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Abstract

The purpose of this article is to introduce a comprehensive instructional model that takes into consideration three frameworks for designing instruction (Universal Design for Learning, Understanding by Design, and the 7E Learning Cycle) and incorporates Technological Pedagogical and Content Knowledge and Mindset (attitudes, beliefs, dispositions toward teaching and learning) that serves to advance STEM (Science, Technology, Engineering, and Mathematics) instruction with pre-service teachers. The proposed model will be used in teaching pre-service prek-12 teachers in the following courses: Mathematics Methods, Science Methods, Human Development and Learning Theory, and Classroom Management. It explores how the frameworks, TPaCK, and Mindset can be integrated to form a holistic and interdisciplinary model for designing instruction, particularly in STEM courses. Each framework has a different focus, which is discussed, along with how TPaCK and Mindset can influence how one uses the framework to design instruction. Among these frameworks, there exists a convergence of pedagogy, instructional design, planning, and strategic use of technology that provides an opportunity for a holistic, interdisciplinary approach to designing instruction that serves both teacher and student: teachers in becoming more effective instructors, and students in becoming more effective learners. A brief review of each framework, TPaCK and Mindset is included as well as the description of The Oswald-Gentile Model of Instruction, a holistic approach to designing instruction that takes into consideration both the learner and the teacher.

Introduction

It is common in the United States for teacher education programs to focus on preparing teachers for certification and qualification is measured using standardized certification tests (Angrist & Guryan, 2004). Approved teacher education programs in the state of Pennsylvania comply with state guidelines outlining what pre-service teachers must know, understand, and be able to do upon completion of the program. These guidelines are defined in the documents: *The Framework for Grades Pre K-4 Program Guidelines (2016), The Framework for Grades 4-8 Program Guidelines (2016), and The Framework for Secondary Grades 7-12 Program Guidelines (rev 2018).* Each framework includes the following elements: Program Design, Program Delivery, Professional Core Rationale, Candidate Competencies (Development, Cognition and Learning; Subject Matter Pedagogy Content; Assessment), Alignment with Pennsylvania Academic Standards and Assessment Anchor Content

Standards, Faculty qualifications, Field Experiences and Student Teaching requirements, and New Teacher Support. There is nothing specific to teaching STEM subjects, or preparing pre-service teachers to teach STEM, in undergraduate teacher education programs in Pennsylvania. Yet in 2011, President Barack Obama emphasized in his State of the Union Address the need to transform the education system and prepare STEM teachers using "effective teacher preparation models" (State of the Union Address, 2011). It is time to move forward with advancing teacher education programs that equip pre-service teachers with the tools for designing effective instruction, particularly in the STEM subjects.

There are frameworks for teaching and there are frameworks for instruction. Frameworks for teaching focus on teacher responsibilities and expectations and are used for evaluation purposes (i.e. Danielson's Framework for Teaching). Although criticism has emerged in terms of how such frameworks serve to improve practice and develop teacher skills (Evans, Wills, & Moretti, 2015). Frameworks for instruction independently focus on various aspects of designing instruction, but we have not found evidence of a model that takes advantage of combining multiple instructional frameworks in a way that designing instruction is informed as much by the teachers' Mindset (attitudes, beliefs, disposition) as it is by the learners. While it is important for pre-service teachers to know about frameworks for teaching and frameworks for instruction, it is more important to develop and apply the skills of designing effective instruction, which is the purpose of The Oswald-Gentile Model of Instruction.

Educators' attitudes and dispositions about teaching and learning influence how they approach designing instruction (Brookhart & Freeman, 1992; Stuart & Thurlow, 2000) and therefore need to be an integral part of the instructional design process. Specifically, pre-service teachers' attitudes and dispositions toward teaching science at the elementary level impact effective implementation of inquiry-based instruction in the classroom (Robert-Harris, 2014). Additionally, there is a lack of pre-service teachers' analytical thinking and ability to make connections between teaching and learning (2014). Being aware of how our mindsets and belief systems influence instructional design is an important consideration if the goal of instruction is that students achieve learning outcomes (Dweck, 2000; Stuart & Thurlow, 2000; Ulug et al., 2011; Wiggins and McTighe, 2005). Typically, frameworks for designing instruction focus on content to be learned, outcomes to be achieved by students, and how technology can and will be used for instruction. Measuring the effects of these frameworks on instruction may be reflected in terms of frequency of use, test scores, feedback from teachers, etc. While these foci are certainly a must in instructional design, we propose that using these frameworks (Understanding by Design, Universal Design for Learning, 7Es Learning Cycle, Technology Pedagogical and Content Knowledge) in a synergistic approach with the specific inclusion of mindset considerations in the design and implementation of instruction, can be most effective. In this article, mindset focuses on both teacher and learner abilities to develop the attitudes, beliefs, dispositions, expectations and behaviors that lead to deeper learning and transference of skills.

The purpose of this article is to propose a holistic model of instruction informed by these different frameworks to promote STEM instruction from an interdisciplinary perspective in teaching pre-service teachers, specifically in the following courses: Mathematics Methods (Prek-4), Science Methods (Prek-4), Human Development and

Learning Theory (Prek-12), and Classroom Management (Prek-12). It will explore how the frameworks focus on learners and their needs, the content and curricular requirements, how the use of and role of technology enhances learning, and propose how the role of mindset might influence that design process. The authors of this article will launch a study in these courses, which are required for Pennsylvania Elementary Education Certification. The study will aim to continue to inform the development of an interdisciplinary, holistic model of instruction that serves the instructor in designing effective instruction and the learner in developing skills for transference, a goal of STEM education.

At the convergence of these frameworks is the opportunity to utilize an integrated approach to designing instruction that includes mindset, improves the teaching and learning cycle, and is a holistic approach focusing on how teachers can be more effective instructors and students more effective learners. This article proposes a holistic model of instruction based on using research-based best practices (pedagogy), multiple frameworks (content and outcomes), and technology to optimize and enhance learning: *The Oswald-Gentile Model of Instruction*. It is grounded in a thoughtful and deliberate implementation of several techniques and frameworks which will be explained. It begins with valuing and operationalizing the framework of Universal Design for Learning (UDL) to remove potential barriers to learning and the logical sequence of content instruction found in Understanding by Design (UbD). Next, consideration is given to how content is delivered within the structure of lesson plans that includes the 7Es Learning Cycle (elicit, engage, explore, explain, elaborate, evaluate, extend), which was developed for Science. Then, how the use of technology can build self-confidence in pre-service teachers (Karatas, et al., 2017) and serve to enhance learning through Technological Pedagogical Content Knowledge (TPaCK) (Tsai & Chai, 2012). Finally, an explanation for how the development and continuous use of productive mindsets (those that lend themselves to motivation and intended outcomes) and reflective practice can lead to effective instruction is provided.

The Frameworks and Their Focus

This section provides descriptions of each framework considered in the proposed instructional model. Each framework has been found to be valuable in teaching pre-service teachers, the instructor using it to design instruction as well as teaching the frameworks to the students, giving rise to exploring the relationship among and between the frameworks in order to enhance learning. The proposed model of instruction carefully integrates the following frameworks (Universal Design for Learning, Understanding by Design, 7E Learning Cycle, TPaCK) while considering mindset, in order to improve the teaching and learning cycle. Each framework was evaluated to understand the role it plays in designing instruction and how they can be used together.

