Justification of Socioscientific Claims as the Basis for Assessing Argumentation

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Abstract: This investigation introduces a novel rubric for the assessment of argumentation quality relative to socioscientific issues and presents results from a field test of its application. Forty-five students participated in interviews designed to elicit socioscientific argumentation regarding genetic engineering issues. A five point rubric was developed to assess how well individuals justified the claims they advanced. Implications for the use of this tool for advancing research agendas in the learning sciences will be discussed.

Toulmin's (1958) philosophical exploration of argumentation has had profound impacts on the study and assessment of argumentation particularly with respect to science education. Toulmin's Argument Pattern (TAP) provides a framework for analyzing argument structure and specifies features such as claims, data, warrants, backings, and rebuttals. TAP has served as the primary analytic tool for many (probably most) studies which have sought to evaluate the quality of arguments offered by students in scientific and socioscientific contexts (e.g., Osborne, Erduran, & Simon, 2004; Sadler & Zeidler, 2005). Despite its frequent use, TAP presents a number of methodological limitations. Chief among the problems associated with TAP is the ambiguous nature of argument structures identified by TAP (Osborne, et al., 2004; Kelly, Druker & Chen, 1998). Distinguishing what counts as data, warrants, and backings can be particularly tricky leaving the reliability of TAP-based assessment schemes questionable. Some of the most recent advances in the application of TAP to science education (Osborne et al., 2004) have minimized the problems associated with the ambiguity of argument structures by collapsing the most problematic categories (i.e., data, warrants, and backings) and focusing heavily on the emergence of rebuttals. While this approach is certainly powerful for some research contexts, it presents its own methodological limitation in that it can only be applied to group discussions.

Research focused on group discourse is certainly important for the study of science education and argumentation; however, it typically positions a group, and not an individual as the unit of analysis. In some instances, particularly in the current era of scientifically-based research, it is necessary to gauge individual student aptitude, epistemic orientation, and progress. If argumentation is a key element to scientific literacy and educators need methods for documenting change in the scientific literacy of individual students, which they surely do given the calls for evidence-based research, then assessment schemes which reliably evaluate the quality of arguments offered by individual students is necessary. This study proposes such an assessment scheme and applies it in order to answer questions relative to factors which influence socioscientific argumentation.

Methods

The development of the assessment scheme was grounded in Kuhn's (1991) work on informal reasoning and argumentation, Osborne et al.'s (2004) modifications of TAP, and the author's previous work related to socioscientific argumentation (Sadler & Zeidler, 2005). Participants were engaged in interviews and asked to articulate positions in response to three genetic engineering issues (gene therapy for Huntington's disease, gene therapy to improve intelligence, and reproductive cloning). The discussion of each scenario was preceded by a short written description providing details and context. An interviewer provided additional verbal prompts to encourage participants to articulate a position and justification. Responses to each of the three scenarios were analyzed according to justification themes.

Forty-five interviews were conducted with individuals in both high school and college. Fifteen high school students participated along with 15 non-science major college students and 15 college students majoring in biology. An a priori framework, based on results of previous work, was used to establish the basis of the argumentation quality rubric, and inductive analyses of the data were employed in order to refine the rubric and clarify distinctions among levels within the rubric. Inter-rater reliability exceeded 90%.

Results

Table 1 presents the argumentation assessment rubric and interview excerpts representative of each category.

Table 1. Argumentation quality rubric

Score - Description	Excerpt
0 - No justification	*In response to the reproductive cloning scenario*: "Yes, I think so [reproductive cloning should be developed]."
1 - Justification with no grounds	*In response to the gene therapy for Huntington's Disease scenario*: "If they can stop someone from suffering, then sure."
2 - Justification with simple grounds	*In response to the reproductive cloning scenario*: I don't think it's right because if you're not able to have a child, it's not God's will. If God wants you to have a child, you should have a child, and you will have a child. But if it's not for you to have a child, I mean, I think you shouldn't tamper with it.
3 - Justification with elaborated grounds	*In response to the gene therapy for intelligence scenario*: "They will develop a dichotomy even more so than we see now with the rich and poor. Now we will have the smart vs. the stupid or those who can afford this procedure and those who cannot. And that will create all kinds of sociological problems. I think that is meddling too much."
4 - Justification with elaborated grounds and a counter-position	*In response to the gene therapy for Huntington's Disease scenario*: "I think that gene therapy, it should be actually used very sparingly because what it does is narrows the diversity—like everyone gets the good copy now so that is not necessarily good because then we do not have a backup for anything. But in cases like this, where the only cure would be replacing the actual gene, then it could be beneficial… If there are no other treatments for it, that would be the only way that I would support using gene therapy for something like that...

Conclusions & Educational Significance

If argumentation is to become a significant aspect of science education as advocated in progressive calls for the enhancement of science education, then researchers require tools for documenting the effectiveness of curricula and pedagogies. Likewise, teachers require tools for documenting individual student growth and success. The assessment scheme developed as a part of this study provides such a tool. It does not provide assessment of all aspects of argumentation (and given the complexity of argumentation a single strategy for doing so is likely impossible), but it does provide a tool for the evaluation of justifications offered in support of claims, which represents a fundamental aspect of argumentation. In this particular study, the rubric was applied to interview data, but it could also be used with data collected through classroom conversations, writing assignments, or technology enhanced argumentation opportunities.

References

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