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TEACHERS ARE THE PROPELLERS IN BOLSTERING STUDENTS OUTCOMES: REVIEW OF EFFICACY OF SCIENCE TEACHERS

Aregamalage Sujeewa Vijayanthi Polgampala[1i],
Fang Huang[2]
Huazhong University of Science & Technology, Wuhan, China
Prof., Huazhong University of Science & Technology, Wuhan, China

Abstract:
The importance of good teachers is no secret. Over the last two decades, research on student achievement has pinpointed the central role of teachers as one of the key propellers referred to in terms of a focus on student outcomes. This review exploits the teacher's effectiveness and what makes an effective teacher. Classroom management, classroom climate and teaching are the three factors that had statistically significant positive impacts on student academic outcomes. Teachers' sense of professional identity influences their relative commitment and resilience as well as their capacities to manage variations to sustain their teaching effectiveness. It draws out implications for policymakers in education and for improving classroom practice. In order to improve teacher efficacy, greater subject specific training in theory and practical work, both in pre-service and continuing teacher training programs could be offered. Conclusions are drawn that highly-qualified teachers are still in high demand for boosting student's motivation for optimum outcome. The findings unraveled in this study that the trend of augmentation in the Sri Lankan science secondary education context is growing at a slow but steady pace and also no significant impacts of teacher training on either teacher or student thus imply the ineffectiveness of short-term teacher training programmes on teacher and student performance.

Keywords: efficacy, science teachers, teacher standards

[i] Correspondence: email sujeewavijayanthi@yahoo.com

1. Introduction

Twenty-first century education is to bolster student engagement and drive more innovation for transformation of education. Learning becomes more authentic with blended approach as it is an umbrella for several important pedagogical strategies that have great potential to deeper learning approaches which connect curriculum to life outside the classroom to the real-world application. Teachers are one of the key propellers referred to in terms of a focus on student outcomes. This review is concerned with teacher's effectiveness and what makes an effective teacher. From the standpoint of effectiveness of science, teacher training serves as an important means for the development of effective and productive in teaching and learning, and in consequence, in focusing attention on the importance of teacher effectiveness was research that took an outcomes-based perspective. By looking at differences in the growth of student achievement across different teachers instead of concentrating on just the background and characteristics of teachers, it was possible to identify the true impact of teachers on students. Teacher effectiveness is generally referred to in terms of a focus on student outcomes and the teacher behaviours and classroom processes that promote better student outcomes Chaudron, 1988). Teachers are one of the key elements in nation building and effective teaching is one of the key propellers for building up balanced personalities to a country (Kyriakides, Creemers, & Antoniou, 2009). The idea that teachers can impact positively on student outcomes is a crucial driver in the rise of interest in student development and popularity of a school. This aims to highlight international examples of best practice in order to effect change and identify how effective school improvement manifests itself. To generate new knowledge and use it innovatively a country requires a scientifically literate population.

A quality science education is vital for scientific literacy (DeBoer, 2000). If students understand the basic concepts, appreciate important ideas and know how science is applied to everyday situations, high scientific literacy can be achieved. Effective science teachers play a pivotal role in this process. A number of common features of effective teachers and the practices that constitute effective teaching have been identified in a large number of research studies conducted in all over the world (Llewellyn, 2005). Terms such as 'instructional effectiveness', 'teacher effectiveness' and 'teaching effectiveness' have been used interchangeably in much of the research literature. The issue of creating effective learning environments heavily depends on teachers' talents and behaviors. There is a common consensus on the idea that teachers' behaviors are guided with a set of organized beliefs (Clark & Yinger, 1979). Teaching efficacy beliefs are one of the key factors affecting teacher practices. Teaching efficacy is