UDL (WHO - The Learner)

Universal Design for Learning, developed by CAST (a nonprofit research and development organization, previously known as Center for Applied Special Technology, that works to expand learning opportunities for all individuals through Universal Design for Learning) is a framework for teaching, learning, assessment, and curriculum which designs curricular materials, technology use, and activities to have the flexibility to match learner strength and needs so they can reach their learning goals (CAST, n.d.). It focuses on the WHO of learning by identifying and addressing potential barriers to learning for each individual student. As defined by CAST on their website: www.cast.org, "Universal Design for Learning (UDL) is a research-based set of principles to guide the design of learning environments that are accessible and effective for all (CAST, n.d.)." The UDL framework reflects and supports many findings in brain-based research such as metacognition, learning styles, and differentiated instruction while intentionally removing potential barriers to learning (CAST, n.d.). It includes guidelines for identifying specific, evidence-based options to consider in designing successful instruction for all learners.

CAST (2018) recommends a three part framework for how the brain works using the three separate networks of the brain that are interconnected in the learning process: recognition, strategic, and affective. 1. The recognition network identifies patterns in the brain and is considered the "what" of learning. 2. The strategic network constructs personal meaning to information and sorts/classifies it. It involves metacognition or thinking about your thinking and is considered the "how" of learning. 3. The affective network looks at the engagement or social interaction of the learner and involves the emotional system responsible for long-term memory, making connections between emotions, and cognitive learning and memory. It drives attention (which drives meaning and memory) and requires engagement to make learning meaningful and for it to be internalized (CASEL, 2019; Frey et al., 2019; Immordino-Yang & Damasio, 2007). It is considered the "why" of learning.

These networks are used in the three essential qualities of UDL which must be considered when designing curriculum to meet the needs of all learners: Representation, Engagement, and Expression (CAST, 2018). Figure 1 denotes the relationship between the networks of the brain and the three essential qualities of UDL.

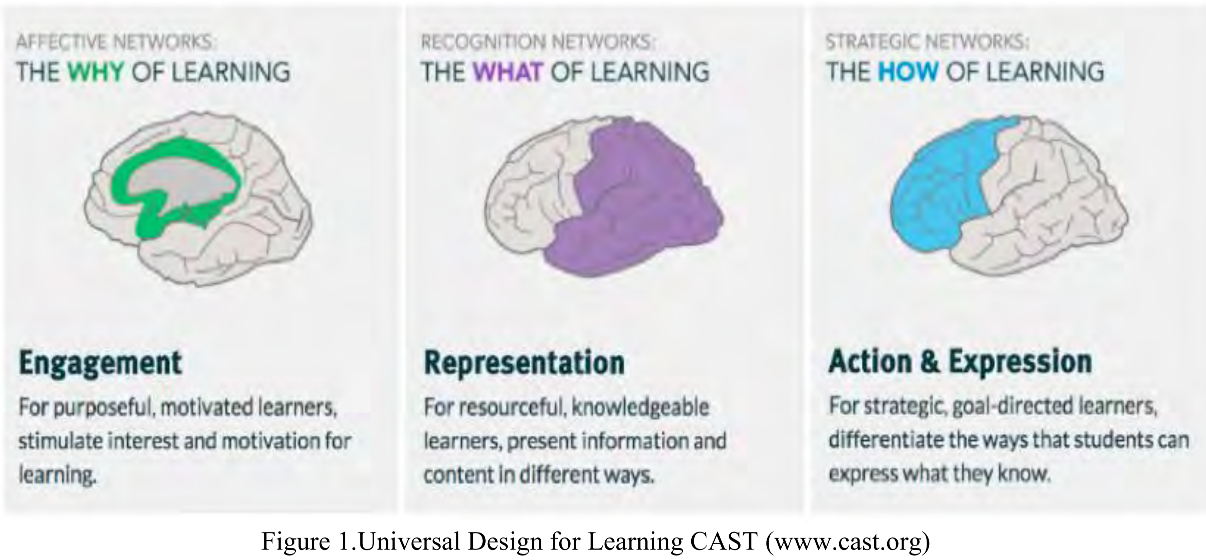

Figure 1.Universal Design for Learning CAST (www.cast.org)

With representation, students are provided with a variety of ways to receive and interpret information such as oral presentation, watching a video, reading text, attending a field trip, using technology, and/or involvement in a role play. Engagement involves knowing students so that their interests can be matched to their learnings. Examples of engagement processes include highlighting, listening, using manipulatives, participating in discussion groups, and using technology. Expression accommodates the strategic and motor systems by reflecting on different ways students may respond using the information they have received (CAST, 2018). Oral reports, poster presentations, written reports, demonstrations, productions, and technology use are some examples of ways for students to express their understanding beyond the traditional paper and pencil examinations so commonly used.

Classes designed using UDL provide students with multiple means of representation to gain information, multiple means to engage and motivate students, and multiple ways to express what they have learned (CAST, 2018; Orkwis & McLane, 1998). A systematic review of methods of UDL implementation for postsecondary students and the degree to which they were effective was completed by Roberts, et al., 2011. The findings revealed promising learning outcomes as supported by the existing literature regarding the effectiveness and practicality of UDL for students at the postsecondary level. As such, UDLis an important part of The Oswald-Gentile Model in that it utilizes brain based practices as well as honoring choice and multiple pathways to learning outcomes to meet diverse learning needs. UDL intentionally removes potential barriers to learning with consideration of best instructional practices including cultural responsiveness. It includes the purposeful integration of technology to facilitate learning which allows for responsiveness, flexibility, customization and personalization aimed for in the UDL classroom.

UbD (WHAT and WHY)

The Understanding by Design (UbD) framework, developed by educators Grant Wiggins and Jay McTighe and published by the Association for Supervision and Curriculum Development (ASCD) in 1998, focuses on the *WHAT* of instruction and *WHY* of learning: what students must know, understand and be able to do in order to achieve the curriculum outcomes and/or standards that develops the transference of skills (Wiggins & McTighe, 2005). It begins with the end in mind, the goal of instruction, and is oftentimes referred to as *Backward Design* (see Figure 2). When a goal is known, then evidence of achievement can be determined, and an appropriate learning plan can be developed to reach the goal.

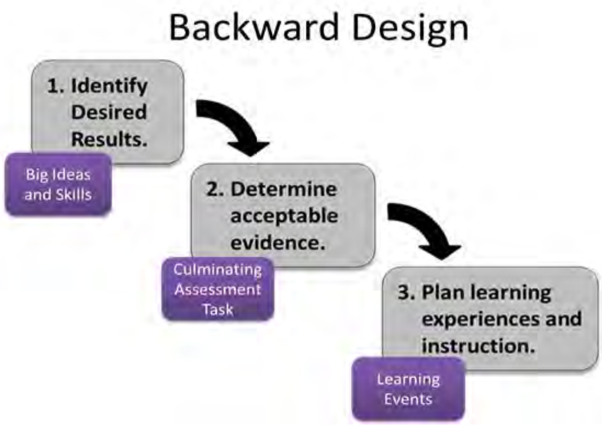

Figure 2. Backward Design [Wiggins, G.P., & McTighe, J. (2005). *Understanding by design*, Association for Supervision & Curriculum Development.]

