HOW DO STUDENTS USE SCIENCE IN MAKING ENVIRONMENTAL DECISIONS? A STUDY OF HIGH SCHOOL AND UNDERGRADUATE STUDENTS IN NY AND NJ

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Abstract. Environmental issues are part of our daily lives, and as a society we are continually faced with making decisions. Issues such as clean energy, urban pollution, and climate change are relatively complicated, and these issues require a combination of social and scientific solutions. In order to participate in decision making processes surrounding such issues, the public needs to be equipped with the tools necessary to do so. Environmental education is one of the many ways to take on this task, by providing students with the scientific knowledge and skills they need to make informed decisions. This study investigated how high school and undergraduate students use science in environmental decision making, what sources of evidence they rely on, how they perceive those sources, the relationship between sources of evidence and the decisions students make, and the relationship between how students use science and the types of decisions they make. Students were asked to participate in a classroom activity designed to encourage them to make an environmental decision based on data. Results from this study indicate that students who exhibited more advanced use of evidence made more informed and environmentally conscious decisions.

INTRODUCTION

Environmental issues are part of our daily lives, and as a society we are continually faced with making decisions about such issues. Issues such as energy sources, climate change, urban pollution, and genetically modified foods are just a few examples of the issues we as a society must be prepared to deal with (Davies 2004). Public participation in the decision making process, and the ability of individuals to promote their viewpoints on environmental and socio-ecological issues are of great significance, especially in democratic societies (Kolsto 2001a). In order to participate in the decision making processes surrounding such issues, the public needs to be equipped with the tools necessary to do so. Unfortunately, approximately four-fifths of the U.S. population is insufficiently knowledgeable about issues that may be affecting their daily lives (Jordan et al. 2009), and thus they are not well equipped to make informed decisions.

So how do we prepare people to face such issues? One way is through environmental education. Environmental education can focus on: ecological literacy and civics literacy. Ecological literacy is defined as the ability to use ecological understanding in order to study the environment, and civics literacy is defined as the capacity to utilize an understanding of social systems to participate in society (Berkowitz et al. 2005). One of the fundamental goals and challenges for environmental education is to prepare citizens to make informed socio-ecological decisions (Arvai et al. 2004; ESA 1988; Gotwals et al. 2010; Jimenez-Aleixandre 2002; Kolsto 2001; Sadler et al. 2004; Siegel 2006). This overall goal of environmental education is often referred to as environmental citizenship. Berkowitz et al. (2005) define environmental citizenship as “having the motivation, self-confidence, and awareness of one’s values, and the practical wisdom and ability to put one’s civics and ecological literacy into action” (Berkowitz et al. 228). If we enable students to understand and effectively utilize the science presented to them about the environmental issues we face, they will be able to make informed decisions. Covitt et al. (2010) argue that, in order to use science in decision making effectively, citizens should be able to:

- Explain and predict using evidence and science
- Evaluate evidence and arguments
- Deal with uncertainty
- Identify and prioritize relevant information
- Justify and explain a decision based on evidence and conceptual understandings

Teaching the Ecology Nature of Science (TENOS) is an education research project currently underway at the Cary Institute. This project addresses the question "Can students develop an understanding of the ecology nature of science (ENOS) that is useful and productive in environmental citizenship?" Researchers affiliated with the project have developed lessons and activities designed to enhance students' understanding of ENOS and assessment tools to describe teachers' and students' understanding of ENOS and enable students to apply ENOS skills and knowledge. For example, the city council activity (Appendix A) is a teaching and assessment tool developed as part of the Math Science Partnerships (MSP) program. It is designed to enable students to engage in environmental citizenship practices. Using this activity as an assessment tool in this research project, we seek to gain an understanding of how students use science to make environmental decisions. We are also interested in gaining insight into what sources of evidence students rely on when making environmental decisions, how students perceive the adequacy of the evidence they use, the relationship between sources of evidence and the decisions students make, and the relationship between how students use science and the types of decisions they make.

RESEARCH APPROACH AND METHODOLOGY

Data Collection

We used the city council activity packet (Appendix A) to collect data for this study. Education researchers from the Cary Institute gave the activity was high school and college teachers participating in the TENOS project and used it as a culminating lesson and source of data on student thinking and learning. The city council activity prompts students to take on the role of city council members in the city of Riverton who need to decide whether to allow the building of a new eco-mall on land that is currently the city park. The packet contains information gathered from multiple stakeholder groups, and this information was presented as evidence to the city council (the students). The information provided about the mall describes many of its "green" features, such as pervious pavement, a green roof garden, renewable power sources, and a recreational park around the mall. After going over all of the information presented to them in the packet, students answered a set of questions that prompted them to make predictions about certain environmental impacts (water quality, biodiversity, carbon emissions, and additional impacts), provide scientific explanations, state which sources of evidence they used to make their predictions, and critique the adequacy of the evidence they used. At the end of the exercise, the students made a decision about whether or not the mall should be built, and explained their final decision.