defined as `the teacher's belief in his or her capability to organize and execute courses of action required to be successfully accomplished a specific teaching task in a particular context' (Tschannen-Moran, Woolfolk Hoy & Hoy, 1998, p. 233). The primary nature of a teacher's work is instructional and that teaching or instruction is generally carried out in the classroom. Classroom management, classroom climate and teaching/instruction were the three factors that had statistically significant positive impacts on student academic outcomes. Furthermore, this provides an important evidence based on the correlates of effective teachers and the behaviours and classroom processes that predict better outcomes for students. It has stimulated initiatives to strengthen and enhance teacher quality through improvements to initial teacher education and continuing professional development programmes. It draws out implications for policymakers in education and for improving classroom practice. The effect of poor quality teaching on student outcomes is debilitating and cumulative on science educational outcomes are greater than those that arise from students' backgrounds (Rowe, 2004). Student achievement and student interest in science subjects and careers will improve if teachers consistently use research-based instructional practices, materials, and assessments. A reliance on curriculum standards and state-wide assessment strategies without paying due attention to teacher quality appears to be insufficient to gain the improvements in student outcomes sought. It forms a useful tool for schools and school administrators, but also acts as a lesson for policymakers in terms of what works around the world. Value added teacher effectiveness research is primarily quantitative; however, there is an increased recognition of the importance of a qualitative element to further illuminate the statistical data. In order to achieve good teaching, good subject knowledge is a prerequisite. Also, the skillful use of well-chosen questions to engage and challenge learners, and to consolidate understanding, is an important feature, as is the effective use of assessment for learning.

2. Theoretical Framework

Great teachers have the ability to transform and enrich the lives and living standards of Sri Lankans. Over the past century, investments in general education-such as the development of and widespread enrollment in government schools, preparation of more students for exams, and improvements in the accessibility of all levels of education have boosted to be productive and innovative. There are many benefits that have been connected with the importance of science education has been recognized in Sri Lanka's science and technology policy. The National Science and Technology Policy acknowledge that Science and Technology (S&T) plays a key role in economic

development and that education is central to achieving this goal (NASTEC, 2010). It recognizes that investment in research and development as well as in a strong S&T resource base is essential to compete successfully in the rapidly growing technology-intensive global market. Key reforms in curriculum and teaching learning methodology were introduced in 1999 and in 2007 to improve the learning of science. This is in response to findings that students were not able to apply their learning to everyday situations and to findings that their skills in open-ended problem solving and decision making relating to innovation and creativity were weak. Few were able to demonstrate the ability to use higher order thinking skills (Downing, Kwong, Chan, Lam, & Downing, 2009).

Science teachers are encouraged to use a variety of strategies to facilitate the teaching learning process. Students are able to get hands on experience and have the opportunity to learn in collaboration with peers. The lack of material and equipment for activities hampers teaching but teachers do adapt, whenever possible, using local materials. Educational effectiveness is a term that was developed to provide a more contained definition than notions of 'good' or 'quality' education. It relates to the idea of examining effectiveness at different levels of an education system, such as nationally, at a Local Authority/School district level, for individual schools, for departments within a school or for individual teachers in terms of their success in achieving particular goals or educational outcomes (Ramsden, 1991). "*A teacher is effective if he/she can accomplish the planned goals and assigned tasks in accordance with school goals*". Thus, the objectives of education and the definitions of the quality and effectiveness of education are closely connected. This means that defining effective teaching must be done in relation to understanding the objectives of education.

Promoting students' cognitive development can be seen as one of the prime purposes of education and teaching, though there are also likely to be other important social, behavioural and affective current and future oriented purposes and goals of education. In this case, the tools are used by supervisors and mentors to collect evidence of student learning by observing classes or watching videos as part of a professional development experience. A person is believed to be self-efficient when he/she can maximize his full capabilities to organize and execute the courses of action in order to attain goals. This is when a person's belief on self about the ability which is reflected in their outputs (Bandura, 1977, 1986, 1997). With this, self-efficacy reflects the teacher's confidence in his or her ability to exert control over motivation, behavior, and teaching environment. This has a considerable effect of teaching experience to produce quality results as reflected on the students' performance. It is inferred that a teacher's behavior is motivated and regulated by self-evaluation reactions to their own actions,

