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The article starts with the next page.

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The purpose of this study was to determine if middle school student scientific understanding could be predicted by the variables: standardized 5th grade score in science, standardized 5th grade score in mathematics, standardized 5th grade score in reading, student attitude towards science, socioeconomic status, gender, and ethnicity. An Attitude towards Science Survey (SATS) and a Survey of Scientific Understandings were administered to 116 middle school 8th grade students during the 2010-2011 school year. SES was a significant predictor of scientific understanding of middle school students since correlation results showed that only SES was a significant contributor to predicting scientific understanding of these students. Low SES students performed lower on the scientific understanding survey, on average, than high SES students. This study can be a source of information for teachers in low-income schools by recognizing potential areas of concern for low-income students in their science classrooms.

Keywords: socioeconomic status, gender, ethnicity, science, mathematics, reading

INTRODUCTION

Enhancing student scientific understanding remains a challenge in science education. It is this challenge that has promoted research in student scientific understanding from the science education experiences of teachers in that field. Science education refers to how students organize, focus, learn, blend, appraise, and explore science content for the purpose of addressing a problem (Tate & Malancharuvil-Berkes, 2006).

Student scientific understanding has had two major concerns since the 1980s. The first concern is whether students have received the appropriate content knowledge from K-12 instructors (Harms, 1980; Hartshorne, 2005). This first concern has already been addressed by the Interstate New Teacher Assessment and Support Consortium (2002), which has created a set of science-specific standards, the National Science Education Standards for teaching (National Research Council, 1996), and several studies, which have determined that the amount of science content taught is not the problem (Anderson, Brown, & Lopez-Ferrao, 2003; Davis, Petish, & Smithey, 2006; Klapper, DeLucia, & Trent, 1993).

The second concern regarding student scientific understanding is much more important. How are middle school students retaining science content and demonstrating scientific understanding? More specifically, what factors are contributing to students' scientific understanding?

According to Wang and Staver (2001), students who received science taught at earlier ages had a more effective transfer of science content, but older middle school students grasped concepts that were more complex at a much faster rate. It is important to know that even though elementary school students

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State of the literature

- Comprehensive focus on writing-to-learn strategies in science education is a developing research area all over the world.
- Complexity exists in five key elements that guide learning from writing in science are writing type, writing purpose, audience, topic and method of text production.
- Writing for authentic audiences in a variety of formats facilitates conceptual understanding in science.

Contribution of this paper to the literature

- This current study seeks to find if a significant difference in students' conceptual understanding of science with respect to the audience factor. This encourages use of authentic audiences along with diversified types of writing in learning various science concepts at all levels of education for all learning modalities and subsets of populations.
- It is necessary to demonstrate the value of non-traditional writing activities in learning science content, which suggests a shift from using traditional writing tasks to non-traditional writing tasks in line with the recent curricular revisions.

demonstrate concrete reasoning, it is middle school students who are capable of more concrete thought, and are more capable of retaining complex science concepts (Sumida, 2004).

Science standards for middle school students focus on a more intensive approach rather than a broad science focus, as with elementary standards (NRC, 1996). Middle school students, according to NRC (1996) standards, are required to know the nature of matter, natural environments, interactions between organisms, and to demonstrate concrete connections with scientific methodology through use of the scientific method. Consequently, Middle school education becomes the critical turning point for students pursuing science careers. Middle school is where students going into high school are to declare a career before applying and attending a high school, allowing them to find a career identity (Kesidou & Roseman, 2002).

The declaration of this career choice has left some discrepancies in recent comparisons of U.S. students and international neighbors. In fact, U.S. students are lagging behind international students, both in their scientific understanding and science education (Carter, 2005; Kormondy, 1985; Sadler & Zeidler, 2009). For Project Synthesis was an interactive effort to determine the needs in natural science education. Science education reformists undertook the job of determining the current status of science education and its future direction. The results of the Project Synthesis were astounding. Project Synthesis research resulted in the determination that science education is given relatively low status at all education levels.

