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The role of teacher belief systems in technology integration

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Abstract

The belief systems of teachers are strongly correlated to their planning, instructional decisions, and classroom practices concerning technology integration. This literature review examines common teacher beliefs, teacher goals and knowledge, and teacher support and barriers regarding technology integration into 21st century classrooms. The characteristics of teacher beliefs analyzed in this review include existential presumption, alternative situations, affective and evaluative loading, and episodic structure. This paper reviews peer-reviewed journal articles, published since 1992, that discuss the role of teacher belief systems in technology integration. Research indicates teachers face barriers and need additional knowledge and skills that build on, and intersect with, their beliefs, technological content knowledge, technology integration content knowledge, and relevant knowledge of information and communication technology to produce effective 21st century learning environments.

THE ROLE OF TEACHER BELIEF SYSTEMS
IN TECHNOLOGY INTEGRATION

A Graduate Review

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Division of Instructional Technology
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Joni M. Walvatne

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The belief systems of teachers are strongly correlated to their planning, instructional decisions, and classroom practices concerning technology integration. This literature review examines common teacher beliefs, teacher goals and knowledge, and teacher support and barriers regarding technology integration into 21st century classrooms. The characteristics of teacher beliefs analyzed in this review include existential presumption, alternative situations, affective and evaluative loading, and episodic structure. This paper reviews peer-reviewed journal articles, published since 1992, that discuss the role of teacher belief systems in technology integration. Research indicates teachers face barriers and need additional knowledge and skills that build on, and intersect with, their beliefs, technological content knowledge, technology integration content knowledge, and relevant knowledge of information and communication technology to produce effective 21st century learning environments.

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Introduction

Zipi, Zippora, and Hadasa are all teachers who have been given a chance to integrate technology into their 21st century classrooms as part of a three-year study. Zipi has realist and behaviorist viewpoints. She believes that knowledge is given and absolute. Knowledge is gained by adopting an objective distance from the world. Hadasa and Zippora both have realist and relativist beliefs. This means that they view knowledge as both transmitted and cognitively constructed (Levin & Wadmany, 2008). The purpose of this review is to closely examine the definition and success of technology integration according to today's standards and the role teacher beliefs, like Zipi's, Zippora's, and Hadasa's play in integrating technology into 21st century classrooms.

Teachers have beliefs concerning their instructional methods in the 21st century, especially where technology is concerned. Teacher beliefs are connected with student success; therefore they play a critical role in 21st century education (Darling-Hammond, 1994). There is a need to determine the connections between existing belief systems and how teachers create teaching and learning environments, and if they can effectively integrate technology (Ertmer, Addison, Lane, Ross, & Woods, 1999; Ertmer & Park 2009). This review will examine common teacher beliefs, teacher goals and knowledge, and teacher support regarding technology integration in 21st century classrooms.

Researchers are exploring the belief systems of teachers and the strong relationship their beliefs have to their planning, instructional decisions, and classroom practices concerning technology (Chen, Looi, & Chen, 2009; Ertmer & Ottenbreit-Leftwich, 2010; Levin & Wadmany, 2008; Pajares, 1992). Research on the beliefs of preservice teachers provides teacher educators with important information to help

determine curricula and program direction (Pajares, 2010). Research supports the idea that teachers will always do what is best for students (Gorder, 2008). Doing what is best for students in the 21st century means implementing technologies and skills that coincide with teacher beliefs and blend with their curriculum (Behrstock-Sherratt & Coggshall, 2010).

This review explores three questions:

- What are the connections between existing belief systems and how teachers create 21st century learning environments?
- What are teachers' goals, knowledge, and beliefs regarding technology integration in the classroom?
- What are the barriers associated with technology integration in the 21st century classroom that affect teacher belief systems, and how can they be overcome?

Methodology

The sources used to write this review were obtained using several search engines. A search was completed using Google Scholar. The key descriptors and phrases used to facilitate the search were *integrating technology*, *barriers to technology integration*, *issues of integrating technology*, *pros and cons of integrating technology*, *teacher belief systems*, *teacher beliefs*, and *technology integration and teacher beliefs*. Using the University of Northern Iowa's, Panther Prowler, another search was completed. The databases used within Panther Prowler were Academic OneFile, Academic Search Elite, CQ Researcher, and Wilson Web. After selecting journal articles within the original databases, a search was accomplished by locating the articles in Google Scholar and Panther Prowler. Once these sources were located, they were evaluated based on relevance to the topic of the roles of teacher beliefs in technology integration.

These sources were selected to be part of the review based on three specific criteria. Relevancy was the first criterion. The article had to be pertinent to teacher beliefs regarding technology integration. The second criterion was authority. The sources had to come from credible journals and include noteworthy information, interviews with teachers, and quantitative or qualitative studies. The research studies were closely examined for the extent of the research and reliability. The third criterion was year of publication. The sources had to be less than 20 years old. Five resources were specifically selected due to the fact that they examined teacher belief systems in the 1990s, and how teachers in that era were looking at teaching and learning in the 21st century.

Reliability of these sources was proven through two specific means. The first proof of reliability was that all sources of this review were obtained from refereed digital

and paper journals. They were discovered using Google Scholar and the University of Northern Iowa's Panther Prowler extensive database. The second proof of reliability was done through source references. This process is known in some academic circles as "snowballing." The "snowballing" process was completed by reviewing the references found within the primary sources selected for this review. The reference sections of those sources were examined to determine if any of their sources would be valuable to this review. From this point Google Scholar and the University of Northern Iowa's Panther Prowler were used to search for the specific sources. There were specific areas of overlap, indicating reliability to the reviewer.

