IS ARGUMENTATIVE DRIVEN INQUIRY (ADI) THE FUTURE OF SCIENCE CLASSROOM?

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Abstract. Argumentative Driven Inquiry (ADI) is a type of problem-based learning (PBL) that allows students to explore the scientific world around them. The ADI format allows students to take ownership of their scientific exploration by allowing the students to create their labs. It is believed that by allowing the students to create their method of exploration they will learn the whole process of the scientific method not just replicating a cookie-cutter lab. This research will look deeper into the ADI method and test its effectiveness on high school Biology students in three senior high schools in southern Indiana. Is ADI the future of science classrooms or is the current method of "cookie-cutter" labs better for students?

Keywords: science activities; communication skills; inquiry; persuasive discourse; activity units; content area writing; content area reading; science experiments; science process skills; science course improvement projects; instructional design; course descriptions

Literature review

Argumentative Driven-Inquiry (ADI) has been conducted in many different types of educational settings. One setting was with college students in an education chemistry class. It was found through surveying the class population that women, without much science background, enjoyed the process the most. The process allowed the students in the class to discuss their lab results and discuss why they were right or wrong (Walker et al., 2012). Being able to discuss the results, then writing their papers, and being able to peer-review their lab reports allowed the students (non-majors) to enjoy the laboratory setting and not be too stressed about not having the correct answers in their reports because they had the chance to edit their reports before turning them in (Sampson et al., 2009; Demircioglu & Ucar, 2015).

Other settings where ADI saw great results were in a classroom with students who had individual education plans (IEP) and English second language students. It was found that it allowed these students to truly understand the process behind labs and why they are important. Most important is that ADI allows students with different abilities to participate and take part in the research and planning where they can be successful.

These students also took advantage of the peer-review and argument sessions (Sampson et al., 2010). Students are confident that they lnow the lab report has the pertinent information before turning it in relieves stress. Another scenario that ADI can be applied to is one involved in co-teaching with two teachers. Two teachers allow for more coverage in the classroom. Another situation that needs to be considered is the impact of block scheduling. Block scheduling allowed the students to spend more time during one class to prepare posters and do argument sessions (Stewart et al., 2019).

The current research available has been mostly conducted on college students. College students are more mature and more invested in their grades then middle or high school students (Jiménez-Alexandre et al., 2000). However, most students enjoyed they were able to work in groups to complete the lab and the reports. Most students also did very well because of the groups. While groups there are students with different abilities such as students with math skills and students with writing skills. Allowing students with different skills to be in groups allows all students to get great grades (Demircioglu & Ucar, 2012).

Method

ADI[1)] consists of eight stages. The stages are identifying the Task and the guiding question, designing a method and collect the data, developing an initial argument, doing an argumentation session, engaging in explicit and reflective discussion, writing an investigation report, doing a double-blind group peer review, and then revising and submitting the report. Each part of the ADI process is as important as the others. They help students understand the scientific method and being a part of their research. Students need to understand that there aren't always answers to the questions asked and sometimes the research that was conducted does not answer the original question, so the method needs to be reviewed and revised. The peer-reviewing allows students to experience what most scientists experience. For research to be proven true it must be peer-reviewed allowing students to see at least some of this process will allow them to understand it in the future.[1)]

ADI was used in four honors freshman biology classes. Students were first given instructions on how ADI was conducted, and the eight stages of the process were explained. Once the students understood the process, they were given a packet about Speciation. The students had to read the packet as a group then design the method of the research and they had to identify a guiding question. Once the guiding questions were identified they students had to research what would happen to a species of frogs over a period of separation. Students had to have a method where the frogs would gain random mutations over time. This was done by using dice and a list of mutations.

In the end, students would compare their last two frogs with a list of specific mutations to decide if the frogs were now different species or sub-species. If the frogs were sub-species then they should be able to interbreed after meeting up again, after being separated, even though they are genetically different. If the frogs had gotten specific mutations that turned them into separate species, they will no longer be able to interbreed.

After the students figured out whether their frogs where different species or sub-species, the students would create a claim statement. The statement differed between groups because each group had different results. The students then used the ADI template to create a poster to use during the argumentation sessions. Once the posters were completed, we conducted argumentative sessions. The argumentative sessions were conducted as two rounds. Each group was composed of four students. During the first round, two students stayed with their posters and explained their evidence and their justification behind their research. After everyone had been to the different groups and seen all the posters, the students switched places. The students who were originally arguing their evidence are now the students looking at the other group's posters and the group listening to the arguments are now the ones presenting the arguments.

After the argumentation sessions, students needed to write their reports. Once they wrote the reports, they were peer-reviewed based on a rubric given. If there were things that needed to be fixed within their reports, they could fix it. After they fixed any issues, they submitted their reports on google classroom.

After ADI, students were given a survey to complete. The survey was based on their opinions on the class while they were doing the ADI and their opinions on what they think the class should always be like.