One such level is in middle schooling. It was obvious that science education reformists develop a means of determining what the current level of student scientific understanding was, and how any future goals were to be met (Eisenhart, Finkel, & Marion, 1996). Since middle school students are at the age where decisions will be made that affect their participation in future science endeavors, the focus of this research study was to determine which factors could predict student scientific understanding.

LITERATURE REVIEW

Science is one of the core subjects taught in most countries, from the earliest grades all the way through high school (George, 2003). In order to measure this understanding, several initiatives have been undertaken by the various institutions responsible for teaching science to students at all K-12 levels. Measuring scientific understanding has been directly linked to student career choice and future endeavors by students in science-based careers.

Science Education Reform

Science education is that education which focuses on everyday situations, scientific reasoning, organizing of thoughts, synthesizing of meaning, and evaluating and exploring alternative hypotheses (Tate & Malancharuvil-Berkes, 2006). Reform in science education takes place through policy changes (Kumar & Altschuld, 2008), curriculum changes and changes in student scientific literacy (DeBoer, 2000), and changes in classroom instructional practices (Altschuld, 2003).

According to Schmidt, McKnight, Cogan, Jakwerth, and Houang (1999), the driving forces behind change in science education were studies such as the Third International Mathematics and Science Study (TIMMS), which found that science curriculum of the United States covers more content than other countries investigated, though these topics covered had little coherence to the in-depth nature assumed to be taught in U.S. classrooms. Through the Statewide Systemic Initiative, the National Science Foundation also joined in the efforts of revolutionizing K-12 science and mathematics education by formatting the various teaching and learning policies and enriching the antiquated instructional content and materials.

Trends in Science Education

To get a better picture of what science education reform is, a breakdown of the three main eras of science education reform is in order. According to De Jong (2007), there were three main waves of science education reform. A shift in the direction of science education began in the late 1950s, where the nation, after much inquiry, determined that neighboring countries had a more prolific understanding of science content and curriculum (De Jong, 2007; Owen et al., 2008).

In the 1980s came the second wave of reform in science education. De Jong (2007) saw this second wave as a response to the report issued entitled A Nation at Risk (National Commission on Excellence in Education, 1983), which was an eye-opener to the passive nature of science education in the U.S. and a change into a more active approach to science education. The second wave of reform in science education led to a national approach to science education reform (National Science Teachers Association, 1982). The U.S. was identified as lagging not only in the educational system, but also in teaching and preparing citizens for careers in mathematics and science. The third wave that started in the late 1990s, was the final wave of reform for science education. The third wave was filled with changes promoting the constant reforming of educational institutions. This was one of the most influential entities, which was the Science-Technology-Society (STS). The STS focused science education reform on the connections between learning science, using technology, and how these components affect society (Kumar & Altschuld, 1999; Kumar & Chubin, 2000; Parker & Gerber, 2000, Sandoval, 2005; De Jong, 2007).

Trends in Research in K-12 Science Education

Research in science education at the K-12 level has focused on many related fields up until a more recent push toward the use of technology for society. The primary focus seemed to be centered on how Science-Technology-Society (STS) can be integrated and to what extent new technology tools could aid in science content knowledge retention for students as well as for science teacher education (NSTA, 1982). Science education at the K-12 level is centered on science teachers and science students. Science content teaching must have a substantial alteration in the programs designed for students to learn, for teacher preparation programs, and for the curriculum from which students must learn (Khourey-Bowers & Simonis, 2004).

Teachers are given opportunities to utilize technology that makes the learning process more active and more effective for students. Yager, Yager and Lim (2006) investigated these methods, cumulatively called STS, and found, with the help of technology, that learning impacted student content retention positively, helped students master science content as shown on a post-examination, and promoted student autonomy. According to the STS approach for teachers, teachers benefit in much the same way as students by making the instructional process more active and revitalizing the teachers' own knowledge of science subject matter (Bybee, 2003; Heath, 1992).