Once the 144 students who participated in this study completed the activity, their teachers collected their worksheets, and provided copies of the worksheets to the Cary Institute. To maintain confidentiality, each student received an ID number, and individual student names were removed from all the data sets. I entered students' responses to the questions on the worksheet into an Excel file, where I organized the responses by sections of the activity (Impacts on Water Quality, Impacts on Biodiversity, Impacts on Carbon Emissions, and Additional Impacts). Once the data collection and entry were completed, the next step was to develop a coding scheme.

Coding

I analyzed the data through content analysis (Alvarado 2010, Sadler et al. 2007, Jimenez-Aleixandre 2002). This is accomplished through classification and evaluation of key themes present in the text. In this study, the text consisted of written materials; however text in content analysis is not restricted to written materials and can include thins such as art, images, symbols, numbers, and maps. Content analysis includes both manifest (explicit) and latent (implicit) content of the communicated material (Alvarado 2010, Eggert and Bogeholz 2009, Krippendorf 2004a).

Before analyzing the collected data, I devised a general coding scheme to follow. This type of coding is defined as a priori coding, i.e., creating a framework prior to coding so that the analysis is not restricted to only what shows up in the materials to be coded (Alvarado 2010, Sadler et al. 2004 & 2007). Emergent coding which is a technique that allows for codes to be defined as they emerge throughout data analysis was also used throughout the study (Jimenez-Aleixandre 2002, Sadler et al. 2007, Siegel 2006). Table 1 shows the general coding scheme I devised for the analysis of students' use of evidence in the activity. After developing the general coding scheme, I identified the various sources of evidence that the students used in this activity, both biophysical and socioeconomic, and assigned a specific code to each (Table 2). Once I had decided on the codes for the sources of evidence, I coded all the student responses from the first two questions (What impacts do you predict?; What evidence supports your predictions?) of every section (Impacts on Water Quality, Impacts on Biological Diversity, Impacts on Carbon Emissions, Additional Impacts) in the activity, using the coding book I had designed as a guiding tool.

To gain a better understanding of how students use evidence in decision-making (science process vs. science content), I developed a scale to rank different ways students use evidence. This scale is based on an understanding of basic science process skills (Padilla, 1990). This scale starts from Level 0 and continues up to Level 3. Table 3 gives a general description of each of the levels; a more detailed description of each level with examples of student responses for each can be found in Appendix B.

I created a coding book that lays out the exact coding scheme designed for the data, with descriptions of each of the codes, what they mean, and some indicators for those codes (Appendix B). Each student response to each individual question in the packet was coded for various themes, such as source of evidence, level of evidence use, and adequacy of evidence. Once 10 percent of the data set had been coded, I asked another researcher to code the same data. This process is called inter-rater reliability, and is undertaken to ensure reliability of the coding process by minimizing individual bias as much as possible. The level of agreement amongst the coders is what is measured in this process, and from it the reliability of the process can be inferred (Krippendorf 2004b). I wanted to achieve at least 90% inter rater agreement, because higher agreement rates generally correspond with a more reliable coding scheme. Once we each completed coding 10% of the data, we compared the results of each of our coding processes, and agreed on 92% of our codes. We discussed disagreements in coding that occurred, and made slight changes to the coding scheme to address these disagreements. Once we agreed upon the coding scheme, I proceeded to code the rest of the dataset.

Statistical Analysis

In order to determine what statistical tests would be appropriate for the analysis of the results in this study, I met with several scientists at the Cary Institute and the University of Vermont. Since the data in this study was all count data, ANOVA would not be the appropriate test to analyze any of the results presented in this research project. ANOVA is used for either parametric (score data) or non-parametric data (ranking/ordering) data, and since it cannot be used for count data, it was ruled out as a possible form of statistical analysis in this study. Chi-square tests are commonly used for data that consists of tallies or counts of categorical responses between two or more independent groups. Since all of the data collected in this study consisted of counts data, Chi-square seems more appropriate for the analysis of the results. However, not all of the data consisted of independent groups, and since one of the assumptions for a Chi-square test is that groups are independent (an individual cannot be in more than one category), a Chi-square is not appropriate for the analysis of all of the results in this study. In addition to the assumption of independence, in order for the Chi-square test to be accurate, each cell in the contingency table must contain 5 or more counts. For some of the results in this study, certain categories contain less than 5 counts, so some modifications in the way the data was collected from the students would be necessary in order to perform a Chi-square test.