Results

Investigative report results

Students were given a day in class to write an investigative report. The students were given a rubric to base their reports on. The reports were graded by the rubric. The lowest grade on the report was 21 out of 25 which is 84%. The grades were as they were in Table 1. The lowest grades were due to being turned in late or the student forgot specific parts of the report that they need in lab reports, such as a methods section or results section.

Table 1. Report grades, graded based on rubric

Percentage	Number of Students
100	54
96	21
92	5
88	4
84	1

Student survey results

The student survey results are posted in Figs. 1 and 2. The survey showed that most students felt that ADI was an okay experience to participate in Fig. 1. They

did not feel like the lab was perfect, but they did feel that it did its job at helping them comprehend the concept. They also said that compared to traditional teaching, ADI did have more time as a group. Most students also learned, through the ADI method, that there is more than one way to ask and answer questions. The students also felt that ADI helped them understand that explanations change over time.

The survey also asked the students what they would prefer the class to be like (Fig. 2). A few of the options almost all the students wanted the class to include what the world is like in and out of the class, they want to work in groups, and they want to be able to let the teacher know if they need more or less time to complete an assignment. Overall the students felt that a typical class should include all the items on the survey.

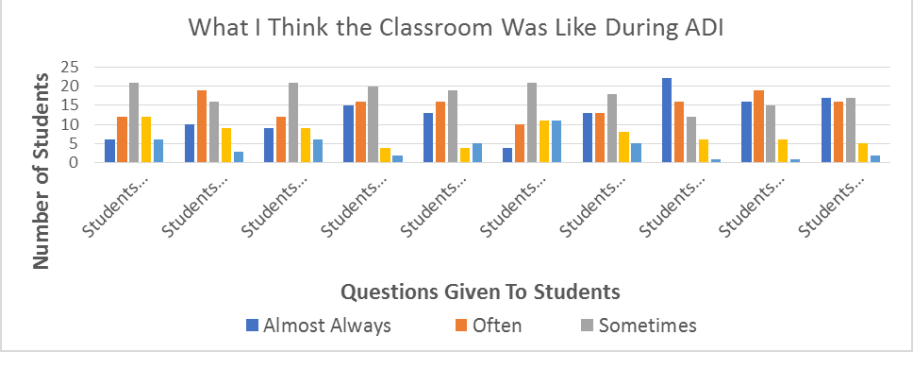

Figure 1. This graph shows that the students felt during the ADI experience

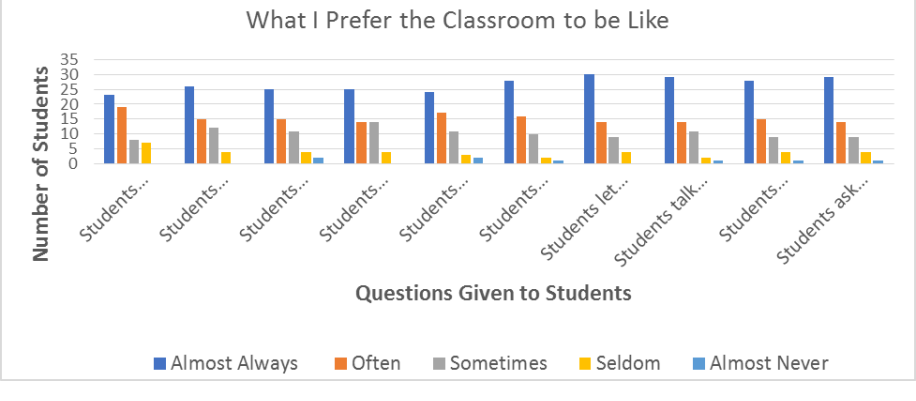

Figure 2. This graph shows what the students want the class to be like. You can tell that they want the class to include all the items in the survey

Argumentative session poster example

Each group had to create a poster as part of their research. These posters are a large part of the ADI process. They help students organize their results and present it to each other. Below are three examples of student's posters that they presented to each other (Figs. 2-4).