Factors Influencing K-12 Science Education and Student Understanding

One of the most debated factors that affect science education and the way that science is taught is gender. Scientific understanding of female students in all academic levels may, in fact, be higher than males, but the majority of research studies regarding female and male student cognitive ability state that both genders develop equally well. Gender bias and gender differences for K-12 students affect their ability to understand scientific concepts (Brotman & Moore, 2008; Farland-Smith, 2009; Lee & Burkam, 1996).

Socioeconomic status is defined as some combination of social status, family economic vitality, educational background, and occupation associated with the individual (Heimer, 1997; White, 1982).

Attitude towards science education influences a student's ability to retain and appreciate the utility of science content (Aschbacher, Li, & Roth, 2010). Science education is designed to promote inquiry. However, negative attitudes toward utility of science make learning through science education difficult (Wang & Staver, 2001).

Financial constraints are far too common for much of the concern that science educators, students, and parents experience. Since students are faced with significant financial restraints and teachers experience the same financial concern for classroom supplies, socioeconomic status can impact science education and science learning for students (Rutherford, 2005).

Another factor that influences student scientific understanding is standardized assessment. Standardized assessments have long been a controversial way of evaluating student understanding in science (Lumpe, 2005). These scores are even a major factor in placement of students into high school programs and put immense stress on teachers and students (Peters & Oliver, 2009).

Ethnic diversity, cultural differences, and individual preferences are concerns for policymakers and teachers in science education. These teachers are concerned about the cultural variances in the science content that students learn. Cultural differences affect the way individuals understand scientific concepts (Rutherford, 2005). The diversity that exists for various cultures, ethnicities, and geographies simply makes having a universal or one-size-fits-all way of teaching science very difficult.

Scientific Understanding and Research

Scientific understanding is considered to be a prerequisite for anyone involved with science. Scientific understanding is identified as an amalgamated visual representation of the world (Schurz &Lambert, 1994). Science education and teachers in science education promote scientific understanding in their students (Kumar &Morris, 2005).

Teachers of science must be versed in all fields, unless otherwise denoted by the subject, which they specify themselves. However, since many science fields are interconnected, almost all institutions require minimal knowledge across physics, chemistry, biology, and all related fields (Bybee, 2003).

Scientific understanding has been researched extensively in the past 30 years. Studies have been undertaken to determine the effectiveness of the standards-based approach to scientific understanding (Lee & Songer, 2001). Schurz and Lambert (1994) investigated conceptual notions of scientific understanding in society and found that scientific learning and career choice were directly connected. Lacey (1999) investigated contextual approaches to scientific understanding and how people perceived nature and found that natural inquiry affected scientific understanding. Regardless of the approach to researching scientific understanding, teachers and students at the K-12 level are often the focus of much of the research in scientific understanding (Sumida, 2004).

Scientific understanding has been connected to discourse; that is, an individual's ability to make connections between concepts is directly influenced by the conversations they have with their peers and instructors (Lee & Songer, 2001). The social connections help students to make critical evaluations of scientific concepts in order to develop their own perceptions of utility.

Students experience the science classroom differently than their peers and it is because of this that several factors associated with either the individual student or the classroom learning environment may affect the students' scientific understanding. The alteration or lack of scientific understanding for students means a direct impact on their scientific literacy. Such factors that can affect scientific understanding include gender differences, ethnicity, student preferences, context of learning, access to technology, or extracurricular learning materials as a result of low-socioeconomic status, attitude, and teacher-student relationship.

METHODOLOGY

Setting and Sample

The study sample consisted of middle school 8th grade science students (N=116). The research site was an urban middle school in the southeast United States. The school consisted of 1,109 students, with respective percentages of multiracial (1%), White (29%), Hispanic (20%), Black Non-Hispanic (48%), and American Indian-Pacific Islander (1%) students. The science staff consisted of three 6th-grade science teachers, three 7th-grade science teachers, and four 8th-grade science teachers.

Procedures

Student 5th grade reading Florida Comprehensive Assessment Test FCAT scores, 5th grade mathematics FCAT scores, and 5th grade science FCAT scores, gender, socioeconomic status, and ethnicity were obtained from county archives. Socioeconomic status was identified via income assumed as associated with eligibility for free, reduced cost, or full cost lunch and breakfast provided by the school system.