UbD is a logical approach (sequence of three stages) to planning instruction (Wang & Allen, 2003) to meet learning goals that can be compared to the Engineering Design Process taught in STEM education classrooms (see Figure 3). It is important to note this comparison because the pre-service teachers experience designing instruction in a way that aligns with and supports the Engineering Design Process used in STEM courses. Kolb's theory of experiential learning supports the idea of providing pre-service teachers with this kind of experience and could serve to develop the pre-service teachers' understanding of designing effective instruction (Kolb, 1984). It serves as an experience that pre-service teachers can engage in that will deepen understanding of EDP while focusing the design of instruction on the goals of learning. Not only do pre-service teachers learn a logical sequence of designing instruction, but they experience a similar process that they will use to teach in a STEM classroom.

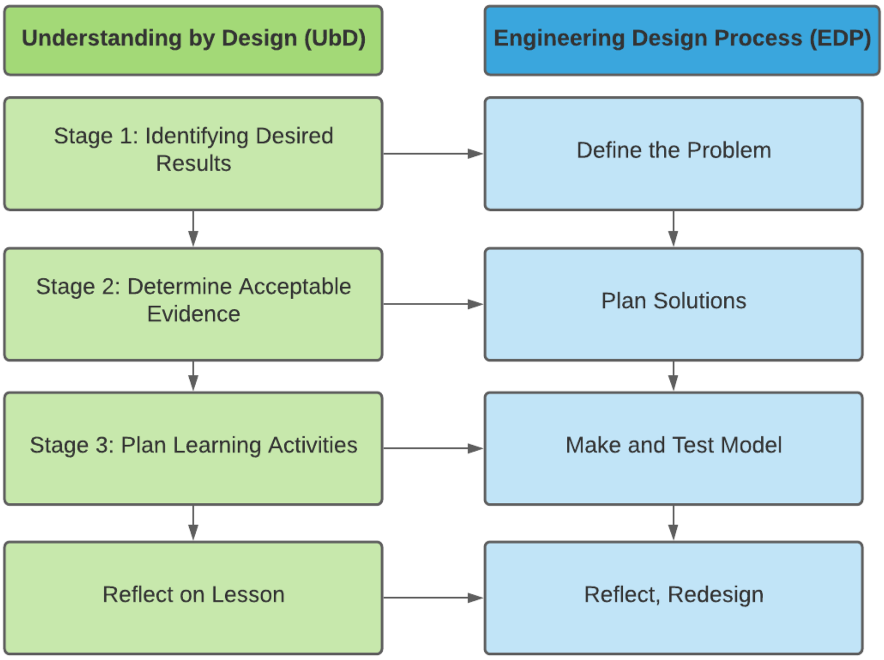

Figure 3. UbD EDP Alignment

It has been the authors' experiences in working with practicing teachers and pre-service teachers that some educators think about lesson planning, and without even realizing it, focus on the topics and planning activities that will engage learners rather than focus on the concepts and skills to be developed and assessed that will lead to student achievement of the outcomes. When thinking about the activities, teachers will often ask questions like: *Will this engage my students? Will they enjoy it? Will all students have an opportunity to participate?* Student engagement, participation, and interest are critical to the success of activities. However, if one does not consider acceptable evidence of student learning before activities are designed, the focus shifts to the activities and, as a result, instruction oftentimes does not lead to the desired outcomes (Wiggins & McTighe, 2005). Having a framework to design instruction provides teachers with sequential steps that ensure alignment of instruction to assessments and outcomes. Teaching pre-service teachers how and why to begin with the end (goal) in mind provides an experience, a connection, to using EDP in the classroom and the critical role EDP plays in STEM education.

UbD is designed to ensure alignment of instruction and evidence of learning (assessment) to learning goals that ultimately leads to students being able to transfer skills (the WHY). It is a framework that considers the WHAT of instruction and WHY of learning (see Figure 4).