Analysis and Discussion

Teachers' beliefs regarding technology integration into the 21st century classroom play a role in learning. Technology can only be embraced as an effective learning tool when teachers believe that what they are being asked to do will work, and that it is the best solution to an identifiable educational problem (Ertmer et al., 1999). To integrate technology effectively teachers must have an understanding of what integration means. Along with examining today's understanding of what technology integration is, there are three specific areas that will be reviewed within the role of teacher belief systems in technology integration. These areas are: common teacher beliefs regarding technology integration; teacher goals and knowledge concerning technology integration; teacher support as they integrate technology into the 21st century classroom; and barriers teachers face as they integrate technology, such as resources, knowledge and skills, institutional issues, subject culture, and assessment (Pajares, 1992).

Understanding Integration

Technology integration has various definitions due to how people see it. The term does have a distinct meaning concerning how it is to be implemented. It is not taught as a separate class, but integrated into the classroom. It should only be a tool used to teach content. The content should not be created to fit technology. Technology integration depends primarily on the knowledge of the teacher and students on how to use technological tools.

Debra Rein (2000) suggests that technology integration can be classified into five levels. These are five different levels or stages that most teachers go through before achieving the ultimate goal of seamless integration. The first level is sparse or entry.

Technology is rarely used or available and students seldom use technology to complete assignments or projects. The teachers at the entry level are not comfortable using technology. They generally avoid using it themselves or with their students. Teachers at this level also rely on someone else within the school district to install updates and software on their classroom computers. The classroom computers in this situation are for students to use independently and are not connected to the curriculum. Rein reports that teachers at this level believe in direct instruction and whole class activities and are fearful that if they or their students use computers, something they do not understand or can manage will happen.

The second level is basic or the adoption stage. At this level technology is used or available occasionally. Usually at this level technology is located in a lab or on a cart rather than in the classroom. Teachers at this level are likely using one or two software applications that they personally find helpful. This software aids them in creating curricular materials or items for their classrooms. In this stage the teacher finds the computer or technology to be convenient for himself or herself. Students have access to computers and technology at this stage. They are generally comfortable at this level using one or two tools to create projects that show understanding of content (Rein, 2000).

The third level is comfortable or adaptation. At this level technology is used regularly. Teachers are beginning to make the transition to using technology as more than just a supplement to instruction. They are now looking at technology in regard to the context of their curriculum. Student assignments tend to still be uniform with the entire class receiving the same assignment. There is little opportunity for students to construct their own knowledge. However, students are comfortable with a variety of tools and are

capable of using them to show understanding of content.

The fourth level is seamless or the appropriation stage. At this level teachers begin to integrate technology for things that it does best. Teachers think of their curriculum objectives and choose the appropriate technology tools to accomplish them. Using technology tools in this manner with their students allows possibilities for higher order thinking, collaboration, cooperation, problem solving, and enhanced comprehension. Teachers have loosened up classroom management and student projects are rigorous, open-ended, and multidisciplinary. Students have access to technology daily, in a variety of ways to create projects that show a deep understanding of content (Rein, 2000)

The fifth level or stage is innovation. This is where the teacher becomes brave and breaks the traditional education mold. He or she has transitioned completely to making technology an ever present part of the curriculum. In this environment teaching and learning is not done in a conventional way. Students are very engaged in learning activities, which are presented through a variety of technology tools on a daily basis. They are allowed to construct their own knowledge and select the right technology tool to accomplish their goal or task. Learning is student directed. They are encouraged to go beyond the teacher's understanding of the topic and the uses of technology. Students feel open to share what they know with others and the teacher (Rein, 2000).

Technology integration happens in phases. It can happen in a positive or negative way depending on how it is being used within the classroom. Students and teachers alike need the opportunity to explore and discover within the world of technology and all its tools. Each technology tool is unique and may serve a specific purpose or a variety.

Teachers have to become familiar with technology and its tools before they can use those tools to provide meaningful learning opportunities in fundamentally different ways.

Teachers learn how to integrate technology within their classrooms through practice, reflection, and sharing of teaching practices (Collins & Halverson, 2009). Students have to be allowed to use the technology tools to construct their own knowledge, depicting a deep understanding of content (Hertz, 2011a).

Research has shown that teachers adopt technology at different rates depending on factors such as beliefs about technology and their individual skills with technology. For technology to be accepted and used in the classroom, teachers must see the benefits it has for their students (Herrington, Hodgson, & Moran, 2009). Teacher beliefs affect the technologies they choose to integrate into their classrooms and curriculum for several reasons. Technology promotes project-based learning, engages students, and requires that students use higher-order thinking, analysis, and problem solving skills (George Lucas Foundation, 2007). The quality of student work is better with the use of technology and a well-trained teacher whose beliefs help integrate it into the curriculum effectively (Dockstader, 1999). If technology is integrated effectively, the positives far outweigh the negatives. Students will be pushed through the use of technology to understand the content in a deeper manner (Hertz, 2011b). They have the ability to make deeper connections because technology provides access to a great wealth of knowledge. Technology is beneficial in the classroom because it allows access to knowledge without discrimination. Any style of learner can use technology for individualized purposes, to fit their unique needs (Hollowell, 2010).

