Research Highlights in Technology and Teacher Education 2011

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PREFACE

The 2011 book of the Society for Information Technology and Teacher Education is the third in the series. Once again, the articles in this collection are clear evidence that the field and our society continue to advance and mature.

We have organized the chapters this year into seven main sections:

Rethinking Pedagogy
Technology, Pedagogy and Content Knowledge (TPACK)
Integrating Newer Technologies
Blended and Distance Environments
Attitudes and Perceptions
Sharing Resources in a Networked World
Games

Over 80 articles were considered for publication. Of those, two review processes involving detailed edits and feedback resulted in 31 selections, which were then further shaped by the editors. We think you will agree that the result is an interesting and valuable record of the diversity of interests of Society members.

Next, we briefly outline the contents.

RETHINKING PEDAGOGY

David Gibson of Arizona State University and Gerald Knezek of the University of North Texas authored Game Changers for Teacher Education. This chapter introduces ideas for a new framework for teacher education based on Complex Systems Knowledge, and Global Flatteners.

Developing a HEAT Framework for Assessing and Improving Instruction is co-authored by Marge Maxwell of Western Kentucky University and colleagues Matthew Constant, Rebecca Stokbaugh and Janet Tassell. HEAT stands for Higher-order thinking, Engaged Learning, Authentic Learning, and Technology integration. The authors have developed an instrument based on these ideas and intended for use assessing instruction and lesson plans of pre-service and advanced teacher education students.

Problem Upon Problem: Integrating PBL Throughout a Computing Curriculum is the work of Samuel B. Fee from Washington and Jefferson College. This chapter discusses the use of Problem Based Learning to engage students in deep problem solving and independent critical thinking.

TPACK

Developing Secondary Mathematics Preservice Teachers’ Technological Pedagogical and Content Knowledge (TPACK): Influencing Positive Growth is by Jeremy Zelkowski from The University of Alabama. Zelkowski investigated the effectiveness of a secondary mathematics teacher education program in developing Technological Pedagogical Content Knowledge (TPACK) in preservice teachers who rarely used technology in their own K-14 mathematics coursework.

Testing a TPACK-Based Technology Integration Observation Instrument, by Mark Hofer from the College of William and Mary and colleagues Neal Grandgenett, Judi Harris, and Kathy Swan reports on successful efforts to construct a TPACK-based observation rubric. The instrument is available online.

Learning by Design: TPACK in Action. Technology Integration Preparation for Preservice Teachers is a chapter by Liangyue Lu and her colleagues at Syracuse University including Laurene Johnson, Leigh M. Tolley, Theresa Gilliard-Cook and Jing Lei. The authors present initial efforts to apply TPACK and Learning By Design in the design and development of a series of technology integration courses for elementary preservice teachers.
Developing a HEAT Framework for Assessing and Improving Instruction

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Abstract: Higher-order thinking, Engaged Learning, Authentic Learning, and Technology integration combine to form HEAT to boost the rigor of instruction to impact K-12 student learning. Through thorough examination of current research on each component, a HEAT Framework or instrument was developed for the purpose of assessing instruction and lesson plans of pre-service and advanced teacher education students. This article presents the theoretical background for the instrument as well as discussion of the levels and approaches for using the instrument.

Introduction

The trend of educational technology use is supplemental and often solely used for getting the attention of students. While teachers feel required to use technology due to state teacher standards, the technology use is dispensable. Similarly, as a need to satisfy university teaching standards, college instructors are perpetuating this problem by requiring technology to be “somewhere” in the lesson plans, not realizing that they are contributing to the trend. The International Society for Technology Education standards for Teachers (ISTE, 2008) and for Students (ISTE, 2007) advocate for a holistic and comprehensive approach to technology integration. Technology should be indispensable and inseparable from higher-order thinking, authenticity, and engagement in designing instruction.