RESULTS

Students cited various sources of evidence a total of 682 times in their responses in the city council activity. Students used the biophysical evidence provided to them in the activity seventy four percent of the time, while the socioeconomic evidence was cited fourteen percent of the time. The remaining eleven percent represents the instances when students in the activity did not cite any evidence for their responses. Of the biophysical evidence cited, thirty eight percent was provided by the Riverton Crossing Shopping Center proposal, thirty three percent was provided by the Riverton Scientists Environmental Impact Statement, and three percent was provided by the Riverton Climate Action Coalition. In terms of the socioeconomic evidence cited by the students, four percent was from the Riverton Downtown Business Association, three percent each from the Riverton Chamber of commerce and the Superintendent of Riverton Schools, two percent each from the Riverton Crossing Shopping Center proposal and Friends of Riverton Park, and one percent from the Riverton Climate Action Coalition (Table 4).

I categorized student responses (n=558) for each section in the activity (water quality, biological resources, carbon dioxide emissions, and additional impacts) according to the levels of evidence use described in Table 3.Twenty one percent of the responses were categorized as Level 0, indicating that the students in these cases did not use any evidence in their responses. Fifty six percent of the responses were categorized as Level 1, where students relied on science content in their responses, using evidence simply by stating it in the form of observation. Seventeen percent of the responses were categorized as Level 2, where students relied on science content skills by interpreting and explaining the evidence they used in their responses. The remaining six percent of the responses were categorized as Level 3, which indicates that in those responses, students not only interpreted and explained the evidence they relied on as in Level 1 and Level 2 responses, but evaluated and critiqued that evidence as well (Table 5).

Figure 1 shows the relationship between levels of evidence in student responses and their final decision about the construction of the mall. Fifty eight percent of students who did not use evidence in their responses were for the mall, while forty two percent were against it. Seventy eight percent of students who used evidence by simply stating it in the form of observation (Level 1) were for the mall, and the remaining twenty two percent were against it. For Level 2, where students interpreted and explained the evidence they used, thirty seven percent of those students were for the mall, and sixty three percent were against it. Finally, students who interpreted, explained, and evaluated the evidence they used (Level 3), were more likely to be against the construction of the mall (seventy eight percent) than for its construction (twenty two percent). Each student completed four different sections in this activity (water quality, biological resources, carbon dioxide emissions, and additional impacts), and the response to each section received a Level 0, Level 1, Level 2 or Level 3. Because of this, we cannot assume independence of groups, meaning that a Chi-square would not be appropriate for analyzing these results. However, breaking up the results by section of the activity would be a way to ensure that a single student would only have one response (instead of four, one for each section), and thus could only receive one Level of evidence use ranking for that particular response; that would allow for a Chi-square test to be performed.

Figure 2 shows students final decision about the mall in relation to the sources of evidence they used. Fifty six percent of the students who did not use evidence were for the mall, and forty four percent were against it. Students who cited biophysical evidence from the Riverton Crossing Shopping Center Proposal were almost equally divided, with forty nine percent for the mall, and fifty one percent against it. For students who used biophysical evidence provided by the city scientists, thirty one percent were for the mall, and sixty nine percent were against it. Twenty four percent of the students who used biophysical evidence provided by the Riverton Climate Action Coalition were for the mall, and seventy six percent of them were against it.

Looking at socioeconomic evidence, seventy two percent of the students who cited the mall proposal were for it, and twenty eight percent were against it. Fifty eight percent of students who used evidence provided by the Superintendent of Riverton Schools were for the mall, while forty two percent were against it. Sixty five of the students who cited evidence from the Riverton Chamber of Commerce were for the mall, and thirty five percent were against it. Almost all the students who used evidence provided by the Riverton Downtown Business Association were against the mall (ninety percent), while only ten percent voted for the mall. Twenty seven percent of the students who used evidence from the Friends of Riverton Park were for the mall, and seventy three percent were against it. Finally, twenty five percent of the students who used socioeconomic evidence from the Riverton Climate Action Coalition were for the construction of the mall, and seventy five percent were against it. It is important to note that each student could have used more than one source, but had only one final vote, meaning that the same student could be represented in more than one of the “source columns” but would only correspond to one type of vote (either for or against).For this reason, I could not analyze these results using Chi-square, since Chi-square requires the assumption of independence, meaning that an individual cannot fit into more than one category.