These unique learning styles sometimes cannot be met through technology

integration for several reasons. First, it may be because the learner or the teacher does not have access to computers and other tools within the world of technology. Technology is very costly and always has to be upgraded so the costs never decrease (Hermitt, 2011). Many schools share technology with several grade levels, so access to technology when teachers want it can be limited. Technology integration for classrooms such as these becomes difficult due to the fact that the technology is not readily available on a consistent basis. Some students may not be exposed to technologies at home due to their socio-economic status and may rely fully on what the school can offer by way of technology to access information and complete homework (Hollowell, 2010).

Secondly, with the use of technology and specifically the use of the Internet, there remains the issue of students becoming distracted by other activities rather than focusing on accomplishing the tasks they were originally using the technology to complete (Hermitt, 2011). They may waste their time and end up having a problem if they do not have access to technology outside of school. The webquest for a unit on weather forecasting may not be finished before the due date and their grades will then be affected. Teachers may be frustrated by having to give students more time if they didn't use their class time with the technology well. Along with the issue of students not having access to technology outside of school, students will also have limited understanding of applications and their uses. Teachers will have to effectively teach students how to use the various technological functions, while at the same time provide a challenging learning environment for those students who have mastered the functions (Healy, 1998).

Finally, if districts are able to afford the costs of technology integration, often times they expect teachers to effectively use technology within the curriculum without

providing them with support and training (Alexiou-Ray, Wilson, Wright, & Peirano, 2003, Dockstader, 1999). Just because teachers may know how to use various technologies does not mean they know how to effectively integrate the use of them into their curriculum and classrooms. It also does not mean that they can teach students how to use technologies either (Shore, 2009). Technology must become part of the curriculum planning process so teachers can easily see the connections that can be made between content and technological tools (Ormiston, 2006).

Teachers require professional development on how to use technology in a productive and meaningful way while making connections between technology and their curriculum. This type of intensive professional development is costly and takes time. Many districts simply do not have the budget to provide teachers with the support needed to integrate technology effectively, so teachers are left to their own devices and some manage to achieve the seamless level while others never make it to the sparse level (Hertz, 2011).

Teacher Goals and Knowledge

Teachers' goals and knowledge play a role in every educational decision they make (Ertmer et al., 1999). The goals can be inherent to the teacher and consistent with his or her beliefs or they can be extrinsic and imposed on him or her by the school, community, or other stakeholders (Ertmer & Ottenbreit-Leftwich, 2009; Levin & Wadmany, 2006; Pajares, 1992). Chen et al., (2009) argue that coherency between a teacher's knowledge, goals, and beliefs and the affordance of the technology is the main key in integrating technology successfully in the classroom. They further state that teacher knowledge includes content knowledge, pedagogical content knowledge, and

knowledge of the students. Chen et al.'s study examined two teachers and the initiation, implementation, and maturation phases of the technology integration of Group Scribbles. They found the time necessary to advance from each phase to another varies from teacher to teacher. One teacher's goals during the initiation and implementation phases were to create a collaborative learning environment and give students freedom to express their solutions in their desired form. By the end of the maturation phase, she was successful at using a shared space for collaborative learning, and she successfully implemented multimodal expressions in her lessons (Chen et al., 2009). The second teacher's goals were different from the first teacher's goals due to the fact that her knowledge of technology in general was higher. She moved faster and remained stable through the three phases. Her goals in the initiation and implementation phases were to create a collaborative environment and to give students freedom to express their solutions in their desired form. By the maturation phase she was ready to learn as much as possible about integrating Group Scribbles so that she can be an independent user. The researchers walked away leaving her in charge of training other teachers how to integrate the Group Scribbles technology.

Teachers are hesitant to incorporate technology into the classroom and set goals for student learning because of their lack of relevant knowledge regarding technology (Ertmer & Ottenbreit-Leftwich, 2009). In order to use technology effectively in the classroom, teachers need additional knowledge and skills that build on, and intersect with, technological content knowledge, technology integration content knowledge, and relevant knowledge of information and communication technology. Therefore, teachers need an adequate amount of support as they struggle to acquire the knowledge to

effectively integrate technology into 21st century learning environments.

Teacher Support

Teaching with technology requires teachers to acquire knowledge of the technology itself and how to use the tools in multiple aspects of planning, implementation, and evaluation processes (Ertmer & Ottenbreit-Leftwich, 2009). Teachers need diverse teaching experiences so that they can enter their classrooms with an extensive range of abilities and an associated positive belief system (Levin & Wadmany, 2008).

Technology integration in the 21st century depends on positive belief systems of teachers. School leadership affects teachers' belief systems. When planning professional development, it is recommended that teachers learn from experts, colleagues, and self, and experience different learning settings. Teachers need help to gain personal experiences that are successful. This means they need to achieve personal mastery. The more positive experiences they have with technology, the more confident teachers will feel about integration. Many teachers made the decision to teach because of their desire to use their knowledge and experience (Behrstock-Sherratt & Coggshall, 2010). Teachers need to be given the chance to use this knowledge. Teachers need support in the following ways: time to familiarize themselves with the tools that make up technology, time to examine their needs, opportunities to collaborate with knowledgeable colleagues, access to suitable models, and the ability to participate in a professional learning community (Healy, 1998). If teachers are supported in these ways, their belief systems will likely be positive towards technology integration in the 21st century classroom (Simkins, Vodicka, & Gonzales, 2009).

