiple angles, not only the scientific ones, to provoke students to do critical analysis on the risk and benefit, to let students do decision making/position taking, or to provoke argumentation). This might be because their students are not believed to be accustomed to discussions of controversial issues. The PSTs themselves may also have little experience in utilizing controversial issues:

I used the student's question to open up the discussion. But the students were not used to talking about something controversial like that. Thus, they needed me to initiate questioning, in order to make them think and talk about the issues from different perspectives, not only looking at the negative side, but also the positive side, such

as the economic effects that cigarettes bring for those who work in that sector.

The PSTs were likely to use non-controversial issues in their teaching, or to completely exclude any controversies behind the chosen contexts. Previous studies (Nida et al., 2020; Nida et al., in press) showed that both ISTs and PSTs feel a lack of personal ability in dealing with controversial issues. This lack in teachers' skills was considered one of the hindering factors when implementing SSI-based learning. The fact that PSTs mostly prefer teaching contexts for student understanding of scientific concepts is not new. Pitipornatapin et al. (2016) in a study in Thailand have also reported that teachers tend to exclude related controversies rather than carrying out SSI-based education. Concerns about the skills and knowledge needed to handle controversial issues have also been expressed by Feierabend et al. (2011), who conducted a study on teachers' views regarding teaching climate change in Germany.

Some PSTs indicated an awareness that the environmental context has to integrate science, technology, society, and environment:

I used the context to show the students that science/technology are strongly related to society and the environment.

Through this issue I also embed technology in water purification and technology in converting plastic waste to fuel by using the plastic waste they produce every day as an example.

Insecurity in dealing with interdisciplinary knowledge is also one of the hindering factors for implementing SSI-based science education in Indonesia (Nida et al., 2020; Nida et al., in press). SSI-based education, however, should be more than just context-based education to show the relatedness between science, technology, and society. It offers teachers an opportunity to engage students and promote the general skills they need to be actively involved in societal debates, which often require them to make decisions regarding SSIs (Eilks et al., 2013b). This was also acknowledged by the PSTs; they nevertheless decided not to choose an SSI-based teaching approach.

From the interviews, we quickly recognized that for the topic of environmental pollution the PSTs rarely incorporated the controversial nature of most of the environmental issues being taught into their lessons. Even if the issue was barely presented as an SSI, the context was mostly used to direct students' learning toward science concepts. It was only used to show its relatedness to society, technology, and the environment, but not to address any controversial nature behind the issue, as has already been reported by Ekborg et al. (2013).

In the strategic plan by the Indonesian Ministry of Education and Culture (Menteri Pendidikan dan Kebudayaan, 2018, 2020), there is a growing agenda about strengthening the curriculum with the emphasis to achieve 21st century skills among students and also fostering education for sustainable development. However, according to the content standards (Menteri Pendidikan dan Kebudayaan, 2016a), as well as core and basic competencies (Menteri Pendidikan dan Kebudayaan, 2016b) for science junior secondary education by Indonesian

Ministry of Education and Culture, the issue of sustainable development (e.g. through SSI-based learning) is not explicitly articulated.

CONCLUSION

All of the PSTs in this sample used daily life contexts in their teaching practices during their internship program. The contexts preferred most were everyday objects and issues. They tended to be presented at the beginning of the lessons, mainly for motivational purposes and to foster student engagement with science concepts. Any contexts presenting a controversial nature caused the PSTs to generally decide not to provoke discussion of the controversies or to choose techniques specifically promoting debate. Although the participants acknowledged the controversial nature of many environmental pollution issues, none of the PSTs planned to use the controversies in their science teaching. Only two PSTs (out of eight) spoke about controversies initiated by their students' questions. The PSTs themselves were not familiar with utilizing corresponding pedagogies in their teaching practices.

Although the PSTs are introduced to context based-learning in a STS course in their teacher education program, it does not explicitly concern theoretical models of SSI-based education. From the sample in this study, it seems clear to us that a focus on SSI-based teaching would enrich the teacher education program. A differentiation between context-based learning and SSI-based education should be emphasized in the teacher education program the participants were taking part in. This needs to incorporate learning about various methods for structuring discussions in the classroom, such as role playing, analyzing authentic media from public debates, or mimicking the authentic practices of communication and debate from society (e.g., Eilks et al., 2013a). We suggest not just teaching about corresponding pedagogies by lecturing, but also mimicking classroom situations with the PSTs. This would allow them to develop self-confidence and self-efficacy, as has already been suggested by Burmeister and Eilks (2013) in the field of education for sustainable development.

This study has several limitations. The number of students is limited and the participants all came from the same teacher education program. Further research into other science teacher training programs in Indonesia might reveal how representative this case study really is. Research might also reveal the program's influence on the teaching practices chosen by the PSTs, as well as the influence of the supervising in-service teachers. Interventions would be needed to see whether a greater variety of pedagogies for SSI-based education would come into play, if the emphasis of the teacher education seminars were to be shifted. The study did not explore in detail the reasons why the PSTs avoided controversies in their teaching. This might be subject to future research.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

SN and NP developed the research questions, planned the data analysis, and did the interpretation of the results, and drafted the introduction, methods, and discussion section. IE drafted the introduction, theoretical framework, and limitation of the

study. All authors contributed to the article and approved the submitted version.

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Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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