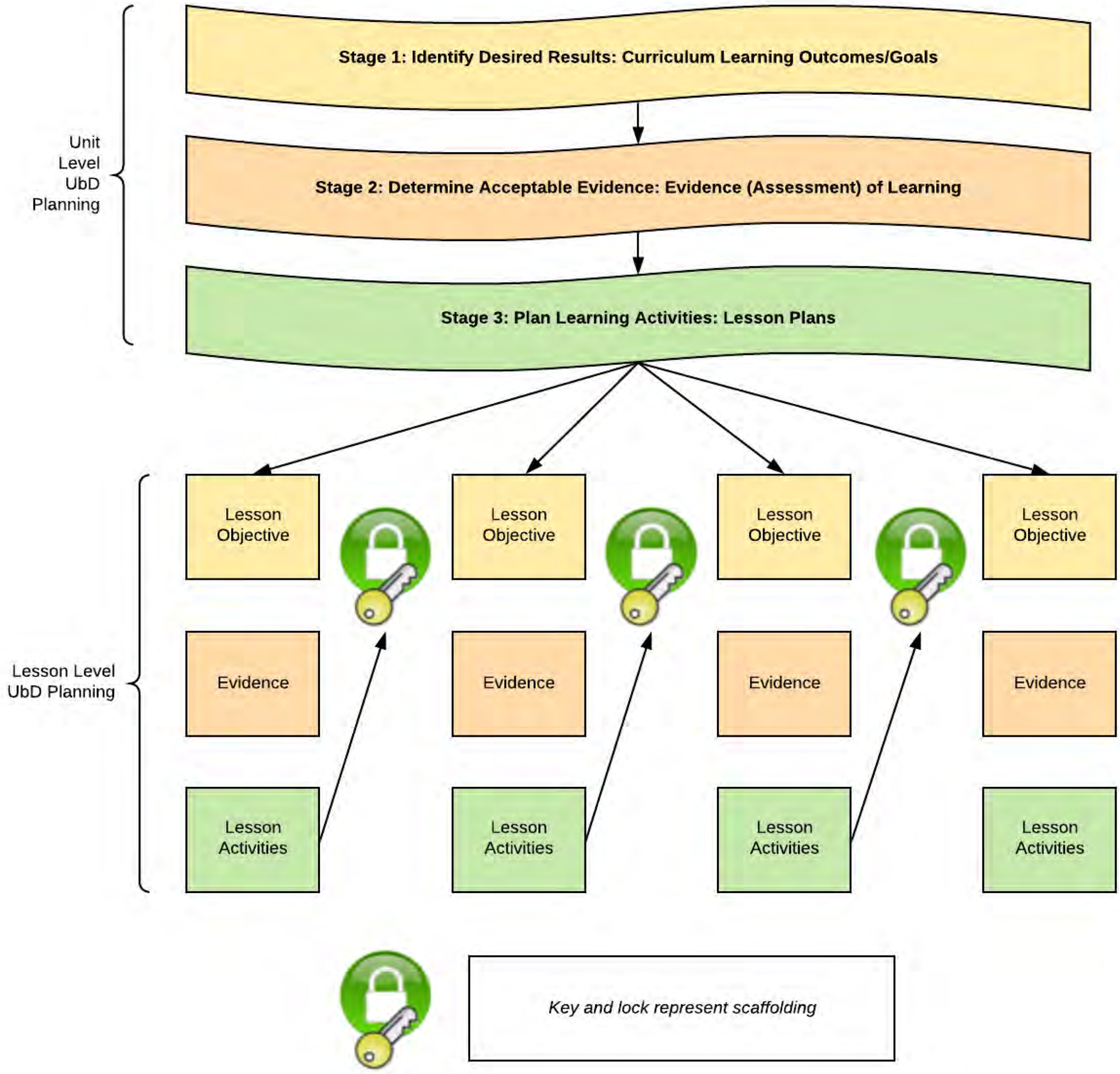

Figure 4. UbD Planning

7E Learning Cycle (HOW)

The 7E learning cycle is an extension of the 5E learning cycle developed by the Science Curriculum Improvement Study (Bybee, 2015). It is based on a constructivist approach to learning and builds on John Dewey's model of learning science described in the 1938 *Science in General Education* report (Bybee et al, 2006). The 5Es of the learning cycle include: *engage, explore, explain, elaborate, evaluate* and have been shown to increase student knowledge and improve motivation (Liu, et al., 2009). The premise of the model is grounded in research on the role of experiential learning in learning science that will serve to develop the concepts and skills in the learning outcomes and promote transference of skills (Eisenkraft, 2003).

The 7E learning cycle extends the 5Es to include *elicit* and *extend* (see Figure 5). The addition of *elicit* indicates a response to the research on prior knowledge and the role it plays in learning (Bransford et al., 2000). The addition of *extend* serves as the opportunity for students to extend their learning in a way that develops the transference of skills (Adesoji & Idika, 2015.)

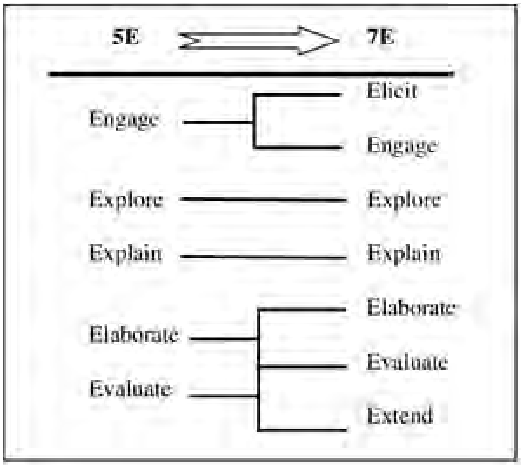

Figure 5. Expanded 5E to 7E by Bulbul (2010)

The 7E learning cycle is a logical approach to designing daily lesson plans that takes advantage of the natural sequence of the learning process. Each step in the learning cycle provides the teacher the opportunity to conduct formative assessment, ensure scaffolding, encourage communication, and higher level thinking.

Elicit - activating prior knowledge, establishing what the learner knows through questioning and discussion
Engage - opportunity to gain attention that is both hands on and minds on
Explore - an experience that introduces concepts and skills
Explain - student engages in articulating what is learned while teacher assesses learning using formative assessment and addresses misconceptions
Elaborate - student practices newly learned concepts and skills
Evaluate - student learning is assessed
Extend - experience beyond the classroom that requires transference of concepts and skills

The 7E Learning Cycle, the *HOW* of instruction, while originally developed to teach science, takes advantage of the natural learning process and can be applied to other disciplines; it is not, nor should it be, limited to just the sciences. This supports Reif's (2010) work, outlined in his book *Applying Cognitive Science to Education,* that emphasizes the critical need for a logical sequence of designing instruction. Reif does not limit that logical sequence to one discipline and so the Oswald-Gentile Model considers the 7E learning cycle applicable to all disciplines.

When the 7E Learning Cycle intersects with the other frameworks, we note the sequence of learning and how each framework is woven through the cycle. For example, UDL in selecting multiple means of representation, engagement, and expression during the Es; UbD in the planning of activities to ensure scaffolding, and TPaCK in utilizing developmentally and pedagogically technologies to enhance the learning.

TPaCK (WHEN and WHERE)

Mishra and Kohler (2006) argue that in order for teachers to effectively integrate technology into instruction, a deeper understanding of *how* Pedagogical Knowledge and Content Knowledge (PCK), and Technological Knowledge (T) intersect (TPaCK), is necessary. This builds on Shulman's (1987) concept of the intersection of pedagogy and content (PCK) in a way that addresses the continuous technological advances in education and our thinking about what teachers need to develop effective instruction in the classroom. Deliberate and careful implementation of technology as part of an overall instrumental framework can enhance learning (Kali et al., 2008; Linn & Eylon, 2011).

Historically, schools in the United States have spent billions of dollars on technology with a continuous increase on spending for hardware, but decrease in budgets for teacher training and tech support (Schaffhauser, 2016). While teacher education programs across the country include "using technology in the classroom" in their programs, explicit instruction, including connections to subject content, is critical for teachers to develop the necessary confidence and competence in using technology to enhance learning. Voogt & McKenney (2015) offer several suggestions of how teacher education programs might provide training within programs that would increase teacher confidence and understanding of using technology as a tool to enhance learning and not just training on how to use technology for the sake of using technology.

The major challenges with using technology by teachers, students, parents, and others faced during the COVID-19 pandemic is a great illustration that more is needed in the way of incorporating TPaCK in pre-service teacher education programs as well as professional development for practicing teachers on using technology for teaching and learning. When schools closed and courses went online, many struggled with the transition and one reason was using technology to teach online. While many districts tout the use of technology and monies spent on technology, many districts simply were not prepared for the virtual platform.

Using technology in education is not about using technology simply for the sake of using it. Understanding how to use technology in the teaching and learning cycle, the *WHEN* and *WHERE*, shifts the mindset of the teacher from *WHAT* technology to use and *HOW* to use it, to appropriately and strategically placing it within the instructional model and from a pedagogical standpoint so that it serves to enhance and optimize learning. What complicates this further is the fact that teacher's attitudes and beliefs about technology, their confidence levels in using technology, influence their use of it (Tsai & Chai, 2012). When considering the intersection of TPaCK with the other frameworks, we see how UDL addresses barriers in learning and how technology plays a key role in how a teacher can address those barriers. We also see how technology contributes to carrying out instruction in lessons and can be used in assessing student learning (Kali et al, 2008). However, if teachers are not considering their own attitudes about technology, they may not be sure to take advantage of it in addressing barriers to learning.