and therefore self-directedness partly determines the teacher's behavior inside the classroom. The goal to look into the connection between teacher's effectiveness in class this work may focus on specific traits found in the tool that the teachers identify as an area where they would like to improve their professional practice. Teacher's educators/supervisors would use the tool to organize and record their evidence in preparation of a debriefing among the observers. The debriefing would focus on collaboratively examining the evidence and identifying ways to make instructional practice more effective at engaging students in productive learning experiences (Erikson, 2012). Teachers' perceptions of what constitutes high quality or effective teaching are often collected in surveys, instruction logs, and interviews. Such logs and their validity and reliability have been questioned because studies tended to fail to pinpoint the relative significance of specific practices over time. It seems that the teachers and researchers do not consistently interpret the key terms and in the same way. As well as finding out what factors, teachers think constitute effective teaching practices; it is also of interest to establish how teachers perceive their own effectiveness and whether this changes over time. Do more experienced teachers perceive that their own effectiveness improves over the course of their career? (Tschannen-Moran, Hoy, & Hoy, 1998). One research study for example, compared 24 middle school science teachers' value added scores with survey and observation based indicators of teacher quality, instruction, and student characteristics. Evidence was found showing that teachers' value added scores were positively correlated with expert ratings of their instruction. However, although many teachers were classified similarly by their value added and observational scores, a minority were not. Teacher efficacy is extremely important for successful teaching.

Teachers' self-efficacy can be viewed as teachers' beliefs about their capabilities to produce a desired effect on student learning. Content knowledge and quality pedagogy play a large part in feelings of efficacy. Caprara et al. (2006) note that a number of studies have pointed to the influence of teachers' self-efficacy beliefs on student achievement and success at school. In addition, teachers' feelings of self-efficacy have been found to be associated with enhanced student motivation, self-esteem, more positive attitudes in classes, and students' own feelings of self-efficacy. They also state that teachers' sense of efficacy is related to their satisfaction with their choice of profession. What factors influence their perceptions of their effectiveness? In this case, the tool would need to be used under more rigorous standards by observers who have been trained on the use of the tool and who have a deep understanding of science instructional practice. Good teachers have a substantial effect on student achievement, especially when assigned to work with disadvantaged students. Teacher quality more

heavily influenced differences in student performance than did race, class, or school of the student; disadvantaged students benefited more from good teachers than did advantaged students (Nye, Konstantopoulos, and Hedges 2004). Achievement gains from having an effective teacher could be almost three times as large for African American students than for white students, even when comparing students with the same prior school achievement (Sanders and Rivers 1996).The effects of teacher quality accumulate over the years. Fifth-grade math students in Tennessee who had three consecutive highly effective teachers scored between 52 and 54 percentile points ahead of students who had three consecutive teachers who were least effective, even though both groups had the same achievement rates prior to entering second grade. A similar study in Texas showed a difference of 34 percentile points in reading and 49 percentile points in math (Sanders and Rivers 1996; Jordan, Mendro, and Weerasinghe 1997). Teachers with four characteristics, or dimensions, of teacher quality consistently generate higher student achievement: content knowledge, experience, teacher training and certification, and general cognitive skills.

3. Teachers' Standards (2012)

1. Set high expectations which inspire, motivate and challenge pupils:
    a) Establish a safe and stimulating environment for pupils, rooted in mutual respect;
    b) Set goals that stretch and challenge pupils of all backgrounds, abilities and dispositions;
    c) Demonstrate consistently the positive attitudes, values and behaviour which are expected of pupils.
2. Promote good progress and outcomes by pupils:
    a) Be accountable for pupils' attainment, progress and outcomes;
    b) Be aware of pupils' capabilities and their prior knowledge, and plan teaching to build on these;
    c) Guide pupils to reflect on the progress they have made and their emerging needs;
    d) Demonstrate knowledge and understanding of how pupils learn and how this impacts on teaching.
3. Demonstrate good subject and curriculum knowledge:
    a) Have a secure knowledge of the relevant subject(s) and curriculum areas, foster and maintain pupils' interest in the subject, and address misunderstandings;

b) Demonstrate a critical understanding of developments in the subject and curriculum areas, and promote the value of scholarship;
c) Demonstrate an understanding of and take responsibility for promoting high standards of literacy, articulacy and the correct use of standard English, whatever the teacher's specialist subject;
d) If teaching early reading, demonstrate a clear understanding of systematic synthetic phonics;
e) If teaching early mathematics, demonstrate a clear understanding of appropriate teaching strategies.