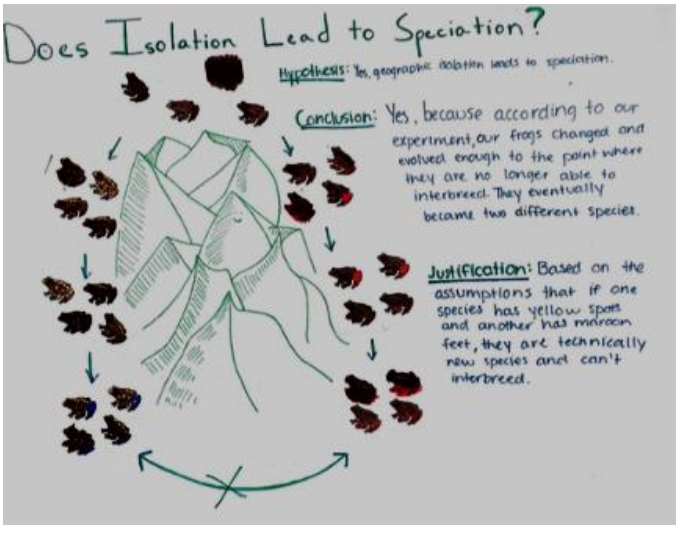

Figure 2. First example

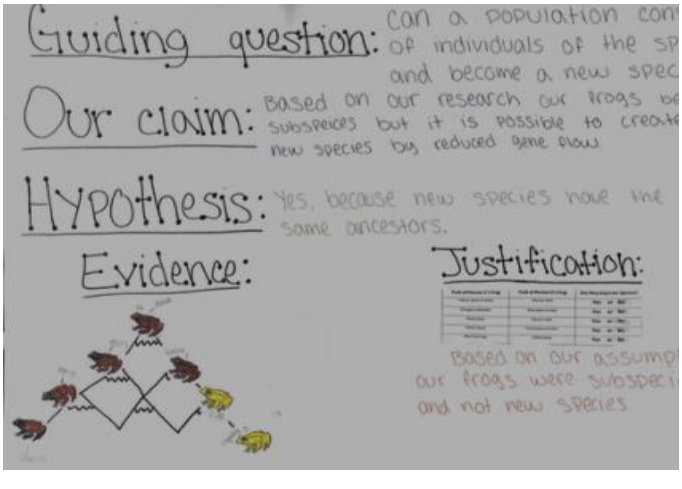

Figure 3. Second example

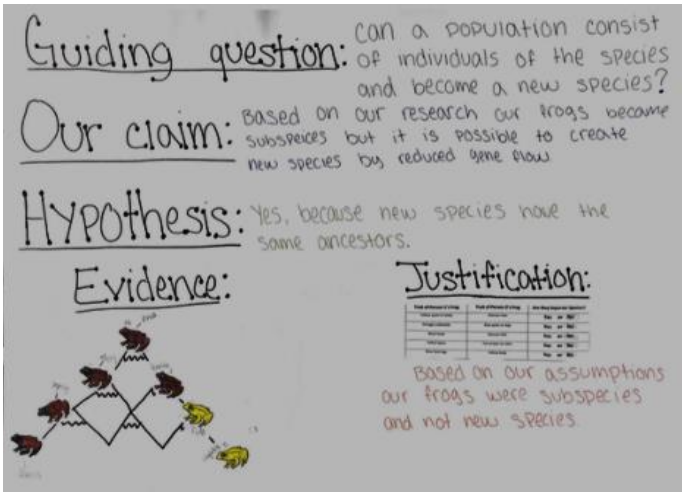

Figure 4. Third example

Conclusion

In conclusion, ADI did keep the students entertained. Some issues went along with the project. The main issue is that the students were not used to the method of learning. I believe that if the method had been used for the entire year like it is recommended it would have gone smoother for both the teachers and students. Another way the lab could have gone smoother from the beginning is to have had the information read out loud as an entire class. The first two classes were not done this way but the last two were. The last two were better for everyone. Another way it could have gone smoother if for the students to have more time. I think that I believe that if a school has block scheduling ADI would be captivating and enjoyable for the students.

Do I think that ADI will replace current science classroom methods? No, I do not. I do not think it was beneficial enough to warrant a weeks' worth of time that the students could have gotten the same amount of enjoyment and knowledge out of a one- or two-day lab. I also think that we need "cookie-cutter" labs to teach good lab practices. Like what is appropriate behavior, what you should and should not wear and do in a lab, how to measure and create graphs. I think cookie-cutter labs as ADI calls them helps students understand that there are correct ways to collect and represent data. Without a specific correct answer, there's no way for students to realize where they went wrong in the lab.

Appendix 1: The Research Survey

Please complete the survey below based on your opinion of the classroom.
What I think the classroom was like during ADI

	Almost Never	Seldom	Sometimes	Often	Almost Always
Students learn about the world in and outside the class					
Students learn how science is a part of in- and outside the class.					
Students learn that there are not always answers to problems					
Students learn that explanations change over time.					
Students learn that there is more than one way to raise questions and seek answers.					
Students help to decide which activities work best for them					
Students let instructors know if they need more/ less time to complete an activity					
Students talk with other students about how to solve problems.					
Students explain their ideas to other participants.					
Students ask other students to explain their ideas.					

Appendix 2: The Research Survey

Please complete the survey below based on your opinion of the classroom.
What I prefer the classroom to be like

	Almost Never	Seldom	Sometimes	Often	Almost Always
Students learn about the world in and outside the class					
Students learn how science is a part of in- and outside the class.					
Students learn that there are not always answers to problems					
Students learn that explanations change over time.					
Students learn that there is more than one way to raise questions and seek answers.					
Students help to decide which activities work best for them					
Students let instructors know if they need more/ less time to complete an activity					
Students talk with other students about how to solve problems.					
Students explain their ideas to other participants.					
Students ask other students to explain their ideas.					

NOTES

1. https://argumentdriveninquiry.com/instructional-model

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