Common Teacher Beliefs

Teacher beliefs are shaped by context of institutions, the profession, and personal experiences (Ertmer & Ottenbreit-Leftwich, 2009; Levin & Wadmany, 2006). Beliefs are difficult to distinguish from knowledge and previous efforts have identified four characteristics of beliefs. Those characteristics are existential presumption, alternative situations, affective and evaluative loading, and episodic structure (Pajares, 1992).

Existential presumptions are viewed as absolute entities that exist beyond individual control or knowledge (Ertmer et al., 1999; Pajares, 1992). An example of existential presumptions can be seen in a longitudinal study completed by Levin and Wadmany, who studied teachers' views on factors affecting technology integration. In this study lasting three years, teachers were given open questionnaires, interviews, and were observed using technology in the classroom. They were provided with technological equipment, professional development strategies, student and teacher learning activities, and had an advisory team of educational technology experts. Zipi was a teacher in this study, who believed knowledge is given and absolute, and that it is gained by adopting an objective distance from the world. Zipi was provided with technologies to integrate into her classroom. The hope was that she would be successful at integrating technology into her lessons and emerge with a more constructivist ideology. Unfortunately, her beliefs at the end of the study still held knowledge as being given and absolute rather than knowledge being transmitted and cognitively constructed (Levin & Wadmany, 2008).

Alternative situations are an individual's attempt to create an ideal situation, which differs from reality (Pajares, 1992). Referring back to Zipi, she was the teacher who changed superficially, or the one who had a low level of reflective behavior, a low

tolerance of ambiguous situations, and a high tolerance for dissonance (Levin & Wadmany, 2008). She thought she actually had effectively integrated technology into her classroom. In reality she was still using direct instruction and using technology as a supplement.

Affective and evaluative loading happens when teachers teach content according to the values of the content itself. Affect and evaluation determine the amount of effort teachers will devote to an activity and how they will apply it (Pajares, 1992). The ways in which teachers integrate computers into classrooms are mediated by their interrelated belief systems about learners (Ertmer & Ottenbreit-Leftwich, 2009). This means if teachers evaluate a given technology and determine it is an effective learning tool, then they will make it applicable to their content (Behrstock-Sherratt & Coggshall, 2010; Ertmer et al., 1999; Ertmer & Park, 2009). Therefore, if teachers evaluate a given technology, such as Google Docs, and see how students are using it to effectively to demonstrate content knowledge of the six plus one traits of writing, teachers will use Google Docs continually in their classrooms (Cuban, 1986). They are affected by Google Docs and are now effectively teaching the content of writing by integrating technology, which in this scenario is Google Docs.

Episodic structure deals with material gained from experience or cultural sources of knowledge. Teachers struggle with cultural pressure, which is the internal representation of knowledge that results in outward effects on the world. Teachers' beliefs appear to interact with the existing culture to create action (Pajares, 1992). This means teacher beliefs are affected by the pressure to belong, an experience that reappears

in the form of norms and values within work and social constructs as adults (Ertmer & Ottenbreit-Leftwich, 2009).

Teacher beliefs are affected by fear of using technology. On the outside, it may seem that teachers have poor attitudes regarding use of technologies. However, generally speaking this is only external. Teachers who display this behavior are normally those teachers who do not have the self-confidence to forge ahead and explore in the world of technology (Ertmer et al. 1999). This could be caused by lack of knowledge or time. This fear can cause them embarrassment, especially if they lack knowledge of how to use the technology. They may not always seek help to understand what they do not know. They may also see benefits of using technology, but feel afraid that they are no longer going to be needed by their students as they have in past. This means that teacher attitudes at this point intersect with their beliefs and can cause confusion and a barrier to technology (Judson, 2006). Teachers will not integrate technologies if they are not consistent with their personal educational beliefs (Ertmer et al., 1999; Levin & Wadmany, 2006).

Barriers Affecting Technology Integration

Teachers face barriers when integrating technology. Some barriers can be easily overcome while others take time. This review previously examined teachers' attitudes and beliefs regarding technology integration and now will examine just how these attitudes and beliefs become barriers. However, attitudes and beliefs are only one barrier of technology integration. According to research done by Foon Hew and Brush there are many more barriers teachers encounter while integrating technology into their classrooms. Previous studies have identified five more barriers besides teacher attitude and beliefs. These barriers include resources, knowledge and skills, institutional issues,

subject culture, and assessment (Foon Hew & Brush, 2006).

Resources

Teachers often face a lack of resources. This has been true in the past and is still true in the 21st Century classroom of today (Rotherham & Willingham, 2010). Lack of resources may include not having technology, lack of access to technology, time constraints, and limited technology support. If teachers do not have adequate technology resources, they will struggle when integrating technology into their curriculum. Even if they do have technology resources available, often times they share them within the school building and sometimes the district. This means they have to sign up weeks in advance to have a particular technology available to them at a given time. Teachers and students will struggle to even be able to use these technologies consistently in these example circumstances.

Lack of time becomes an issue, not only when signing up to reserve technologies, but also when researching and previewing websites and other technology tools that may be utilized in multimedia projects. Since technology should be used as a tool within curriculum integration, teachers must spend an adequate amount of time preparing lessons that include technology use. They must have a specific plan with specific technologies in mind before presenting the lesson to students. If they present the lesson prematurely, then they risk students playing around with the technology or surfing sites not intended to be used within the lesson. Teachers need to be the facilitators when it comes to technology and preparation is a major part of this role. Thus, teachers often have to do this preparation outside of school hours. This means late nights outside contracted hours.