Mindset (REFLECTION)

It is essential that educators consciously and deliberately reflect on their mindset regarding their belief systems and expectations for themselves and for their students (Stuart & Thurow, 2000). There is a plethora of research that demonstrates the impact of beliefs and expectations on teaching and learning (Aronson, 2002; Blackwell et al., 2007; Yeager & Dweck, 2012). Mindset, for the purposes of this article, refers to more than the Growth vs Fixed Mindset suggested by Carol Dweck who emphasized the underlying beliefs people have about abilities and intelligence as well as the profound impact it can have on behaviour (Dweck, 2006). It also includes the attitudes, belief systems, expectations, and disposition held by students and by teachers. It deliberately includes these concepts because they all have the potential to impact the fidelity and effects of instruction.

Research also demonstrates that mindset is scalable...something that can be taught and implemented within the classroom with measurable impacts (Blackwell et al., 2007; Good, et al., 2003; Paunesku et al., 2015; Yeager & Walton, 2011). People have tremendous potential to acquire new knowledge, develop new skills, and improve their brains throughout their lives and applying effective learning strategies enhances this process (Green & Bavelier, 2010; McLaughlin et al., 2018). We have the opportunity to empower all learners through an understanding of their brains' unique capacity to change as the result of learning and to equip them with practical learning strategies that can significantly improve the growth of knowledge and skills. Understanding brain plasticity provides a scientific basis for adopting a growth mindset (Boaler, 2013; Murphy et al., 2015). When educators model and teach effective learning strategies, students experience academic gains, which in turn support the process of sustaining a growth mindset to persist even through progressively more difficult learning tasks (Hattie & Anderman, 2020; Murphy et al., 2015; Yeager & Walton, 2011). Research has demonstrated that mindset influences resilience in academic challenges (Blackwell et al., 2007; Reinberg, 2001; Yeager & Dweck, 2012). As such, Mindset should be a deliberate part of lesson planning and reflection. Similarly, we believe that pre-service teachers should be taught ways to incorporate growth mindsets so that they have the resources and understanding to use it effectively in their classrooms.

Student Mindsets involve the conscious and unconscious beliefs students hold about their ability to learn and to master challenging concepts (self-efficacy) as well as the beliefs they perceive others to hold about them. Teacher Mindset involves the conscious and unconscious beliefs the teacher holds about their students' ability (teacher expectancy) to learn as well as about their ability to reach and teach their students (self-efficacy). These mindsets can be influential to instructional practices used by teachers and learning processes experienced by students.

There are neurological underpinnings to mindset, which show that our beliefs can physically change our brain networks (Boaler, 2013; Murphy et al., 2015; Yeager & Walton, 2011). Teaching about mindset can increase motivation, improve self-regulated learning, reduce anxiety when learning, improve academic performance, and increase enjoyment in learning (Dweck & Legget, 1988; Dweck, 2006; Hattie & Anderman, 2020). Mindset can be the impetus to motivation. When students recognize that they can make progress through effort and the use of effective strategies, they are motivated during the learning process. How feedback is phrased, praising process rather than product, and teaching students how to reach high standards makes a difference. Small interventions in mindset have shown great benefits. For example, there have been seminal studies that demonstrated that changing just one line of feedback from product oriented ("you must be very smart") to process oriented ("you must have worked really hard") influences students' performance and willingness to engage in difficult tasks (Dweck & Legget, 1988). Similarly, another study demonstrated that the teacher indicating his belief in the students with one line ("I'm giving you this feedback because I have high expectations of you and I know you can achieve them") had similar positive performance outcomes (Yeager, et al., 2014).

Teachers need to be aware of their influence on students' mindsets. According to a study by Reinberg (2001), teachers with a fixed mindset perceive students who struggle as not sufficiently bright, talented, or smart in the subject. Low achievers in classrooms of teachers with a fixed mindset left as low achievers at the end of the school year. Teachers with a growth mindset perceive struggling students as a challenge – learners who are in need of feedback and guidance on how to improve. Low achievers in classrooms of teachers with a growth mindset moved up and became moderate, and in some cases, high achievers (2001).

For this reason, it is very important for teachers to be aware of their attitudes and dispositions about teaching and about the students they teach. The Oswald-Gentile model of instruction emphasizes that educators need to model these practices and teach this described concept of mindset to students. Teacher attitudes as well as the teacher-student relationship are a critical piece to learning. As highlighted in the seminal work of Maslow (1943) and revisited in the research, students' humanistic needs including social and emotional needs, must be met in order for deeper learning to occur (CASEL, 2019; Frey et al., 2019; Immordino-Yang & Damasio, 2007). The best instructional strategies will not be maximized without them and therefore, they must be explicitly addressed.

Mindset is the continuous reflection that is embedded throughout our holistic instructional framework. It is to be considered at each phase of the instructional design as well as during and after the implementation of instruction. Checking one's mindset as the teacher and incorporating instruction to promote growth mindsets in students is an integral part of our framework because it has a powerful influence on how well we do a given task (Blackwell et al, 2007; Dweck, 2000). Modelling this continuous reflective practice in Teacher Preparation courses can enhance the learning experience of teacher-educators and prepare them to implement the approach in their future classrooms.

The Proposed Model - The Oswald-Gentile Model of Instruction: A Holistic Approach

The proposed model of instruction is named for the authors Oswald and Gentile. It considers each of the three instructional frameworks, TPaCK, and Mindset and how each influences and informs the others (see Figure 6). It serves to take advantage of the purpose of each framework and create a holistic approach to designing instruction. In order to develop a holistic model, each framework provides the insight to a part of designing instruction. Each framework, TPaCK and Mindset, is like a lens that highlights a particular aspect of the design. When using all lenses, we are able to maximize each part of the design to create a holistic model of instruction.

The authors contend that including the elements of each framework, TPaCK, and Mindset, that a holistic model can provide a comprehensive structure and strong foundation for ensuring effective instruction.