Students then took the Attitude Towards Science Survey during class time for a length of 10 minutes (Simpson &Oliver, 1990). The Attitude Towards Science Survey was followed on the next class day with the Survey of Scientific Understanding (Klapper et al., 1993). The students were given 30 minutes during class time to complete the Survey of Scientific Understanding (Klapper et al., 1993).

Instrumentation

The Survey of Scientific Understanding (Klapper et al, 1993) was designed, developed, and utilized in a previous research study involving the comparison of elementary and middle school teachers with college students' scientific understanding. Klapper et al. (1993) developed the survey in order to fully analyze student scientific literacy and scientific understanding. The survey consists of 25 items, and takes approximately 30 minutes to complete. The survey has five areas of science on which it focuses: biology (containing five questions), chemistry (containing four questions), physics (containing four questions), mathematics skills in scientific usage (containing five questions), and earth-astronomy (containing seven questions). Each question on the survey was assigned to one of these five areas of science and was graded right or wrong for each student taking the survey. In this study a coefficient alpha of 0.68 was calculated for the total score on the Survey of Scientific Understanding (Klapper et al., 1993).

Table 1. Intercorrelation Matrix among Predictor Variables and Criterion Variable

	OSUS	FGSS	FGMS	FGMR	SATS	SES	GENDER
OSUS	1.000	-.094	-.144	-.141	.152	*.337	.083
FGSS		1.000	.918**	.845**	.037	.026	-.054
FGMS			1.000	.846**	-.071	-.078	-.022
FGMR				1.000	-.024	.039	.088
SATS					1.000	.048	-.124
SES						1.000	.024
GENDER							1.000

Note. ** p<.01

The second instrument used was an Attitude towards Science Survey (Simpson & Oliver, 1990). The survey used in this student only 7 questions from the original Attitude Towards Science Survey as these questions pertained specifically to students attitude toward science, while other questions focused on parents attitude, teachers attitude, and overall valuing of science. These same questions were utilized in a subsequent study that reported a coefficient alpha of 0.88 (Owen et al., 2008).

In addition to the two instruments used, data from a third instrument were acquired from the county database. This third instrument was the FCAT standardized exam that students take in fifth grade. FCAT are tests given each year to document student understanding in the respective subject matter.. 5th grade reading, 5th grade mathematics, and 5th grade science FCAT scores, which were available from the county database. The reliability of these standardized assessments in science, mathematics, and reading is represented by an alpha coefficient value of 0.87, 0.88, and 0.91 respectively (Florida Department of Education, 2004).

Data Analysis

A correlation coefficient was computed to determine the strength of the relationship between the Survey of Scientific Understanding (OSUS) scores and seven other predictors, which are Attitude Towards Science(SATS) scores, 5th grade FCAT mathematics scores (FGMS), 5th grade FCAT reading scores (FGMR), fifth grade FCAT science scores (FGSS), gender, socioeconomic status (SES), and ethnicity. The only predictor variable that was significantly correlated with scientific understanding was SES (See Table 10). Students within the Full priced versus free lunch SES bracket scored a mean OSUS score of 10.05 (SD = 2.32), while the lower SES bracket for free and reduced lunch scored a mean score of 8.66 (SD = 2.33). Effect size was calculated using the means and standard deviations for full priced and free lunch SES groups, and Cohen's d was 1.03. The effect size was thus large.

In order to determine if ethnicity had a relationship with OSUS an ANOVA was conducted. The ANOVA was used to test the difference in OSUS mean score across only Black, White, and Hispanic students as the Asian and ethnically mixed categories had too few subjects. The results of the ANOVA, F (2,107) = 1.573, p = .212, demonstrated that the three group means were not significantly different from one another.