Figure 3 shows students’ perception of the sources they cited throughout the activity. Students were asked to rate the adequacy of the evidence they had used. Although students cited various sources of evidence a total of 682 times, there were only 517 rankings for the evidence, because not all of the students ranked each source of evidence they had used. It easy to see that students ranked evidence as either adequate most frequently, the main exceptions being in the cases of socioeconomic evidence from Friends of Riverton Park and the Climate Action Coalition (n for both was 4). For a more detailed description of the results regarding adequacy of evidence see figure 3.

As the n values for each of the sources of evidence shown in figure 3 suggest, there is a lot of variation in how often certain sources were cited by the students. This means that there was also a lot of variation in the number of times students rated the adequacy of a particular source as unsure, inadequate, somewhat adequate, adequate or very adequate. In order to perform a Chi-square test, the counts in each cell of the contingency table must be at least 5. This would have meant that a lot of the data about the adequacy of evidence would have to be excluded in order to perform a Chi-square. For example the total n for both socioeconomic evidence from the Friends of Riverton Park and the Riverton Climate Action Coalition is 4, meaning that these would have to be excluded from the test. However, having fewer levels of adequacy, or grouping some of them (such as somewhat adequate and inadequate) could help solve this issue, by decreasing the number of cells in the contingency table and increasing the lower values in the cells.

Finally, in the last section of the city council activity, students were asked to make a decision about whether or not, in light of all the evidence that had been presented to them, they supported the mall being built. Fifty eight percent of the 144 students who participated in the activity voted against the building of the mall and 42% were in favor of the building of the mall.

DISCUSSION AND CONCLUSION

The results of this research project have been relatively successful at addressing the main research questions that guided it. Since the main research question “How do students use science in making environmental decisions?” is relatively broad in scope, the results are broad in scope as well. I found that students relied on biophysical evidence (seventy four percent) more frequently than they relied on socioeconomic evidence (fourteen percent) throughout the activity. This activity was presented to the students as a part of their science class, so students may have felt that using such evidence in this activity was most appropriate. Also, the activity has four main sections, and three of those sections focus on environmental impacts of the mall’s construction, such as water quality, biological resources, and CO_2 emissions. The last section asked the students to address any additional impacts they thought were important, and this is where the use of socioeconomic evidence came into play. Since students were not explicitly asked to address social and economic impacts of the mall on the Riverton community, they may have not been so forthcoming with their predictions and thoughts on these issues, and thus had less of an opportunity to use socioeconomic evidence in the activity.

With respect to how and to what extent the students used evidence throughout the activity, 315 of the 558 student responses were categorized as Level 1 (fifty six percent), indicating that students used the evidence by simply stating it in the form of observation (ex. more cars means more CO_2). This type of evidence use would fall under the basic science process skills described by the National Association for Research in Science Teaching (Padilla 1990). One of the goals of the TENOS project is to enhance students’ science process skills, and enable them to utilize more complex, integrated science process skills, where students are not only able to interpret and explain information they are provided with, but are also able to critique and evaluate it. In this activity, most of the students did not exhibit the use of such skills in their responses. It is important to note that the city council activity is one of the many forms of assessment the students participated in throughout the school year as part of the TENOS project, and the other assessments may provide some additional insight into whether students were using integrated science process skills throughout the school year. Another factor to keep in mind is that both 1st year college students participated in this study as well as high school seniors, and this study did not attempt to differentiate between those two groups of students. Even though student responses categorized as Level 2 (n=92) and Level 3 (n=34) represented a relatively small portion of the total student responses (n=558) in the activity, these responses were provided by students who were much more likely to vote against the mall (Figure 1). This is an interesting insight, and could be an indication that enhancing students’ science process skills could enable them to make decisions that are more sensitive towards environmental risks associated with the particular decision. It also may be interesting for future research efforts to look into the differences in levels of evidence use between students at different academic research, by collecting data from high school students in the ninth to eleventh year, and college upperclassmen.

Students who used socioeconomic evidence, such as evidence about the impact of the mall on small businesses and on the local community, were more likely to vote against the mall (Figure 2). Socioeconomic evidence was cited much less frequently than biophysical evidence in this study (fourteen and seventy four percent respectively of n=682), so these results are relatively tentative with regards to socioeconomic evidence and its effect on the decision making process. It was also interesting to see that there was not much of a difference between votes for and against the mall among students who cited biophysical evidence from the mall, almost equally divided with forty nine percent for the mall and fifty one percent against the mall (n=257). This provides some indication of how students in this project responded to the evidence provided in mall proposal, and it would be interesting to see if these numbers would be different had the mall in the proposal been a traditional one rather than an eco-friendly one.