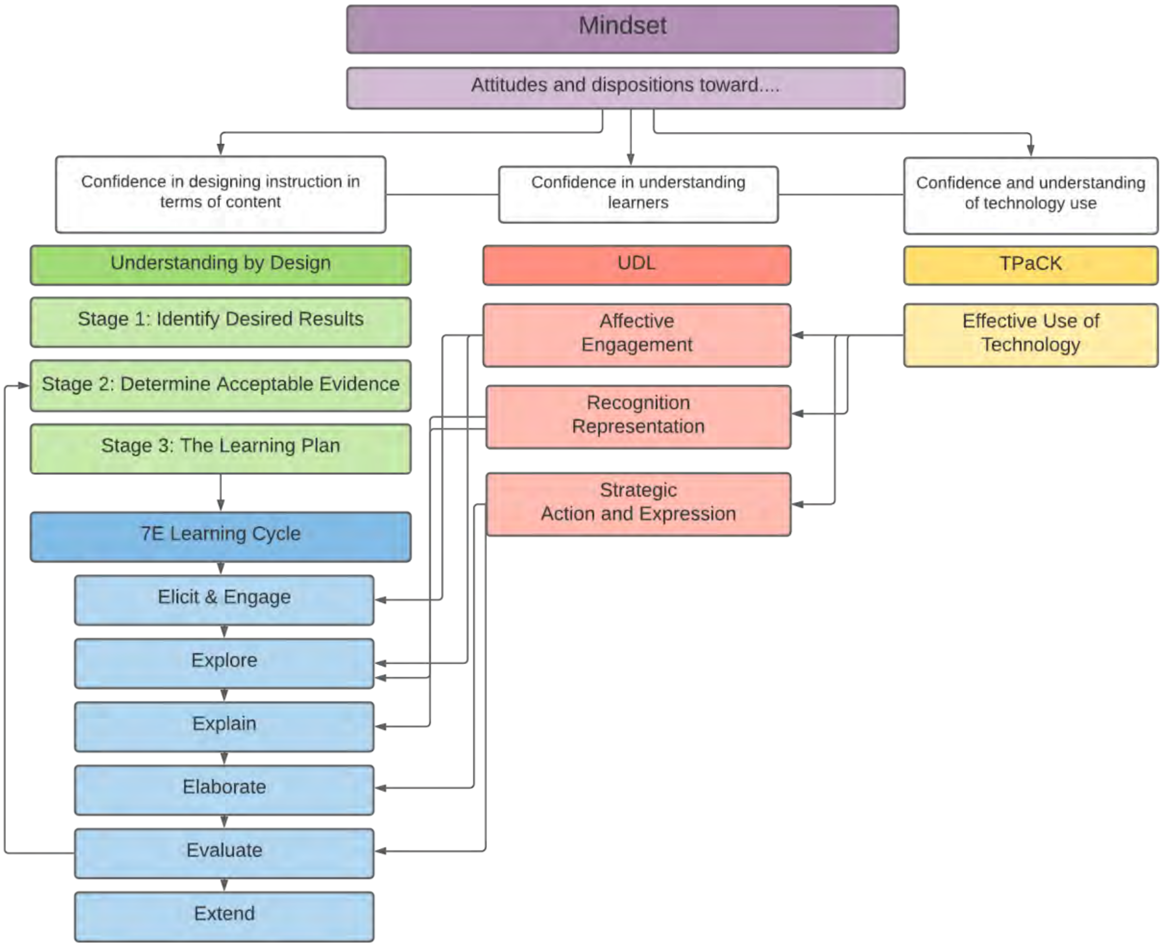

Figure 6. Integration of Frameworks

UbD begins with the goal in mind (Stage 1), the content (concepts and skills) students are expected to know, understand, and be able to do by the end of the unit, but it doesn't indicate *who,* UDL is what informs this aspect. UDL considers the teacher an architect of design. The UDL framework emphasizes the necessary consideration of learners while planning for instruction: the affective, recognition, and strategic networks. It provides a structure for understanding potential barriers in learning and how to address those barriers and educators must consider the multiple modes of representation, engagement, and expression that will address both seen and unseen barriers for the learners. This includes extensive consideration to the use of technology and how it can be used to address boundaries in learning.

The proposed model takes this into consideration, *prior to planning*, and will support UbD's 3 stage sequence of design by ensuring that learner needs, including potential barriers, are understood *in advance of* planning. The careful consideration of the other frameworks and factors involved in curriculum and learning is critical. Otherwise, students may not be fully engaged in the learning which limits the benefits of the UDL framework. It is here where the role of TPaCK is critical: to strategically inform the appropriate use of technology tools to be used for instruction and learning so that students are engaged and not limited.

The 7E Learning Cycle is where the decisions are made regarding when and where to use technology and appropriate methods of instruction. The 7E cycle fits into UbD Stage 3 and will provide a sequence to designing instructional activities that will include consideration of learners' needs (informed by UDL) and ensure scaffolding of concepts and skills. TPaCK will inform the developmentally appropriate technology tools to be used for instruction and learning, as well as assessment, which is during UbD's Stages 2 and 3.

While the technical aspect of designing instruction is articulated, the model is not complete. Mindset plays a critical role. As mentioned earlier, teachers' attitudes, beliefs, and dispositions influence how instruction is designed and carried out and so the Oswald-Gentile Model focuses at every level of planning on an awareness of mindset and reflection (see Figure 7). Teachers must be aware of their mindset regarding their teaching ability and the learning ability of their students. Belief systems greatly impact performance (Rodriguez, 2009; Schafer, 2013; Stuart & Thurlow, 2000).

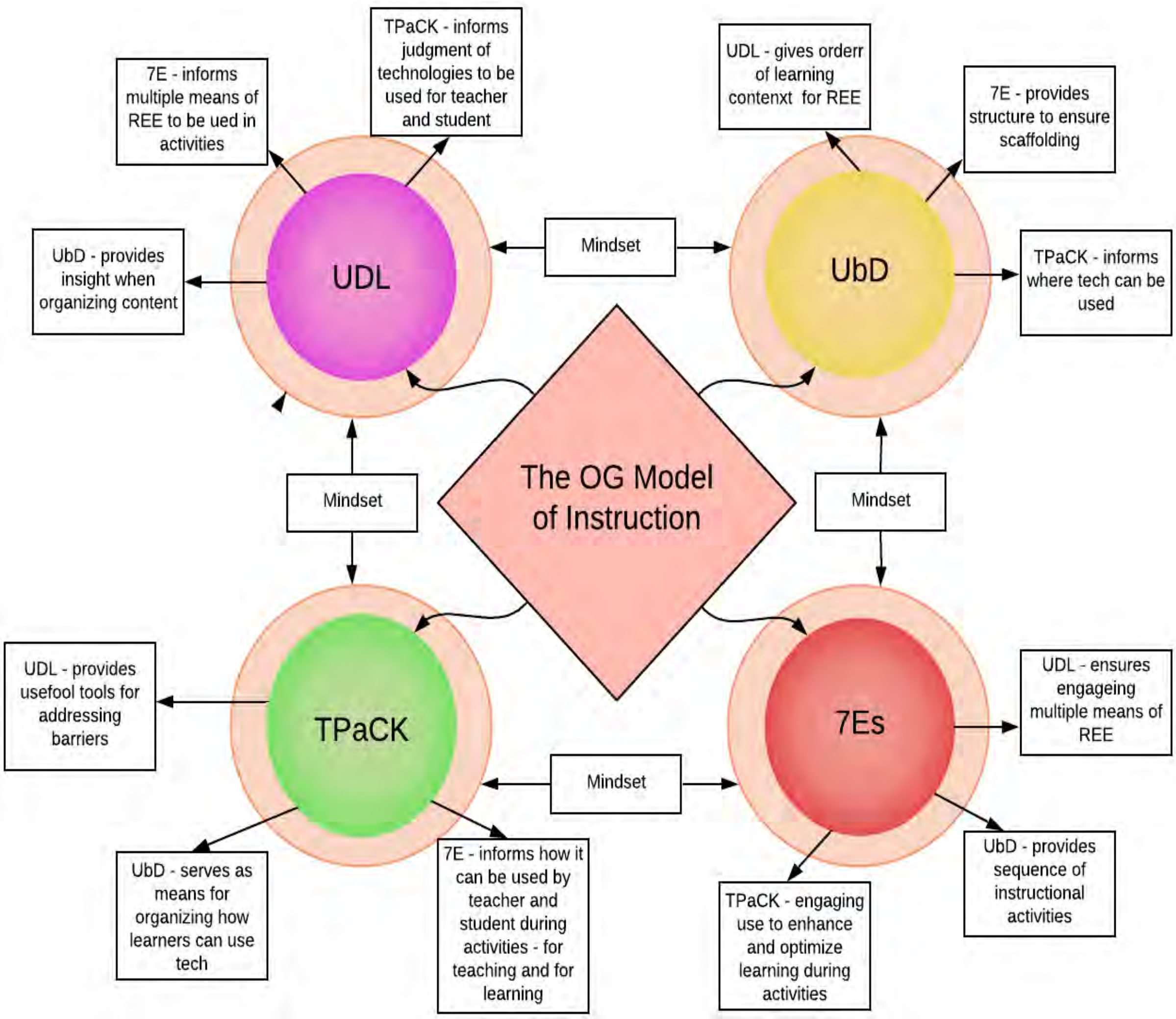

Figure 7. Oswald-Gentile Model of Instruction

Carrying out - Next steps (WHAT and WHY)