Table 10 identifies the several significant correlations between the predictor variables, in addition to the one significant correlation between the criterion variable and SES. The 2-tailed correlations identified by asterisks represent the strong, positive correlation between the predictor variable SES and the criterion variable, OSUS. The intercorrelation matrix reveals three additional significant correlations between the predictor variables themselves (See Table 1).

Significance of Model

The multiple regression model including all seven variables (ethnicity coded into two dummy variables) was significant with a squared multiple correlation of .173, F (8,107) = 2.567, p= .014. Consideration of the model weights and relevant contributions of predictors (Table 2) also represent SES as the only significant predictor. The variable inflation factors were not large, thus collinearity was not a problem.

FINDINGS

Fifth grade science, mathematics, and reading scores on the state standardized exam are an area to begin the discussion. However, the fact that 5th grade scores on the science standardized assessment returned no significant correlation with student scientific understanding is puzzling. It is puzzling because this content on the test is supposed to be subject-specific, but did not predict student scientific understanding. It is possible that this standardized test does not actually assess student scientific understanding and, in fact, measures some other aspect of their learning capability, such as critical thinking or the ability to take a test (Lewis, 2004).

Table 2. Coefficient Table for Variables Predicting Student Scientific Understanding (OSUS)

Variable	B	β	VIF
FGSS	.003	.097	8.408
FGMS	.001	.025	8.601
FGMR	-.008	-.272	4.333
SATS	.064	.140	1.101
SES	1.705	.344*	1.327
Gender	.580	.119	1.091
Black	-.097	-.019	1.506
White	.215	.040	1.553

Note.**p*< .05.

Student attitude towards science is the second area of focus for this discussion. The concern has been long documented, mainly because students' perception of science and its utility is directly controlled by their attitude toward science learning, content, and concepts (Jalil, Sbeih, Boujettif, & Barakat, 2009; Kose, Sahin, Ergun, & Gezer, 2010). On the contrary, this study returned no significant correlation between the scores students received on the Survey of Scientific Understanding survey and the Attitude Towards

Science Survey, p>.05. This result means that students' attitude toward science did not affect their performance on the Survey of Scientific Understanding (Klapper et al., 1993).

Socioeconomic status (SES), returned a significant correlation p<.01, thus showing predictive accuracy of the model. This means that SES can predict scientific understanding. This relationship can possibly be attributed to the resources that students with higher SES have outside the academic realm (Battle & Lewis, 2002; Carbonaro, 2005; Considine & Zappala, 2002; Eamon, 2005; Easton-Brooks & Davis, 2007; Ma, 2000).

CONCLUSIONS

Recalling the limitations of the study will shed light on the conclusions. Since only students who were placed in the study group were tested, not all of the possible students in the 8th grade class of this sample were tested thus resulting in a limitation. The standardized exam that was used as a foreground for the current level of scientific knowledge was also a limitation. Not only is the test for science, formatted regionally for Florida students regarding science but also for the mathematics and reading skills that Florida requires of its students. This limits the applicability of these tests to predict student scientific understanding.

The first conclusion from the research is that the socioeconomic status of students does predict middle school student scientific understanding, as documented by the OSUS. That is, it is more likely for students with a larger family income (higher SES) to perform higher on the OSUS than it is for students with a lower income (lower SES). This conclusion is supported by the literature (Caldas &Bankston, 1997; Considine & Zappala, 2002; Sirin, 2005).

A second conclusion can be taken from the preexisting scores on student5th grade standardized science assessments. The FLDOE (2004) proposed that this assessment is comprehensive and assesses student understanding of science concepts, life science, earth and space science, chemical and physical science, and scientific thinking. Based on this definition, it could be assumed that when students take a scientific understanding survey on the same science subjects, they would demonstrate scientific understanding. However, this is not the case, since these scores did not predict student scientific understanding.

A third conclusion can be taken from the Attitude towards Science Survey (SATS). The returned Cronbach reliability allows for the assumption that this survey is a reliable measure of student attitude towards science. However, it is possible that regardless of how negatively a student might perceive science, the student still can demonstrate scientific understanding.