Lastly, in terms of how students perceived the sources of evidence presented to them in the packet, in most cases students thought the evidence was adequate. This activity prompted students to scrutinize the adequacy of the evidence they chose to use to make their predictions, however it did not ask them to state what they thought of the evidence they chose not to use. I think this set up meant that students were most likely to say that they thought the evidence they chose was adequate to some extent, since after all, they had chosen to use it for their predictions. Their choice of sources, to a certain extent, gives us some insight into their perceptions of the adequacy of those particular sources. In order to gain an understanding of how students perceived the various sources of evidence in the packet, perhaps asking students to weigh in on what they thought of each source would have been more effective.

This research project was intended as an exploratory project, seeking to gain insight into how students use science in making environmental decisions and how that impacts their ability to make informed environmental decisions. The results of this study indicate that more advanced science process skills may correspond to decisions more sensitive towards environmental impacts. A key question remains unanswered "how do we enhance those skills through environmental education?", and I think continued research in this area would be extremely beneficial to the environmental education community, science educators, and most importantly students who will increasingly need to deal with such complex issues as responsible citizens.

LIMITATIONS AND RECOMMENDATIONS

There have been a few limitations that I recognized throughout this study, and I would like to propose some recommendations in response to these limitations, and regarding the overall study and citizenship activity as a whole. When I first began designing a coding scheme for the student responses to the citizenship activity, I had hoped to gain some qualitative information from the last question (question number 7) in the activity (Appendix A). This question asks students to vote for or against the mall, and asks them why they voted the way they did. I did use the students' final votes from that question for the purpose of this study; however I was unable to gain any substantial information for the second part of that question asking them why they voted a certain way. This was because many students did not answer this question at all, and when they did, provided little more than a sentence response, providing very little in information in response to the question. By this point in the activity, students had already been asked multiple times to provide their predictions and reasoning about a variety of scenarios related to the environmental impacts the mall would have on the town (water quality, biological resources, carbon dioxide emissions, and additional impacts). If the students had not already presented their reason for voting a certain way about the mall throughout the four main sections of the activity, they probably were not too enthusiastic to do so this late in the activity. Perhaps designing an activity that would give students more freedom in stating what issues they thought were important to discuss with regards to the decision they must make would provide a different perspective on what issues would influence the students decisions.

There are a few more specific issues that became more evident once I had collected the results of this study. The first was that students cited biophysical evidence more often than socioeconomic evidence in this activity (Table 4). This may be because students were not given equal opportunity in the activity to discuss to discuss both the biophysical impacts of the mall on the environment and the socioeconomic impacts of the mall on the community. The four sections of the activity stressed impacts on water quality, biological resources, carbon dioxide emissions, and the fourth section allowed students to discuss any additional impacts they thought were important. It is easy to see how students were more likely to cite biophysical evidence than socioeconomic evidence throughout the activity for that reason alone. It is also important to remember that this activity was presented to students within their science courses, so they may have thought it most appropriate cite biophysical evidence in that setting. It also became evident to me that most students ranked the evidence that they had chosen to cite as adequate (Figure 3). The way the adequacy question is presented in the activity, asking students to rank the adequacy of the evidence they had chosen to use to make their predictions, seems to set students up to rank it as adequate. The students probably chose particular sources of evidence because they found them to be adequate or very adequate, so asking them how adequate they thought a source was, after they had chosen to use it probably would result in a very uniform response from the students. Perhaps asking the students to rank the adequacy of each source of evidence, regardless of whether they chose to use it or not may have given more insight into what students really thought of the evidence, and provided some insight into their ability to critique and evaluate the evidence. It is also important to note that sources of evidence were very frequently cited together by students in their responses, making it difficult to isolate the relationships between a single source of evidence and final decisions about the mall made by students.

This activity was originally designed to be completed both individually and in groups. Due to the fact that this activity was completed by the students late in the semester, teachers were pressed for time and were not all able to have their students complete the activity in groups as well. This meant that there wasn't enough data from the group activity to be used in this study. The students were asked to act as city council members in this activity, and make a decision about the eco-mall in their town. Such decisions are actually made in groups, so studying how students use science in making environmental decisions working in group settings would be a really interesting next step for future studies in this area of education research.