The authors will be using the Oswald-Gentile Model in their courses (Mathematics Methods, Science Methods, Human Development and Learning Theory, and Classroom Management) with pre-service teachers in an undergraduate teacher education program in Pennsylvania. The purpose will be to determine the effects of deliberate integration of UbD, UDL, 7Es, TPaCK and Mindset in teaching STEM subjects. Students will be given the opportunity to experience, from a learner's perspective, the impact of integrating multiple frameworks for instruction and will provide feedback on the effectiveness of the integrated model.

The purpose of the Oswald-Gentile Model is not only to improve our practice, but to serve our learners in developing their practice and building confidence as future teachers of Mathematics and Science. As future teachers of STEM subjects, pre-service teachers must learn how to design instruction that will enable them to carry out STEM in the classroom using an integrative approach. Barriers to understanding how to do this are caused by teacher confidence levels and lack of understanding of areas within STEM (White, 2014), which is why Mindset plays a critical role in the model. Additionally, the idea of using technology is more complex than simple use of computers (2014) and so understanding TPaCK is necessary in designing effective instruction and important in the model. It is the intention that the implementation of this model of designing instruction will facilitate student growth in their development of becoming expert learners, but also serve as a model for them as future teachers through the design of an interdisciplinary STEM Unit of instruction that carries out The Oswald-Gentile Model of Instruction.

Conclusion

Pre-service teachers and teacher candidates have an incredible charge: to educate the next generation. That generation is moving at lightning speed in technological advances and STEM is at the center of education discussions. A new teacher's role in providing effective instruction that leads students to the transference of skills is one that requires not only a knowledge base (subject content and curriculum standards), but the ability to design and carry out instruction (Ko & Sammons, 2013). It requires teachers to have a deep understanding of their learners, of effective pedagogical practices, and a high level of competency in using technology to enhance learning (not just adding technology for use), while integrating across disciplines (2013). Perhaps of greatest importance though, is how one's mindset influences one's instruction and, ultimately, the learner.

When you ask someone what STEM means, you are likely to get different responses, from simply stating what it stands for: Science, Technology, Engineering, and Mathematics, to saying EDP, Robotics or fields of study, etc. The reality is that STEM education is NOT simply a set of courses, or fields of study, or even just for bright students. STEM education is deliberate and intentional design of instruction (interdisciplinary) that takes advantage of the natural learning process of children in ways that students are able to transfer skills well beyond the classroom walls.

It includes the humanities and the arts, the two areas of the curriculum that ironically best illustrate what is meant by integration, but that are often neglected. Providing all students with an education that is well designed, deliberate and intentional, with the goal of the transference of skills, requires well prepared teachers in designing instruction that serves this purpose. And it begins with training pre-service teachers how to design integrative instruction using not just one framework, but using a model that takes advantage of multiple frameworks. In doing so, instruction reflects consideration of both teacher and learner, environment, content and curriculum, and appropriate use of technology so that all students can succeed.

The proposed holistic, integrated model of instruction (Oswald-Gentile Model) is the careful integration of three instructional frameworks, TPaCK, and Mindset that are grounded in brain based research and best practices for teaching and learning. It includes the identification of the intersection that maximizes the teaching and learning process while being guided by the power of conscious reflection and Mindset. We have found it to be an excellent example to model the kind of instruction needed for 21st Century learning.

References

Adesoji, F.A., & Idika, M.I. (2015). Effects of 7E learning cycle model and case-based learning strategy on secondary school students' learning outcomes in chemistry. *Journal of the International Society for Teacher Education*, *19*(1), 7-17.

Angrist, J., & Guryan, J. (2004). Teacher Testing, Teacher Education, and Teacher Characteristics. The American Economic Review, 94(2), 241-246. Retrieved November 25, 2020, from http://www.jstor.org/stable/3592890

Aronson, J. (2002). Stereotype threat: Contending and coping with unnerving expectations. In J. Aronson (Ed.), *Improving academic achievement: Impact of psychological factors on education* (pp. 279-301). Academic Press.

Blackwell L.S., Trzesniewski, K.H., & Dweck, C.S. (2007). Implicit theories of intelligence predict achievement across an adolescent transition: A longitudinal study and an intervention. *Child Development, 78*(1), 246–263

Boaler, J. (2013). Ability and Mathematics: The mindset revolution that is reshaping education. *Forum, 55*(1), 143-150.

Brode, A. Ways in which technology enhances teaching and learning. 2005. ERIC document reproduction service No. ED490591.

Bransford, J., Brown, A. L., Cocking, R. R., & National Research Council (U.S.). (2000). *How people learn: Brain, mind, experience, and school*. National Academy Press.

Brookhart, S. M. & Freeman, D. J. (1992). Characteristics of Entering Teacher Candidates. *Review of Educational Research, 62*(1), 37-60. https://doi.org/10.3102/00346543062001037

Bülbül, Y. (2010). *Effects of the 7E learning cycle model accompanied with computer animations on understanding of diffusion and osmosis concepts*. Middle East Technical University.

Bybee, R.W. *(2015). The BSCS 5E instructional model:creating teachable moments.* NSTA Press.

Bybee, Rodger & Taylor, Joseph & Gardner, April & Scotter, Pamela & Carlson, Janet & Westbrook, Anne & Landes, Nancy. (2006). The BSCS 5E Instructional Model: Origins, Effectiveness, and Applications.

BSCS.

BSCS. (2006). *Learn about BSCS's 5E Instructional Model.* Retrieved from https://bscs.org/bscs-5e-instructional-model/

Collaborative for Academic, Social, and Emotional Learning (CASEL). (2019). *What is SEL?* Retrieved from https://casel.org/what-is-sel/

CAST (2018). Universal Design for Learning Guidelines version 2.2 Retrieved from http://www.udlguidelines.cast.org

Darling-Hammond, L. (2006). Constructing 21st century teacher education. *Journal of Teacher Education*, *57*(X):1-15.

Dweck, C. S. (2000). *Self-theories: Their role in motivation, personality and development*. Psychology.