4. Plan and teach well-structured lessons:
   a) Impart knowledge and develop understanding through effective use of lesson time;
   b) Promote a love of learning and children's intellectual curiosity;
   c) Set homework and plan other out-of-class activities to consolidate and extend the knowledge and understanding pupils have acquired;
   d) Reflect systematically on the effectiveness of lessons and approaches to teaching;
   e) Contribute to the design and provision of an engaging curriculum within the relevant subject area(s).
5. Adapt teaching to respond to the strengths and needs of all pupils:
   a) Know when and how to differentiate appropriately, using approaches which enable pupils to be taught effectively;
   b) Have a secure understanding of how a range of factors can inhibit pupils' ability to learn, and how best to overcome these;
   c) Demonstrate an awareness of the physical, social and intellectual development of children, and know how to adapt teaching to support pupils' education at different stages of development;
   d) Have a clear understanding of the needs of all pupils, including those with special educational needs; those of high ability; those with English as an additional language; those with disabilities; and be able to use and evaluate distinctive teaching approaches to engage and support them.
6. Make accurate and productive use of assessment:
   a) Know and understand how to assess the relevant subject and curriculum areas, including statutory assessment requirements;
   b) Make use of formative and summative assessment to secure pupils' progress;
   c) Use relevant data to monitor progress, set targets, and plan subsequent lessons;
   d) Give pupils regular feedback, both orally and through accurate marking, and encourage pupils to respond to the feedback.

7. Manage behaviour effectively to ensure a good & safe learning environment:
    a) Have clear rules and routines for behaviour in classrooms, and take responsibility for promoting good and courteous behaviour both in classrooms and around the school, in accordance with the school's behaviour policy;
    b) Have high expectations of behaviour, and establish a framework for discipline with a range of strategies, using praise, sanctions and rewards consistently and fairly;
    c) Manage classes effectively, using approaches which are appropriate to pupils' needs in order to involve and motivate them;
    d) Maintain good relationships with pupils, exercise appropriate authority, and act decisively when necessary;
8. Fulfill wider professional responsibilities:
    a) Make a positive contribution to the wider life and ethos of the school;
    b) Develop effective professional relationships with colleagues, knowing how and when to draw on advice and specialist support;
    c) Deploy support staff effectively;
    d) Take responsibility for improving teaching through appropriate professional development, responding to advice and feedback from colleagues;
    e) Communicate effectively with parents with regard to pupils' achievements and well-being.

4. Evidence for Teachers Standards

A teacher is expected to demonstrate consistently high standards of personal and professional conduct. The following statements define the behaviour and attitudes which set the required standard for conduct throughout a teacher's career.

a) Teachers uphold public trust in the profession and maintain high standards of ethics and behaviour, within and outside school
b) Teachers must have proper and professional regard to the ethos, policies and practices of the school in which they teach, and maintain high standards in their own attendance and punctuality.

The ultimate aim of characterization effective teaching practices involves identifying the generic features and dimensions of effective teaching, measuring the relative impacts of teacher effects on students' learning outcomes, and establishing the relative influence of contextual conditions that may influence teacher effectiveness. The first task begins with summarizing results of research that sought to provide profiles of effective teachers and effective teaching. Highly effective teachers have long found

ways to engage, thus motivate, their students. But it is increasingly clear that the public education system needs to address student motivation far more systematically, and on a much larger scale. Researchers have identified a number of ingredients that contribute to student motivation. They differ on how they weigh and categorize them, but among them are a student's belief that he is able to do the work, a sense of control over the work, an understanding of the value of the work, and an appreciation for how he and the work relate to a social group. These factors, in turn, can be shaped by many others, including how academic content is taught and how students interact with and practice that content. Another promoter of student motivation, according to research, is an educational environment that helps students develop and maintain positive, meaningful relationships with adults and peers at school. In other words, students care when they feel cared about.

5. Teacher quality counts

More than two decades of research findings are unequivocal about the connection between teacher quality and student learning. Indeed, What Matters Most: Teaching for America's Future (1996), the influential report of the National Commission on Teaching and America's Future, made teaching the core of its "three simple premises" in its blueprint for reforming the nation's schools. They are:

- What teachers know and can do is the most important influence on what students learn.
- Recruiting, preparing, and retaining good teachers is the central strategy for improving our schools.
- School reform cannot succeed unless it focuses on creating the conditions under which teachers can teach and teach well.

Key teacher quality provisions of the No Child Left Behind Act (NCLB) underscore the importance of these premises. Central to NCLB's goal of closing the achievement gap by 2014 is the requirement that all teachers be highly qualified by the end of the 2005-06 school year. For new teachers, this means that they must meet existing state certification requirements and demonstrate mastery of the content area in which they teach, either by passing a content knowledge test or by having majored in the subject in an undergraduate or graduate program.