The researchers believe in the potential to improve K-12 student performance through targeted levels of instructional design by pre-service and advanced teachers. One vehicle to infuse this potential is through the development of the HEAT Framework. (See Table 1.) The researchers use this instrument in scoring lesson plans developed by pre-service and advanced teacher education students at a southeastern university. The assertion is that as teachers design lessons at higher HEAT levels, higher K-12 student performance can be achieved. The HEAT Framework was originally based upon work by Moersch (2002) and expanded by the researchers using more current research studies. The HEAT instrument consists of six levels of performance for each component: Higher-order thinking, Engaged learning, Authentic learning, and Technology integration (see Table 1 for HEAT Framework). The following section describes the research and theoretical background of each component of the HEAT Framework.
<table>
<thead>
<tr>
<th>HEAT Levels</th>
<th>Higher-Order Thinking</th>
<th>Engaged Learning</th>
<th>Authentic Learning</th>
<th>Technology Integration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 0 Non-Use</td>
<td>• Lecture; Students taking notes only</td>
<td>• Teacher directed completely</td>
<td>• No connection to real world</td>
<td>• No technology use is evident by students or teacher</td>
</tr>
<tr>
<td>Level 1 Awareness</td>
<td>• Students learning at Remembering and Understanding level of Bloom’s Taxonomy</td>
<td>• Students report facts they have learned on tests or questions posed by teacher</td>
<td>• Non-relevant problems using textbook/ worksheets</td>
<td>• Teacher uses technology for demonstration or lecture</td>
</tr>
<tr>
<td>Level 2 Application</td>
<td>• Students learning at Applying level of Bloom’s Taxonomy</td>
<td>• Students are engaged in a task or activity directed by the teacher</td>
<td>• Learning experiences use real world objects or topics and provide some application to real world</td>
<td>• Minimal or no student technology use</td>
</tr>
<tr>
<td>Level 3 Exploration</td>
<td>• Students learning at an Analyzing, Evaluating, or Creating levels of Bloom’s Taxonomy</td>
<td>• Student choice for projects or to solve a problem posed by teacher</td>
<td>• Learning may be relevant to the real world or the past</td>
<td>• Technology use appears to be an add-on or alternative—not essential for task completion</td>
</tr>
<tr>
<td>Level 4 Integration</td>
<td>• Student-generated questions/projects at Analyzing, Evaluating, or Creating levels of Bloom’s Taxonomy</td>
<td>• Students are engaged in projects based on preferred learning styles, interests or passions</td>
<td>• Learning occurs in a simulated real-world situation such as a class store</td>
<td>• Technology is used for higher-order thinking tasks such as analysis and decision-making.</td>
</tr>
<tr>
<td>Level 5 Expansion</td>
<td>• Student learning/questioning at Analyzing, Evaluating, or Creating level of Bloom’s Taxonomy</td>
<td>• Problem solving based on student questions</td>
<td>• The learning experience provides real world tasks which can be integrated across subject areas</td>
<td>• Technology use is integrated and essential to task completion</td>
</tr>
<tr>
<td>Level 6 Refinement</td>
<td>• Student learning/questioning at Analyzing, Evaluating, or Creating level of Bloom’s Taxonomy</td>
<td>• Students partner with the teacher to help define the task, process, and/or solution</td>
<td>• Learning has a classroom or school emphasis and impact</td>
<td>• Technology use promotes collaboration among students for planning, implementing, and/or evaluating their work.</td>
</tr>
</tbody>
</table>