Finally, a lack of technical support can also influence whether technology integration will be successful. Not all teachers are technologically savvy. Teachers' levels of technological abilities range as previously stated, from beginning, which would be likely at the sparse level, to expert, which would be at the seamless level. Teachers especially need technical support when they first begin integrating technology into the curriculum and their classrooms. It is equally important that this support continue throughout the process until the teacher becomes an expert. Even at the expert stage, there will continue to be a need for technical support, largely due to computer maintenance, but the need will be lessened considerably because the teacher will have the experience and confidence to handle issues and develop new lessons using technology. Another barrier within technical support is the lack of technicians available to help. School budgets often dictate how large the number of technical personnel can be. Without an appropriate number of technical staff available to assist teachers in technology integration, the timing to integrate will be considerably longer. They cannot respond to teacher requests quickly, nor can they devote a lot of time to teaching teachers how to use technology resources (Foon Hew & Brush, 2006).

Knowledge and Skills

The second major barrier facing technology integration is the knowledge and skills teacher's possess. As stated previously in this review, a teacher's knowledge and skills regarding technology determine their attitudes and beliefs concerning technology integration. This section of the review will specifically look at specific knowledge and skills teachers lack and how it affects technology integration into the

classroom and curriculum. The specific knowledge skills affecting technology integration are not only the lack of teacher's knowledge and skills concerning technology, but also technology-supported pedagogical knowledge, and technology-related classroom management knowledge as well (Collins & Halverson, 2009).

Teachers' lack of knowledge and skills concerning technology limits them when it comes to integrating technologies into their curriculums and classroom. The only way to solve this dilemma is to provide adequate technology support for teachers as previously mentioned (Hoffman, 1997). The issue of lack of technology-supported pedagogical knowledge is another issue altogether. It can be categorized in three technology functions. These functions are replacement, amplification, and transformation. Technology as replacement involves technology allocating itself as a different representation to the same instructional goal. An example of this could be a teacher using an iPad to have students practice writing lowercase letters instead of writing it on paper. The instructional goal remains unchanged. Technology as amplification involves the use of technology to complete tasks more efficiently and effectively without changing the task. An example would be students writing a paper using Google Docs and then submitting them to one another for editing. The task was to edit the document and the students are able to peer edit without having to actually rewrite the paper multiple times to include others' changes. Technology as transformation provides inventive educational opportunities by helping to reorganize students' cognitive processes and problem-solving activities. An example of transformation would be students using software to create and solve real world problems. Transformation cannot take place, no matter how innovative it could

possibly become, when teachers are not aware of the software or technology available to use within the curriculum or have the knowledge to aid students as they use it (Foon Hew & Brush, 2006).

Classroom management in relation to technology integration becomes vitally important as teachers have to be equipped with technology-related classroom management skills, so they can effectively organize opportunities to utilize technologies. Teachers also need to familiarize themselves with technology problem-solving skills in case problems arise when students are using the technologies. If teachers are provided with training and given time in which to use the training they have had, teachers will most likely be successful in transitioning their knowledge and skills in a positive way to technology integration (Foon Hew & Brush, 2006).

Institutional Issues

Schools or institutions themselves provide barriers to integrating technology. This seems strange that institutions supporting integrating technology into their districts' curriculums and classrooms would provide their own barriers to the very success integrating technology may have upon their district. However, it happens and is done unknowingly through three specific channels. These channels consist of leadership, school schedule or structure, and school planning. Leadership deals with the institutional administration. Sometimes, like teachers, administrators do not always understand technology, how to integrate it, and how to create policies that will effectively utilize technology to its full capacity. School schedules provide a barrier to integrating technology because the times are not flexible. Some students only have limited times to use technology since most classes are shorter than an hour. Then

they move on to the next class. Students may not have access to certain technologies outside of that particular class. This creates a domino effect, which looks a little like the following: teachers have to allow more time for students to complete tasks, which in turn affects the amount of content that can sometimes be covered. Content affects how students perform on tests, which in the long run ends up affecting the school district. Scheduling relates to planning in the way that schools sometimes make policies for integrating technology without planning on how to execute the policies. This means that some institutions purchase and install technologies with no plan for how to use them effectively with their students (Foon Hew & Brush, 2006).

Subject Culture

Institutions are each distinct in the culture they present to the surrounding community of which they are a part. This happens within institutions as well concerning the various subjects that are taught. These subjects make up a climate within the institution known as the subject culture. The definition of subject culture refers to a set of institutionalized practices and expectations, which have grown up around a particular school subject, and shapes the definition of that subject as a distinct area of study (Foon Hew & Brush, 2006). An example would be an institutional expectation of students to use an online reading program to build reading fluency and a teacher choosing to continue to build fluency by reading particular passages from a book. She would have a viable excuse for choosing not to use the technology because her way works to build fluency too. This teacher would not be helping his or her institution to integrate technology successfully into the

reading curriculum, which is where the barrier might lie, but would still be providing a way for students to increase their fluency (Ertmer & Ottenbreit-Leftwich, 2009).

Assessment

Assessment is another barrier affecting technology integration. It is defined as the activity of measuring student learning. Teachers often feel pressured to use high stakes tests known as summative assessments. There are two forms of assessment. The first is formative, which is the type of assessment teachers use on a daily basis to determine if students comprehend the information being taught. It can be as simple as an observational checklist. Formative assessments are normally left up to the teacher to decide when and how to use them.