The fourth conclusion comes from the results obtained for gender and student scientific understanding. Gender has long been attributed not only to career choice (Debacker & Nelson, 2000; Spelke, 2005) but also to student interest in certain science subject areas (Rolin, 2008). However, from this study, it can be seen that the Survey of Scientific Understanding is not gender subjective, as the result did not correlate gender with predicting student scientific understanding, p> .05.

A final conclusion can be made about the predictive value of this multiple regression model. However, it must be remembered that this is only one of many models that could be constructed in order to predict student scientific understanding.

Further Research Recommendations

The study provided some significant results and answers on what predictor variables influence student scientific understanding as well how these variables can predict this understanding. Variables affecting scientific understanding and their significance were identified in this study. However, there are additional areas that warrant further investigation. Further research is critical in order to expand the current scientific understanding of students. Based on the findings of this study, the following recommendations are made for further research:

1. *There is a need to study other variables that can influence student scientific understanding, as documented by the Survey of Scientific Understanding (Klapper et al., 1993).*
2. *There is a need to investigate the effect of different ethnicities of the instructor providing the Survey of Scientific Understanding and additional areas of focus identified by the U.S. Department of Education (The Education Trust, 2003).*
3. *There is a need to investigate other grade levels in middle schools that are diverse as well as similar in demographic makeup to the sample school studied in this research.*
4. *There is a need to investigate ethnicities and how they really affect a student's scientific understanding through each cultural difference present in these ethnicities.*
5. *There is a need to look further into the science curriculum taught and to determine if the Survey of Scientific Understanding is an appropriate means to assess the science curriculum that these middle school students have encountered.*
6. *There is a need to investigate how technology influences scientific understanding of students who have access and students who do not have access.*
7. *There is a need to investigate how students' individual intelligences may affect their performance on standardized assessments and the Survey of Scientific Understanding (Chen & Howard, 2010).*
8. *There is a need to investigate how many teachers who were introduced to diverse classroom teaching practices and more importantly, classes that have foundations in diversity.*

General Implications of the Study

The findings of this study suggest several implications for the future of the measurement and assessment of scientific understanding:

The first general implication comes from the idea that teaching science to varied student backgrounds is for the purpose of ensuring scientific understanding. Socioeconomic status (SES) of students is one variable of concern because these students do not just face inadequate resources but also encounter competitive opportunities for science careers without the necessary skills had they been provided with adequate resources.

The second general implication stems from the dynamic relationship between gender, ethnicity, and student scientific understanding. Gender is normally a factor that affects a student's opinion about science (Brotman & Moore, 2008), while ethnicity plays more of a sociocultural part as certain cultures represented by certain ethnicities place value in different career choices (Watt, 2010).

The third general implication comes from the non-correlation seen between 5th grade standardized science assessment scores and student scientific understanding. Scientific understanding is demonstrated through science assessment, which makes this no correlation perplexing.

One final general implication of this study is that if students are lacking the scientific understanding, as documented by the scores on the Survey of Scientific Understanding, then a reformatting of the current science curriculum is required so that basics in analytical thinking can once again close the developmental gap in scientific understanding that the United States students have with other countries.

Implications for Stakeholders

Those who have invested in the progression of public education, specifically public education stakeholders, have much to offer in improving science education. Implications of this study for teachers, curriculum developers, school administrators, school service providers, teacher educators, policymakers, and parents are as follows:

Implications for teachers

Implications for teachers are important to note because they are the line between the real world and the classroom in which a student learns. Teachers are at the forefront of the battle for equity in science education (Kane, Rockoff, & Staiger, 2006). One implication is that they service the student population, utilizing available technology and integrated instructional tools (Kumar & Scuderi, 2000; Kumar & Maslin-Ostrowski, 2008a)

Implications for curriculum developers

Several implications exist for curriculum developers as well. The first of these implications comes from the use of technology and computers in the development of curriculum that stimulates academic growth for all students, regardless of socioeconomic status (Kulm, 2007). These curriculum developers must take into consideration several milestones in education reform when understanding the full implications for curriculum developers and writers. The milestones include the computer technology revolution which encompasses the Digital Divide, and more recently the Innovative sciences such as Nanoscience, Nanotechnology, and Virtual Learning (Kumar & Maslin-Ostrowski, 2008a).