Maxwell, Constant, Stobaugh, and Janet Tassell
HEAT Framework

Higher-Order Thinking

There is great emphasis in today’s 21st-century landscapes for problem solving and open-ended challenges. Anderson and Krathwohl (2001) define higher-order thinking as “the mental processes that allow students to develop factual, conceptual, and metacognitive knowledge within the creative and critical domains.” Bloom (1956) provided the firm teaching and learning foundation from which most classrooms continue to operate. Defining and quantifying levels of student thinking, Bloom (1956) identifies Knowledge, Comprehension, Application, Analysis, Synthesis, and Evaluation levels. The model is designed to allow for foundational knowledge (knowledge and comprehension) in order to apply higher levels of thinking (Application, Analysis, Synthesis, and Evaluation) which integrate among and across content areas. Krathwohl (2002) recognizes the 21st-century need to better identify teaching strategies that may further engage learners thereby producing higher-level thinkers. Based on his researched observations, cognitive processes are better defined and observable based upon an expansion of Bloom’s work. The updated levels, then, include: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating (Krathwohl 2002). The proposed HEAT instrument focuses on the aggregate effect of the four variables (higher-order thinking, engagement, authenticity, and technology) to primarily focus on the Analyzing, Evaluating, and Creating levels of the Revised Bloom’s Taxonomy (Krathwohl 2002).

The Revised Bloom’s Taxonomy’s most notable difference from the original Bloom’s Taxonomy lies within the complexity of each cognitive level. In effect, the revised taxonomy moves into a two-dimensional model, whereby more specific types of knowledge, for instance, are identified and observed (Krathwohl, 2002). In the revised taxonomy, knowledge is specified by factual, conceptual, procedural, and metacognitive. As teachers plan lessons, this Knowledge level is identified and subsequently charted against the higher levels of the revised taxonomy. Kreitzer (1994) and his associates argue that there are more demands of knowledge than other levels might involve and thus must be delineated for the teacher. As the taxonomy further evolved, a cognitive process domain became more accepted for use. The Knowledge level, then, was replaced by Remembering and Understanding. Krathwohl (2002) and his colleagues believed this better described and captured students’ initial thinking processes. The Applying level remained with subdomains of executing and implementing. Analyzing, then, was described as breaking material into constituent parts and could be thought of in terms of differentiating, organizing, or attributing. Krathwohl (2002) also interchanged the original taxonomy Synthesis and Evaluation, and ultimately changed Evaluation to Creating. Evaluating, or making judgments based on criteria and standards, could be considered as checking or critiquing. The Creating level, according to Krathwohl et. al (2002), replaced the original taxonomy level of Evaluation and added an original student product or thought by generating, planning, and producing.

Liu Ru-De (2010) investigated the importance of companion resources in accommodating and leveraging higher-order thinking. Her study looked at the construction of word problems along with the availability of data collection software that also prompted and guided users (through feedback, tutoring, and reflection prompts). Students who were able to understand at a deep level were able to construct their own rationalizations, explanations, and extrapolations (Ru-De, 2010). Supporting a complete and radical change of today’s traditional education system, Ru-De (2010) believes reform steeped in Information and Communication Technology (ICT) will lead to knowledge creation and innovation, the top levels of thinking.

In Marzano’s exploration about delivering high-quality teaching and learning in the 21st-century classroom, cognitive thinking skills were identified and codified into writing techniques, thinking techniques, and general information processing strategies. Marzano reported positive results when coaching students to make inferences about processes. Inferential methods are routinely skipped or ignored by classroom teachers but are the foundation for higher-order thinking processes (Marzano, 2010). The learning target or objective of a lesson can be raised to higher levels of cognitive thinking. As teachers raise the learning target of a particular lesson, it can be argued that instruction has improved. When objectives, activities, and assessments are properly aligned at higher levels of cognitive thinking, not only has instruction improved but also student learning improves (Raths, 2002).
Engagement

Whether we realize it or not, teachers are preparing their K-12 students not only for the world they will face when they leave school (a world we know), but also for a future where technology will become significantly faster, more powerful, and much smaller (a world we can hardly imagine). The only way to succeed is to conceptualize learning in a new way, with adults and young people each taking on new and different roles from past teacher-directed methods. Today’s 21st century learners need to focus on new tools, finding information, making meaning, and creating. Teachers must focus on questioning, coaching and guiding, providing context, ensuring rigor and meaning, and ensuring quality results. Prensky (2010) calls this partnering—a 21st century method of students and teachers working and collaborating together to produce and ensure student learning while preparing them for a new and different future.