Summative assessments refer to the assessment of learning and summarize the development of learners at a particular time. A summative assessment would be the Iowa Test of Basic Skills. Summative assessments are generally administered according to grade level, but some tests, such as the ACT, were not developed in this format. The district or the state usually decides which summative assessments need to be administered.

Teachers often feel pressured by high stakes testing due to the fact that this type of testing usually carries serious consequences for students and teachers alike. For students, these consequences may be promotion or graduation. For teachers, it may affect them in the area of rewards and sanctions. Sometimes these tests affect teacher pay as well. It takes time to teach the broad concepts and skills covered by high stakes testing. This leaves little room to teach with technology. Technology is not viewed as

a tool to prepare students for these tests, but rather as a means to administer them (Foon Hew & Brush, 2006).

Overcoming the Barriers Affecting Technology Integration

Changing teachers' beliefs allows them to progress through levels of integration. If they have the support, time, and resources, their beliefs are positively affected, thus allowing for quicker passage through the levels due to the barriers being removed. This review has examined how teachers' beliefs affect technology integration. Theodore Kopcha (2008) presented a systems-based mentoring model of technology integration that is researched based. In this model, there are four main stages consisting of initial setup, teacher preparation, curricular reform, and community of practice. These stages need time to develop and each teacher will differ in the amount of time needed to cycle through each stage. Their beliefs and barriers affect progression through the levels of integration. Teacher beliefs are always changing, especially since barriers tend to occur frequently. As previously stated, teacher beliefs tend to change as the barriers are overcome. How effectively teachers integrate technology into their classrooms depends on the technology at times, too. If the technology works for them, the integration process will take less time, and often be used effectively. Teachers integrate technology better with the support of other teachers, or what Kopcha calls mentors. This may be someone who has reached the seamless level of technology integration. These teachers act as mentors and are available to support their colleagues as they overcome barriers, such as lack of time, troubleshooting problems with technology, and learning how to effectively integrate technology into the classroom. If technology is going to be successfully integrated into 21st century classrooms, it must be allowed to be a gradual process done

with enough support to ensure that teachers and students alike are prepared to effectively use technology and its tools. This support may come in the form of help from a colleague operating at the seamless level, technology staff, or professional development. If this process is done gradually, teachers' beliefs have a chance at a positive progressive change towards technology integration. Often times their beliefs regarding technology integration are negative due to certain barriers. These barriers are specifically teacher resources, teacher knowledge and skills, institutional issues, subject culture, and assessment. These barriers have been previously outlined in this review, but there is now a need to determine how to help teachers get past these obstacles. Research implies it is essential for teachers to overcome these barriers. When this happens, teachers will allow their beliefs to change and be able to provide the opportunity for themselves to successfully integrate technology into their classrooms.

The first barrier to overcome is the issue surrounding teachers and their lack of technology resources. If teachers' technology needs are not met with adequate resources, their belief systems are affected. There are strategies available to overcoming the lack of technology, lack of access to technology, and lack of time. First, one must decide which resources are absolutely necessary. Introducing technology into one or two subject areas at a time ensures that teachers and students in those areas have adequate access to technology. This may mean only certain grade levels are able to access certain types of technology until more is available. Developing a hybrid technology setup in classrooms that involve cheaper computer systems can also help solve the issue of the lack of technology. Using laptops with wireless connections can save building maintenance costs

of computer labs, thus allowing more funds to be available for other technologies (Foon Hew & Brush, 2006).

Teachers often do not have access to technology and this becomes a barrier that affects their beliefs. Putting technology directly into the classrooms rather than centralized locations allows access whenever the time is right, rather than whenever available. However, if this is not possible to achieve, and if there are any classroom technologies such as computers available, then a rotation schedule for each student to have access can be created. The next issue within the resource barrier surrounds the lack of time teachers have within the school day to devote to technology integration. This can be solved by allowing teachers to collaborate and create technology-integrated lessons, using the TPaCK model (Mishra & Koehler, 2008). The last issue associated with the resource barrier concerns the lack of technical support some teachers are given. This can be solved by allowing students to help other students and teachers with the various technology issues that arise (Foon Hew & Brush, 2006).

The second barrier to overcome is a teacher's level of knowledge and skills. Many times institutions are the ones that support teachers in their professional learning endeavors. They provide the professional development opportunities, but they do not control how teachers learn and what teachers learn on their own time. They may support teachers in their self-study, but they do not have the right to mandate what teachers must learn unless the institution is paying for the education. A study previously referred to in this review, completed by Chen et al., (2009), concluded that coherency between a teacher's beliefs, goals, and knowledge and the affordance of the technology is the main key in leveraging the technology successfully. This study investigated the different

knowledge goals and beliefs of two teachers in an elementary school as they integrated a technology called Group Scribbles. They discovered that the time required to progress from each phase to another depends on the teacher. The two teachers had a different trajectory with different initiation, implementation, and maturation phases. In fact, Chen et al., (2009) noted that, not only are the trajectories unequal, but it is not always true that teachers will exhibit progress in integrating technology. Sometimes teachers will actually regress in their knowledge and skills. They also discovered that it is possible to progress through multiple states in the implementation stage and never arrive at the maturation stage. This is a barrier and to overcome it support is needed from administration, other teachers, and researchers. This support remains a vital factor in overcoming the knowledge and skills barrier to technology integration. It also is imperative to have if teachers are to develop the competency to effectively integrate technology.