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APPENDIX

TABLE 1. General coding scheme for students' use of evidence

<table>
<tr><td rowspan="12">Doesn't Use Evidence</td><td colspan="2">Uses Evidence</td></tr>
<tr><td>Types</td><td>Sources</td></tr>
<tr><td rowspan="4">Biophysical</td><td>Riverton Crossing Shopping Center Proposal</td></tr>
<tr><td>Riverton Scientists Environmental Impact Report</td></tr>
<tr><td>Friends of Riverton Park</td></tr>
<tr><td>Riverton Climate Action Coalition</td></tr>
<tr><td rowspan="6">Socioeconomic</td><td>Riverton Crossing Shopping Center Proposal</td></tr>
<tr><td>Superintendent of Riverton Schools</td></tr>
<tr><td>Riverton Chamber of Commerce</td></tr>
<tr><td>Riverton Downtown Business Association</td></tr>
<tr><td>Friends of Riverton Park</td></tr>
<tr><td>Riverton Climate Action Coalition</td></tr>
</table>

TABLE 2. Codes developed for sources of evidence use

Code	Source of Evidence
0	No evidence
B-1	Biophysical evidence from the Riverton Crossing Shopping Center Proposal
B-2	Biophysical evidence from Riverton Scientists Environmental Impact Report
B-6	Biophysical evidence from Friends of Riverton Park
B-7	Biophysical evidence from Riverton Climate Action Coalition
S-1	Socioeconomic evidence from Riverton Crossing Shopping Center Proposal
S-3	Socioeconomic evidence from Superintendent of Riverton Schools
S-4	Socioeconomic evidence from Riverton Chamber of Commerce
S-5	Socioeconomic evidence from Riverton Downtown Business Association
S-6	Socioeconomic evidence from Friends of Riverton Park
S-7	Socioeconomic evidence from Riverton Climate Action Coalition

TABLE 3. Levels of evidence use

Level	Description
0	Student does not use evidence
1	Student relies on science content using evidence by stating it in the form of observation
2	Student relies on science content skills using interpretations and explanation of evidence
3	Student relies on science process skills using interpretation, explanation, and evaluation of evidence

TABLE 4. Sources of evidence used by students in their responses (n=682)

No Evidence		Biophysical Evidence			Socioeconomic		
Frequency	%	Source	Frequency	%	Source	Frequency	%
79	11	Mall Proposal	257	38	Mall Proposal	14	2
		Scientists' Report	225	33	Riverton Schools	19	3
		Climate Action Coalition	19	3	Chamber of Commerce	21	3
					Downtown Businesses	31	4
					Friends of Riverton Park	12	2
					Climate Action Coalition	5	1

TABLE 5. Levels of evidence use in student responses (n= 558)

Level of Evidence Use	Frequency	%
Level 0 – Student does not use evidence	117	21
Level 1 - Student relies on science content using evidence by stating it in the form of observation	315	56
Level 2- Student relies on science content skills using interpretations and explanation of evidence	92	17
Level 3 - Student relies on science process skills using interpretation, explanation, and evaluation of evidence	34	6