Partnering is the very opposite of teaching by telling. In the partnering pedagogy the teacher’s goal is to do no telling at all (at least to the whole class). The teacher needs only to give students, in a variety of interesting ways, open-ended, thought-provoking questions to be answered. Partnering teachers find that the process of students actively answering higher-level questions leads to higher engagement. The increased engagement typically produces better retention of material and higher test scores. Utilizing students’ passions and interests are the perfect routes and filters through which partnering teachers create individualized learning—learning that will stick in their minds, be valuable in their lives, and make them want more. In a partnering pedagogy we are all both teachers and learners who mutually respect one another. Students will do what teachers want them to do if teachers will do some of what students like. Mutual feedback on the partnering process is an opportunity for students to learn proper and effective methods of giving feedback and expressing opinions, especially when they are negative. (Prensky, 2010).

The degree to which teachers vary instructional strategies also plays a role in the level of engagement observed. Bogaert, Pressley, & Hawkins (2006) collected artifacts from ten sixth grade classrooms and categorized teachers into either highly-engaging, moderately-engaging, or low-engaging. Results indicated the teachers with the most variety of instructional strategies coupled with providing support for student independence and choice were the most engaging.

The level and complexity of the task given must also be considered when examining engagement. While small group collaborative work may be an effective instructional strategy, if the tasks are focused on procedures rather than higher-level thinking the cognitive engagement levels are low (Blumenfeld & Meece, 1988; Nystrand & Gamoran, 1991). Instructors, then, must carefully plan activities that incorporate cognitive demands and foster appropriate collaboration if the desired end result is higher cognitive, emotional, and behavioral engagement (Wu & Huang, 2007).

Authentic Learning

Marc Prensky (2010) makes a keen distinction between relevance and real. Relevance means that students can relate to something taught, or something said, to something they know. In other words, the context is familiar to them or happened in the past. Prensky posits that the problem with relevance is that it does not go far enough. Real means that there is a perceived connection by the students, at every moment (or at least as often as possible), between what they are learning and their ability to use that learning to do something useful in the world. Real learning not only relates content to current issues/events in the world today or the future, but it involves making a difference or having an affect on those current issues or events.

Making education real goes beyond teaching content just because it is in the curriculum. Instruction and content should relate to the students’ world in a real (not just a theoretical, relevant) way. Further, learning should not just be about the students’ world but about changing and improving their world. For example, history and social studies should be less about “what happened?” and more about “what can we learn or use from other civilizations, times, places, cultures, events, wars, and people to improve our own lives or the world?” Students need to relate math not to real-world or relevant math word problems but to “real” experiences actually taking place such as a bridge collapsing or being built (computing forces or stress), an election that’s taking place (probability, percentages, statistics), a space launch (trajectories, fuel consumption, rates of speed and acceleration), golf tournament (parabolas), baseball or football (statistics), or a song being recorded (timing, notes, compression, sampling rates (Prensky, 2010).
Teachers can help students make real-world connections with workers, practitioners, and outside “experts” as possible. These community or field experts can serve as models, guide in research, and assist with problem solving. (Prensky, 2010). Howard Gardner (2008) presents the “disciplined mind” as one that has mastered at least one way of thinking—a distinctive mode of cognition that characterizes a specific scholarly discipline, craft, or profession. “Without at least one discipline under his belt, the individual is destined to march to someone else’s tune.” For example, scientists observe the world; come up with tentative classifications, concepts, and theories; design experiments in order to test these tentative theories; revise theories in light of findings; and then return to the same process. Historians attempt to reconstruct the past from scattered and often contradictory fragments of information. Teachers’ feedback to students should also address students’ abilities to pick up the distinctive habits of the mind and behavior of the profession or “discipline” they are studying. Gardner further believes that it is essential for students to study the “gateway” disciplines of science, mathematics, history, and at least one art form. He poses that a course in history can open up the gates to a range of social sciences and one art form eases entry into others.