Computer technology revolution

One implication for curriculum developers is how computers have revolutionized not only the way teachers teach, but also the way curriculum is constructed for the teachers and students to utilize (Ryder & Banner, 2010). The use of new forms of technology is often limited because of the availability of this technology, often called the Digital Divide (Kumar & Helgeson, 1996; Gunkel, 2003).

Innovative science

Innovative science is the direction that science education is taking in order to remediate, educate, and evaluate students' scientific understanding. Burns, O'Connor, and Stocklmayer (2003) described this trend as a redefining of the meaning of science. Burns et al. (2003) further described these innovative sciences as an informal means of educating through science to address the necessary skills related to the technological advancement of society (Kumar, 2003).

Nanoscience education, also known as nanotechnology focuses on the various applications of how nano-sized particles can be employed to teach students scientific concepts (ESANT, 1999; Kumar & Maslin-Ostrowski, 2008b). Nanoscience education is just one of the outgrowths of the innovations in science; others include virtual reality and virtual learning (Dittmer, 2010), which is done through a virtual program called Second Life. Though this program is revolutionary, it is not available to all student populations, thus making the Digital Divide even wider.

Implications for school administrators

One implication for school administration is that policy regarding student achievement is used so that student populations can be assigned to certain teachers and programs (Altschuld & Kumar, 2010)

Implications for school service providers

School services are not exempt from this study because they provide the necessary foundation for learning. One implication for school services is that in order to meet the need of a fast-paced growth in science education, it is vital that the needs outside the academic realm for students be met. Maslow (1943) identifies these needs as necessary to be met in order for the student to progress through self-actualization.

Implication for teacher educators

Teacher educators are individuals who prepare teachers for the real world situations that they will encounter in the classroom. One implication for teacher educators is that they will need to modify their programs to prepare future educators for both the abundance and the lack of necessary technology for teaching science (Kumar & Maslin-Ostrowski, 2008b).

Implications for policymakers

Policymakers are also affected by the needs of the students that are not met. Kumar and Altschuld (2003) described it best by stating that policymakers are often making decisions based on the surface value of situations without being well informed through research and investigatory studies. In fact, it is these policies that are developed without critical research that affect students in low socioeconomic schools the most, because of the appropriation of state and local funds (Kumar, 1997b; Yokoo, 2008).

Academic and social policies

Policymakers must be aware of policies that affect both the academic and social realm of students. The policies that affect a student's academic options and social functionality are the focus of the next implication for policy makers. It is the social policies that are designed to guide, not to restrict (Kumar, 1997a).

Academic policies are designed to address student academic needs but are not designed with the understanding that socioeconomics can impact a student's motivation (Daniels & Arapostathis, 2005), a student's ability to interact with technological advances, and to acclimate their cultural values to this technology usage (Debacker & Nelson, 2000).

Political policy

Politics has much to do with education, and it is because of this connection that one final implication for policymakers must be identified. The implication for policymakers that holds the most value is that policies made for the political ring, such as class-size reduction amendments (K.A. Johnson, 2002), do not take into account the necessary allocation of funding for school districts.

Implications for parents

Parents and parental involvement in the academic realm are another implication that must be considered. Since the majority of learning begins with parental interaction with each student, then there should be resources designated for each parent that focus on preparing their children for science. Parents are also influenced by decisions that are made for the enrichment of their children's learning experiences in science education (Koch, 2001).

Toward a needs assessment

A comprehensive needs assessment is the only key to truly devising a plan of action for the previously stated implications. Altschuld and Kumar (2010) documented such a needs assessment and characterized similar needs assessments as evolving with the changing of the practice of teaching. Thus, teachers, curriculum developers, school administration, school service personnel, teacher educators, and policymakers would benefit from a comprehensive needs assessment of the directionality of the blending of science education and innovative technology.

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