Achieving this goal is proving to be a challenge for states and districts. The 2004 estimates put the number of teachers who have not yet met the highly qualified standard at 20 percent in elementary schools and 25 percent in secondary schools (U.S. Department of Education 2004).

Yet a growing body of research shows why current education policies emphasize teaching and why it's important for states and districts to rise to this challenge. These studies not only provide insight into the characteristics of good teachers, they reveal how these contribute to student learning and closing achievement gaps.

6. Characteristics of an effective teacher

The following teachers qualities are related to higher student achievement are:

- Content knowledge: Effective teachers have a solid background in the subject area they teach as measured by a college major or minor in the field.
- Teaching experience: Teaching experience, typically five years or more, produces higher student results. Some studies further suggest that the effect of inexperience can be a significant obstacle to student achievement.
- Teacher training and credentials: Certified teachers are more effective than uncertified, particularly in mathematics. In general, teachers with emergency certificates don't perform as well as those with traditional certification. However, opinions conflict about the effectiveness of Teachers who enter classrooms with alternate certificates.
- Overall academic ability: Teachers with stronger academic skills perform better, whether these skills are measured by teachers' science scores, grade point average or selectivity of the college they attended.

7. Implications for closing the achievement gap

Research consistently shows that teacher quality—whether measured by content knowledge, experience, training and credentials, or general intellectual skills—is strongly related to student achievement: Simply, skilled teachers produce better student results. Many researchers and analysts argue that the fact that poor and minority students are the least likely to have qualified teachers is itself a major contributor to the achievement gap. It follows that assigning experienced, qualified teachers to low-performing schools and students is likely to pay off in better performance and narrowing gaps.

This is sometimes easier said than done. Some attempts to redistribute good teachers to low-performing schools have not been entirely successful. The most common strategy has been to offer pay increases or signing bonuses for teachers to come to high-need areas or to teach high-need subjects. Massachusetts, for example, offered a $20,000 signing bonus to attract qualified candidates into the teaching

profession. Yet even when the incentives were substantial, teachers have not always been willing to go to or to stay in difficult schools. Major drawbacks to these efforts were: (1) not enough attention to what was needed to retain teachers, and (2) too much attention to individuals and too little on schools (Liu, Johnson, and Peske 2003).

What these results mean is that incentives to work in hard-to-staff schools should also take into account the working conditions they provide for teachers. For example, low-performing schools often have weak organizational supports for teachers. Often they do not have a culture of high expectations for students and teachers or that values teacher learning, collegiality, and cooperation. Districts also need strategies to ensure that these schools have strong and resourceful principals and that teachers have sustained professional learning opportunities, including intensive long-term new teacher-induction programs, in which they can work with colleague to continually sharpen and upgrade their knowledge and skills. This research also suggests that scattering a handful of good teachers around the district is not going to produce wide-ranging results. One study has identified a teacher quality "tipping point" when the proportion of underqualified teachers is about 20 percent of the total school faculty. Beyond this point, schools no longer have the ability to improve student achievement (Shields, Esch, Humphrey, Young, Gaston, and Hunt 1999). Clearly, districts need to recruit, develop, and retain a well-qualified teaching force.

8. Toward a highly qualified teacher in every classroom

Problem still remain for research to answer. Most of the effective teacher studies, for example, have focused on elementary school. While a few studies suggest that the teaching effect is somewhat less in high school, a lot more needs to be discovered before we can make that statement with confidence. In addition, the conflicting findings on the effectiveness of alternate route teachers need to be resolved, especially since many districts rely on such non-traditional candidates to deal with teacher shortages. We also need to know more about the incentives and working conditions that will attract highly effective teachers to traditionally hard-to-staff schools.

But as this review has shown, there is already enough evidence to show unequivocally that good teachers are vital to raising student achievement and closing achievement gaps. The challenge in Sri Lanka is to ensure that every classroom is staffed by a skilled, qualified science teacher.

9. Discussion

Good teachers have a substantial effect on student achievement, especially when assigned to work with disadvantaged students.