The third barrier to overcome is institutional, which in turn, affects teachers. Providing the hardware without adequate training in its use and in its endless possibilities for enriching the learning experience leaves the great promise of Internet technology unrealized (Solomon & Schrum, 2007). It is important for institutions to help teachers change their beliefs. The federal government published the National Educational Technology Plan in 2004, which lists seven steps and recommendations for technology integration within institutions. This plan is designed to help overcome the institutional barrier previously mentioned in this review, which affects teacher beliefs regarding technology integration. Table 1 notes the five steps and recommendations of the 2004 National Educational Technology Plan.

Table 1.
Seven Steps and Recommendations of the 2004 National Educational Technology Plan

Steps	Recommendations
Step 1: Strengthen Leadership	Hiring of tech savvy administrators and technology specialists to aide in the process
Step 2: Innovative Budgeting	Creative financial plan for a district wide initiative 1:1 Example: 1:1 Computing
Step 3: Improve Teacher Training	Professional development is ongoing and meets the needs of the institution's teachers
Step 4: Support e-Learning and Virtual Schools	Expanding curriculum to include online and virtual communities
Step 5: Encourage broadband access	Institutions need to be capable of supporting large amounts of Internet based technology
Step 6: Digital Content	Institutions becoming paperless environments
Step 7: Integrating data systems	Systems designed for institutional purposes of integrating technology

Teacher beliefs are often affected by the institutions in which they are associated (Hoffman, 1997). A study completed by Eugene Judson (2006), which examined how teachers integrate technology and their beliefs about learning, demonstrated that teachers' beliefs about instruction do not necessarily resonate in their classroom practices while integrating technology. Teachers must choose to attempt to use technology on their own, but they need support provided by the institution to integrate technology effectively. Teachers need strong leadership from the school board, district, and administration to overcome this barrier to integrating technology. Institutional leadership is important because to succeed, teachers should be using technology, not only because they choose to, but also because they perceive that their institution expects it of them.

Teachers already deal with daily problems of time, space, supervision, and access, and learning something new often times can be very overwhelming. This is why it is so valuable to teachers to be provided with effective professional development by their institutions. Effectively integrating technology is a very long process. Teachers are

trained to be professionals. To be successful where technology is concerned, they must provide some measure of self-study. This may mean attending conferences, workshops, and classes recommended by their districts on their own time with their own finances. Districts will often provide inservice courses, on-site consultant instruction, and coaching from other teachers, but often it is not enough. Teachers need the extra support in the way of self-study. Technology integration research estimates that teachers need five to six years of specific technology integration professional development. These specifics include how teachers can use technology as a tool for productivity, how to integrate technology into individual classrooms, and how to make wise decisions for purchasing and using technology. Effective technology professional development leaders structure individual inservice classes with a specific curricular focus and application, and give teachers opportunities to examine and use software that develops higher order thinking and problem-solving skills (Judson, 2006).

Judson's study indicated that technology professional development content should always parallel teachers' interests or needs. It must be specific to the goal of integrating technology in a constructivist manner. The emphasis needs to focus on the rationale of constructivism and not on forcing the use of technology. Often teachers start using technology because it is expected of them, but they continue to use it and develop their skills when they make personal connections with it. Teachers are motivated to use technology when they perceive technology as expanding student learning, experiences, capacities, and productivity. Teachers also are motivated when technology helps them teach more effectively in the sense that their lessons are more engaging, motivating for students, relevant, reinforcing, and applicable to the real world (Hoffman, 1997).

Along with professional development, teachers need the technology available to them for use when they need it. If teacher beliefs are to change and technology integration is to be successful, the technology needs to be available and working. Many schools are choosing to go one-to-one with either a tablet or laptop in the 21st century classroom (Levinson, 2010). This is largely due to the fact that institutions are seeing the need for students to have a computer or device that connects them, not only to the online world, but also ensures they each have equal opportunities to learn and complete homework. Whether institutions decide to go one-to-one or keep their computer labs, it is vitally important that they provide easy access to computers and other technologies to reduce barriers to using it. This does not mean that teachers are going to change their beliefs about using the technology, but it will at least not be a barrier for them using it. Teachers determine how the technology is used within their classrooms and how often. This makes them a key determinant in technology implementation, hence the reason why institutions need to support teachers as they integrate technology into their classrooms. The end result is always about student learning, and teachers are once again a key determinant where they are concerned (Judson, 2006).

Overcoming the subject culture barrier will help teachers to integrate technology. Subject culture mainly affects institutions and the climate within. However, teachers are a part of that climate and their beliefs regarding technology are influenced by what is around them. A positive environment towards technology generally means positive beliefs, while a negative technology environment equals a negative belief system. The institution sets the atmosphere for how teachers, administrators, staff, students, and the community work together. Institutional leaders should create a vision and technology

integration plan with teacher participation. Teachers play an important role in subject culture and its effect on technology integration because they are the ones who will use various technology tools within their curriculum and instruction. A study completed by Ertmer et al., (1999) observed that lack of equipment was a barrier for several of the teachers, but particularly for Lola. Lola did have computers but because she did not have enough for her students, did not use them to the extent she could have. Here one can see not only a subject culture and institutional barriers, but one of knowledge and skills too. These barriers can be overcome in two possible ways, starting with acquiring knowledge and skills. Professional development provided by the institution and effectively delivered should help Lola develop the knowledge and skills she needs to extend her curriculum, even with the limited amount of computers. Lola could also write a grant to acquire more computers, thus reducing the subject culture and institutional barriers herself.