Splitter (2008) makes a case for educational authenticity being referenced from the earliest philosophical writings of Plato and Rousseau. Certo, Conley, Moxley, and Chafin (2008) reported students stated “un-authentic” assignments as completing worksheets or taking notes. These methods, according to them, precluded any kind of meaningful classroom dialogue. Instructional activities students recommend as lending to authenticity include: cooperative learning, role-playing, simulations, games, and technology-based work (Certo, et. al., 2008).

Utilization of context involves awareness of the makeup of the classroom and using that makeup to draw upon real-life experiences with specific intent to tie those experiences to the learning content (Lin 2006). In fact, the role of the teacher becomes more of a facilitator in an authentically-charged classroom (Renzulli, Gentry, and Reis 2004).

Technology Integration

Little research exists on the other three components in HEAT related to technology integration. Baylor and Ritchie (2002) qualitatively studied technology integration impact on teacher morale, perceived student learning, and higher-order thinking skills in classrooms. They found that three variables are important to consider in terms of student content acquisition: strength of technology leadership on the school level, teacher openness to change, and teacher non-school computer use all. The degree to which higher-order thinking took place in classrooms was predicted by teacher openness to change, the amount of individual technology use in creative situations, and the level of integration attempted within the classroom.

While researchers continue to make the case for the positive correlation between higher-order thinking skills and integration of technology (Agnew 2002; Lee 2002; Thomas 2002), making the exclusive connection remains difficult (Sherry & Jesse 2000; Trucano 2005). Sharma and Haigh (2008), in fact, conducted a case study in which computer integration and thinking skills were intended as isolated factors. However, they found the two extremely difficult to isolate when considering the varied and obvious environmental factors that had measurable effects.

The International Society for Technology in Education (ISTE) published the National Education Technology Standards (NETS) for Students in 2007. These standards support the holistic view of Technology integration found for the HEAT instrument by calling attention to: creativity and innovation; communication and collaboration; research and information fluency; critical thinking, problem-solving, and decision-making; digital citizenship; and technology operation and concepts. These standards have pieces that are directly related to the HEAT instrument document. Related to Higher-order thinking, a connection to Standard 1, Creativity and Innovation, is that students “created original works as a means of personal or group expression.” Another is “apply existing knowledge to generate new ideas, products, or processes. Also related to Higher-order thinking, in Standard 3, Research and Information Fluency, a connection to the HEAT framework T column for Technology integration is “process data and report results.” Related to Engaged learning, in Standard 2, Communication and Collaboration, a connection to the Technology integration on the instrument is made with “contribute to project teams to produce original works or solve problems.” Also, related to Engaged learning, from Standard 5, Digital Citizenship, the HEAT document connects with “exhibit a positive attitude toward using technology that supports collaboration, learning and productivity.” Related to Authentic learning, from Standard 4, Critical Thinking, Problem-Solving, and Decision-Making, three components relate to
Technology integration on the HEAT framework: “identify and define authentic problems and significant questions for investigation,” “plan and manage activities to develop a solution or complete a project,” and “collect and analyze data to identify solutions, and/or make informed decisions.” As a pure Technology integration connection, from Standard 6, Technology Operations and Concepts, the HEAT framework includes the essence of “select and use applications effectively and productively.” It appears that Standard 6 is what technology in the past would have encompassed.

HEAT Framework Levels

The HEAT instrument incorporates six levels of performance for each component: Higher-order thinking, Engaged learning, Authentic learning, and Technology integration (see Table 1 for HEAT Framework). The levels are as follows: 0 = Non-Use, 1 = Awareness, 2 = Application, 3 = Exploration, 4 = Integration, 5 = Expansion, and 6 = Refinement.