- **Teacher quality more heavily influenced differences in student performance than did race, class, or school of the student**; disadvantaged students benefited more from good teachers than did advantaged students (Nye, Konstantopoulos, and Hedges 2004).
- **Achievement gains from having an effective teacher could be almost three times as large for African American students than for white students**, even when comparing students with the same prior school achievement (Sanders and Rivers 1996).
- **The effects of teacher quality accumulate over the years.** Fifth-grade math students in Tennessee who had three consecutive highly effective teachers scored between 52 and 54 percentile points ahead of students who had three consecutive teachers who were least effective, even though both groups had the same achievement rates prior to entering second grade. A similar study in Texas showed a difference of 34 percentile points in reading and 49 percentile points in math (Sanders and Rivers 1996; Jordan, Mendro, and Weerasinghe 1997).

Teachers with four characteristics, or dimensions, of teacher quality consistently generate higher student achievement: content knowledge, experience, teacher training and certification, and general cognitive skills.

10. Conclusions

The collected results show the pre service science effectiveness, besides other factors, depends on the learners´ outcomes type. This individual characteristics decides on the way how the teacher activates learner´s inner motivation, which then the learner integrates to the education process. The research emphasizied the fact that strong attention should be paid in the process of designing the lesson plan as they have substantial impact on the whole process of instruction (McKeachie, 1987). In accordance with the research aim, it was proved effectiveness significantly differs. The highest effectiveness was reached through learning activities. However, the validity of these results should be considered through limitations of the conducted research which are reflected in two main factors. The first one is that the period learners were exposed to practice teaching was relatively short (three months). The experimental method of the research is the second factor. In previous phases (years) learners were used to

exploiting them. Therefore, in this research good results were reached by learners who are able to quickly adapt to changing conditions, which is more suitable for dynamic situations. Reflecting this finding, the "inquiry-based" concept should not be merely limited to Science subjects (Edwards, 2012).

Teacher effectiveness is generally referred to in terms of a focus on student outcomes and the teacher behaviours and classroom processes that promote better student outcomes. This review, based upon research evidence, suggests that effective teachers:

- accesses a rich repertoire of instructional practices/strategies and applies them appropriately to the particular needs of his/her students aligned with the cognitive demand of the science content (pedagogical content knowledge),
- demonstrates proficiency in the use of measurement and data collection tools and techniques to gather, manage, analyze, and interpret data; including computer-based measurement devices, modeling tools and instructional supports to enhance student learning opportunities,
- accesses a rich repertoire of instructional practices/strategies and applies them appropriately to the particular needs of his/her students aligned with the cognitive demand of the science content (pedagogical content knowledge),
- creates learning environments where students are active participants in creating, questioning, sharing, discussing, reasoning and analyzing the processes involved in solving scientific problems/tasks,
- motivates students to achieve, and nurtures their desire to learn in an environment that promotes empathy, compassion, and a mutual respect both among students and between students and the teacher,
- nurtures and motivates student desire to learn and achieve and promotes empathy, compassion, and mutual respect among students and between students and teacher,
- encourages students to accept responsibility for their own learning and respects the right of each student to ask questions and to request resources to more fully understand, enhance, or add clarity to the learning,
- provides learning experiences that actively engage all students as individuals and as members of collaborative groups,
- displays effective and efficient classroom management (e.g., in facilitating cooperative groups, in use of equipment or hands-on materials),
- provides sufficient time in science class for students to engage in hands-on experiences and to make connections with these experiences and scientific principles,

- uses multiple methods and systematically gathers data about student understanding and ability (formative and summative assessments)
- uses student work/data, observations of instruction teaching, assignments and interactions with colleagues to reflect on and improve teaching practice,
- revises instructional strategies based upon student achievement data (short term and long term),
- uncovers students' prior conceptions about the concepts to be addressed and addresses students' misconceptions/incomplete conceptions,
- co-develops scoring guides/rubrics with students and provides adequate modeling to make clear the expectations for quality performance,
- guides students to apply rubrics to assess their performance and identify improvement strategies,
- provides regular and timely feedback to students and parents (focused, descriptive, qualitative) that moves learners forward,
- works with other teachers to make connections between and among disciplines to show how science is a part of other major subjects,
- possesses an understanding of a variety of technology appropriate to the content area, computer-assisted instruction, CBLs and probes for data collection, scientific and graphing calculators for middle/high school,
- integrates a variety of learning resources with classroom instruction to increase learning options for all students; these should include guest presenters, field experiences, and career explorations,
- effectively incorporates technology that prepares students to meet future challenges, as articulated in the Partnership for 21st Century Skills.

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