According to Foon Hew and Brush (2006), institutions could introduce technology into one or two subject areas at a time to ensure that teachers and students have the adequate technology and access to the technology. As noted with Lola's situation, teacher skills are part of overcoming the subject culture barrier. According to research done by Foon Hew and Brush, professional development to increase teacher knowledge and skills has three essential overlapping facets. These facets insist that professional development be appropriate to the needs of teachers and classroom practices, provide opportunities for teachers to engage in active learning, and focus on technological knowledge/skills, technology-supported pedagogy knowledge/skills, and technology-related classroom management knowledge/skills training. If institutions provide adequate professional development to their faculty and staff regarding

technology and support them in using it, then the subject culture is benefitted in a constructive way. Teachers will most likely be willing to attempt new technologies with their students and within curriculum because they know they have institutional support (Ertmer & Ottenbreit-Leftwich, 2009).

The final barrier is assessment. Research shows that there is little reasoning to invest heavily in curriculum and human capital without also investing in assessments to evaluate what growth is or is not occurring in the classroom. Schools do not have the assessments adequate enough to measure accountability and equality. Schools need assessments that are reliable and comparable between students and schools. Teachers need these assessments to evaluate students for growth and learning needs (Rotherham & Willingham, 2010). In their study of barriers and strategies to overcome barriers of technology integration, Foon Hew and Brush (2006), recommend closely aligning the technology to state curriculum standards. They also noted there was a need for more research to be completed on new ways to assess students' multimedia work. By using appropriate assessments, which are both reliable and valid, teachers are able to understand how students learn specific content and how specific instructional practices support the learning process (Ertmer & Ottenbreit-Leftwich, 2010).

Conclusions and Recommendations

This review asked three questions. What are the connections between existing belief systems and how teachers create 21st century learning environments? What are teachers' goals, knowledge, and beliefs that support technology integration in the classroom? What are the barriers associated with technology integration in the 21st century classroom that affect teacher belief systems? This review considered teachers' goals, knowledge, and beliefs concerning technology integration in the K-12 classroom. It specifically examined barriers teachers face and common teacher beliefs regarding technology integration, teacher goals and knowledge concerning technology integration, and supporting teachers as they overcome barriers to integrate technology into the 21st century classroom.

Teachers need additional knowledge and skills that build on, and intersect with, technological content knowledge, technology integration content knowledge, and relevant knowledge of information and communication technology to use technology effectively in 21st century learning environments (Ertmer & Ottenbreit-Leftwich, 2010). Teachers' goals, knowledge, and beliefs concerning technology integration in the classroom are all interrelated to one another. Teachers' knowledge of technology affects their goals and beliefs for implementing technology (Ertmer et al., 1999). Teacher beliefs are shaped by context of institutions, the profession, and personal experiences (Levin & Wadmany, 2006). These contexts can also become barriers, which affect whether a teacher will view technology integration in a positive or negative manner. The four characteristics of beliefs examined in this review are existential presumption, alternative situations, affective and evaluative loading, and episodic structure (Pajares, 1992).

If teacher beliefs are to have a positive influence on technology integration, then they need to feel successful. Teachers need support as they integrate technology into their classrooms. This support can come from a variety of resources, administration, colleagues, mentors, and technology support personal. Teachers need time to integrate technologies. They need the time to gain perspective to what and where technology tools can be used in the content they teach. They need to familiarize themselves with the tools that make up technology and have opportunities to collaborate with colleagues and share what they are learning. If teacher support of technology is not in place, then teacher beliefs will be negative and their desire to integrate technology will remain low. Often times their beliefs regarding technology integration are negative due to specific barriers. These barriers are teacher resources, teacher knowledge and skills, institutional issues, subject culture, and assessment. When these barriers are removed or compensated for, teacher beliefs are shown to become more positive in nature and entry-level technology integration can begin to take place within the classroom.

This review can be used to support teachers as they seek to integrate technology into 21st century learning environments. It can be used to acquire an understanding of teacher viewpoints and open doors for collaborative efforts between schools, teachers, and the world of technology. This review is also beneficial when working with teachers to help them understand their own belief systems. This reviewer recommends that future research be done on how to effectively help teachers, use the TPaCK (Technological Pedagogical and Content Knowledge) model as they integrate technology into their 21st century classrooms (Mishra & Koehler, 2008). There is little research done about how TPaCK can change teacher beliefs and help them overcome barriers of technology

integration. TPaCK has the potential to lead teachers in effectively integrating technology by helping them join technology, pedagogy, and content knowledge. The reviewer acknowledges that TPaCK can be modified at each educational level. Whether or not it changes the beliefs of teachers will need to be researched at each level. It would be beneficial to examine how assessment fits into the TPaCK model. A study could be done to determine if teacher beliefs change regarding assessment when they use the TPaCK model to integrate technology.

Future research could be done on how teachers change their beliefs as they integrate technology. Research is needed on how teacher beliefs impact decision making when it comes to choosing which technology tool to integrate into their teaching and learning environments. Due to little research on strategies for overcoming the subject culture barrier, this review is recommending that future studies be completed to develop those needed strategies. Finally, there is a need for research surrounding new avenues of assessing students and multimedia work (Foon Hew & Brush, 2006).

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