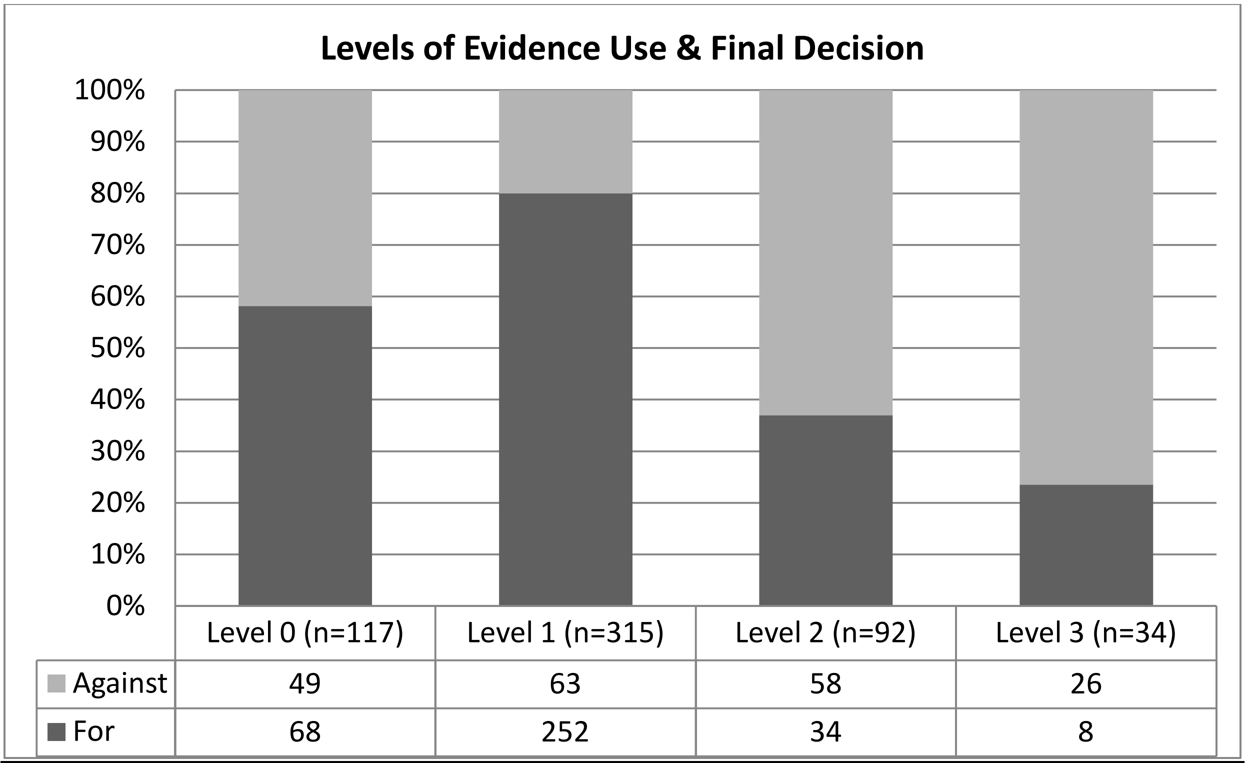

FIGURE 1. Final decisions for or against the mall in relation to levels of evidence used by the students (n= 558).