Several overarching themes began to influence the development of this HEAT Framework. One significant theme is whether the instruction is teacher-directed or student-directed. This is the separating line between levels 3 and 4 through all components. While the researchers believe and much of the research supports the interaction and almost inseparability of Higher-order thinking, Engaged learning, and Authentic learning, an attempt was made to keep the research and framework levels as pure as possible for those three components. The interconnections are then included in the discussion and the HEAT framework in the Technology integration component. The researchers pose that technology is a skill that supports and interacts with the other three components. Another important consideration is the emphasis that instruction must achieve a level three or higher on each component of the HEAT Framework. Across the components, level three includes the minimum of acceptable instruction: some higher-order thinking (Analyzing or higher even if it is teacher-directed), some student choice in projects or varied instructional strategies; some relevant (not real) world instruction; and students are using some technology to create a product or solve a problem. The researchers continue to emphasize that the Higher-order thinking component means Higher-order thinking with the content, not just the technology. Many teachers are impressed with the glitz of technology and think that just creating something with higher-order thinking. This framework views technology as a means or tool to create higher-order thinking with the topic or content.

The Higher-order thinking component is measured using the Revised Bloom’s Cognitive Taxonomy (1956). Levels three, four, five, and six all require the Analyzing or higher level of the Revised Bloom’s Taxonomy (Krathwohl, 2002). Other concepts that distinguish those levels include teacher or student-directed instruction, multiple indicators of learning, complex thinking (such as problem-solving, decision making, reasoning, investigation, and reflection) and a complex, open-ended learning environment. The instruction or lesson plans must be rated at the Analyzing level or higher (Krathwohl, 2002).

The Engaged learning component is based on indicators presented by Jones, Valdez, Nowakowski, and Rasmussen (1994) and Prensky’s partnering strategies. Indicators that distinguish among the levels include acceptance of multiple solutions, student choice in projects/assignments, student-student collaboration, student-teacher partnering, student-expert collaboration whether local experts or global experts.

The Authentic learning component levels are concerned with relevant or real learning (Prensky, 2010) as well as use of a disciplined mind. (Gardner, 2008).

The Technology integration component is primarily based on how technology is used by students, not the teacher. Other distinguishing indicators include how integral or necessary the technology is to instruction, promotes collaboration, higher-order thinking, and engagement. The complexity of the technology use, use of several types of technology, and use of technology as a seamless medium to solve real global issues are also indicators of the six levels.

Using the HEAT Framework

The HEAT Framework is taught in teacher education courses at both the pre-service and graduate level. Emphasis is placed on creating instruction where students must employ the Analyzing level or higher on the Revised
Bloom’s Taxonomy; alignment of objectives, instructional activities, and assessment; real world involvement; student-directed lessons (partnering with student and teacher); collaboration among students, teacher, and experts; and seamless technology integration. Lessons plans from pre-service and graduate courses are evaluated for each component of the HEAT Framework. Research is underway to determine the effectiveness of the HEAT Framework instruction, the instrument reliability, and improvement of lesson plan instruction of pre-service and graduate teacher education students.

This research has potential to improve K-12 student performance as pre-service and advanced teachers are called to higher levels of performance and design. One vehicle to infuse change is through challenging pre-service and advanced teachers to design lesson plans with a focus on HEAT. This research can be harnessed to design new indicators and descriptions of performance levels to challenge pre-service teachers to implement HEAT thereby increasing K-12 student performance. As teachers design more effective lessons, graduates should be able to better meet and exceed state teacher standards. The key is to combine the four components in teacher preparation programs at both levels—Higher-order thinking, Engaged learning, Authentic learning, and Technology integration. Technology should be indispensable and inseparable from higher-order thinking, authenticity, and engagement in designing instruction.

References