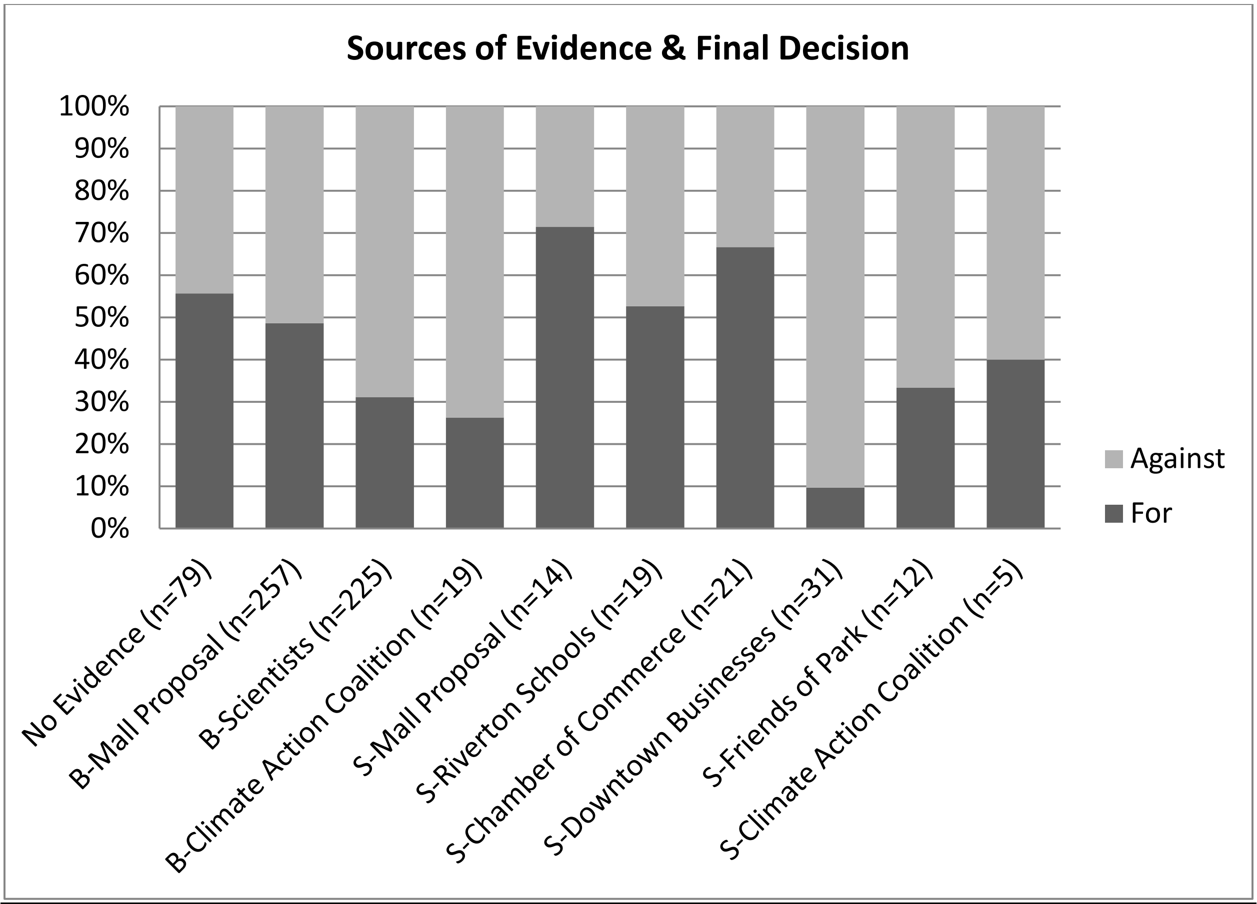

FIGURE 2. Final votes for and against the mall in relation to the sources of evidence used by the students (n= 682).

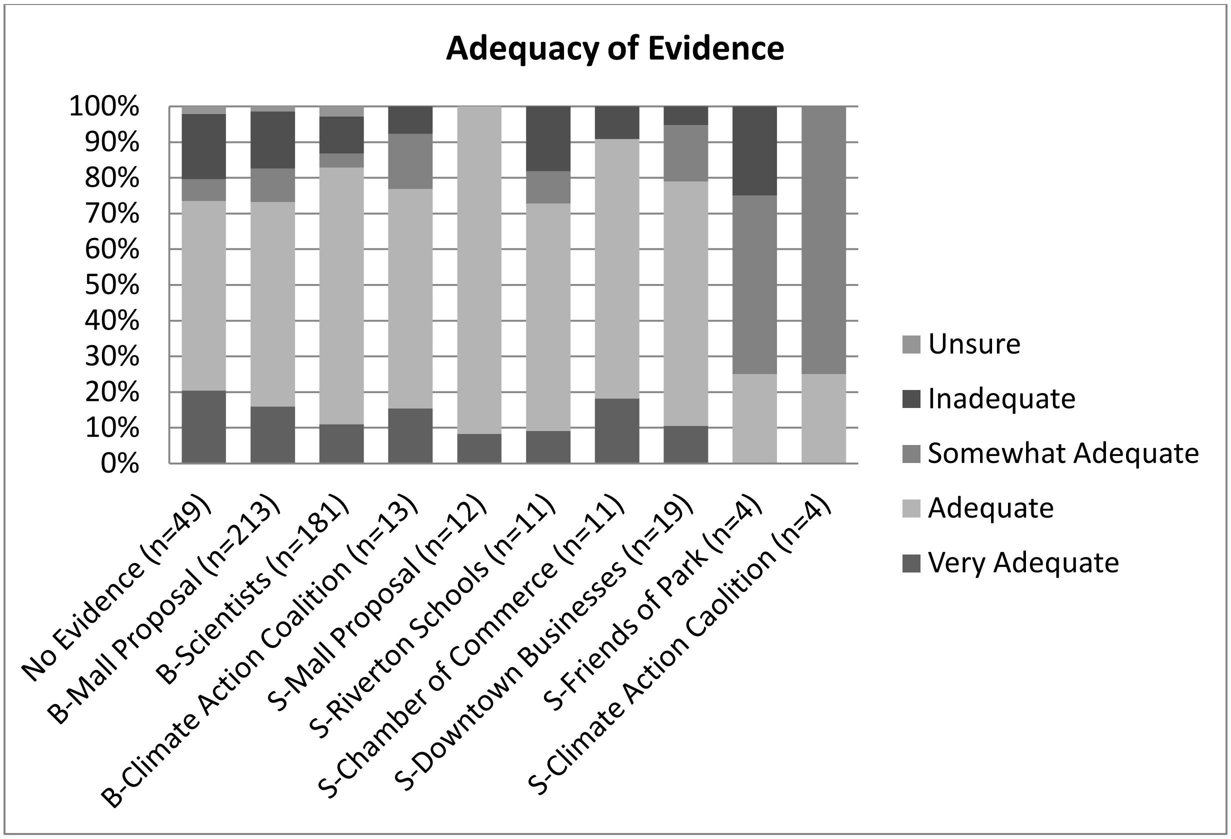

FIGURE 3. Adequacy rankings for evidence provided by each of the sources used by the students (n=517).