Dweck, C. S. (2006). *Mindset: The New Psychology of Success.* Random House.

Dweck, C. S. & Legget, E.L. (1998). A social-cognitive approach to motivation and personality. *Psychological Review, 95*(2), 256-273.

Eisenkraft, A. (2003). Expanding the 5E model: a proposed 7E model emphasizing "transfer of learning" and the importance of eliciting prior understanding. *The Science Teacher*, 70, 56-59.

Evans, B. R., Wills, F., & Moretti, M. (2015). A Look at the Danielson Framework for Teacher

Evaluation. *Journal of the National Association for Alternative Certification*, *10(1),* 21-26.

Frey, N., Fisher, D., & Smith, D. (2019). *All learning is social and emotional.* ASCD.

Good C, Aronson J, & Inzlicht M. (2003). Improving adolescents' standardized test performance: An intervention to reduce the effects of stereotype threat. *Journal of Applied Developmental Psychology*, *24*(6):645–662.

Green, C. S. & Bavelier, D. (2008). Exercising your brain: A review of human brain plasticity and training-induced learning. *Psychology and Aging, 23*(4), 692-701. https://www.doi.org/10.1037/a0014345

Hattie, J., & Anderman, E.M. (2020). *Visible learning: Guide to student achievement.* Routledge.

Institute on Trauma and Trauma Informed Care, University of Buffalo (2015). What is trauma informed care? Retrieved from http://socialwork.buffalo.edu/social-research/institutescenters/institute-on-trauma-and-trauma-informed-care/what-is-trauma-informedcare.html.

Kali, Y., Linn, M. C., Roseman, J. E., & Tinker (2008) *Designing coherent science education:Implications for curriculum, instruction, and policy.* Teachers College Press.

Karatas, I., Tunc, M., Yilmaz, N., & Karaci, G. (2017). An Investigation of Technological Pedagogical Content Knowledge, Self-Confidence, and Perception of Pre-Service Middle

School Mathematics Teachers towards Instructional Technologies. Journal of Educational

Technology & Society, 20(3), 122-132. Retrieved November 25, 2020, from http://www.jstor.org/stable/26196124

Ko, J.& Sammons, P. Effective teaching: a review of research and evidence. 2013. ERIC document reproduction service No. ED546794.

Kolb, D.A. (1984). *Experiential learning: experience as the source of learning and development*. Prentice Hall.

Linn, M. C. & Eylon, B. S. (2011). *Science learning and instruction: Taking advantage to promote knowledge integration.* Routledge: Taylor & Francis Group.

Maslow, A. H. (1943). A theory of human motivation. *Psychological Review, 50*(4), 370-396.

McLaughlin, P. M., Curtis, A. F., Branscombe-Caird, L. M., Comrie, J. K., and Murtha, S. J.E. (2018). The feasibility and potential impact of brain training games on cognitive and emotional functioning in middle-aged adults. *Games Health, 7*(1), 67-74. https//www.doi.org/doi: 10.1089/g4h.2017.0032

Mishra, P. & Koehler, M.J. (2006). Technological Pedagogical Content Knowledge: A Framework for Teacher Knowledge. *Teachers College Record, 108*(6), 1017-1054. Retrieved August 8, 2020 from https://www.learntechlib.org/p/99246/.

Murphy, P., Firetto, C. & Long, V. (2015). Harnessing the power of knowledge and beliefs in teaching and learning: Interventions that promote change. In D. Scott & E. Hargreaves *The Sage Handbook of Learning* (pp. 388-403). SAGE. https://www.doi.org/doi:10.4135/9781473915213.n36

Orkwis, R. & McLane, K. (1998). A curriculum every student can use: Design principles for student access. ERIC/OSEP Topical Brief. ERIC ED 423654.

Paunesku, D., Walton, G. M., Romero, C., Smith, E. N., Yeager, D. S., & Dweck, C. S. (2015). Mind-set interventions are a scalable treatment for academic underachievement. *Psychological Science, 26*(6); 784-793.

Reif, F. (2010). *Applying cognitive science to education: Thinking and learning in scientific or other domains*. MIT Press.

Rheinberg, F. (2001). Bezugsnormen und schulische Leistungbeurteilung [Reference norm and assessment of achievement], in Leistungmessung in Schulen, ed Weinert F. E., editors. (Weinheim: Beltz), 59-71.

Roberts, K. D., Park, H.J., Brown, S., & Cook, B. (2011). Universal Design for Learning in Postsecondary Education: A systematic review of empirically based articles. *Journal of Postsecondary Education and Disability, 24*(1), 5-15.

Rodriguez, C. M. (2009). The impact of academic self-concept, expectations and the choice of learning strategy on academic achievement: the case of business students. *Higher Education Research & Development, 28*(5), 523-539. https://doi.org/10.1080/07294360903146841

Schafer, C. (2013). How individual beliefs impact individual performance. *Human Resource Management Research, 3*(3)*,* 71-81.

Schaffhouser, D. The Journal. Report: Education Tech Spending on the Rise. 2016. Retrieved from https://thejournal.com/articles/2016/01/19/report-education-tech-spending-on-the-rise.aspx

Shulman, L. (1987). Knowledge and teaching: Foundations of the new reform. *Harvard Educational Review, 57*, 1–22.

Sleeter, C. E. (2011). An agenda to strengthen culturally responsive pedagogy. *English Teaching: Practice and Critique, 10*(2), 7-23.

State of the Union Address, 2011

Stuart, C. & Thurow, D. (2000). Making it on their own: Preservice teachers' experiences, beliefs, and classroom practices. *Journal of Teacher Education, 5*1(2): 113-121.

Tsai, C.-C., & Chai, C. S. (2012). The "third"-order barrier for technology-integration instruction: Implications for teacher education. *Australasian Journal of Educational Technology*, *28*(6). https://doi.org/10.14742/ajet.810

Voogt, J. & McKenney, S. (2017) TPACK in teacher education: Are we preparing teachers to use technology for early literacy?, *Technology, Pedagogy and Education, 26*:1, 69-83, https://doi.org/10.1080/1475939X.2016.1174730

Wang, D., & Allen, M. (2003). UNDERSTANDING BY DESIGN MEETS INTEGRATED SCIENCE: A high school science curriculum is developed using the principles of "backward design". *The Science Teacher, 70*(7), 37-41. Retrieved November 20, 2020, from http://www.jstor.org/stable/24155119

White, David. (2014). What is STEM education and why is it important?. *Florida Association of Teacher Educators Journal, 14,* 1-8.

Wiggins, G. and McTighe, J., 2005. *Understanding By Design, Expanded 2nd Edition*. ASCD.

Yeager, D. S. & Dweck, C.S. (2012). Mindsets that promote resilience: When students believe that personal characteristics can be developed. *Educational Psychology, 47*, 302-314.

Yeager, D. S. & Walton, G. M. (2011). Social-psychological interventions in education: They're not magic. *Review of Educational Research, 81*(2), 267-301. https://doi.org/10.3102/0034654311405999

Yeager, D. S, Purdie-Vaughns, V., Garcia, J., Apfel, N., Brzustoski, P., Master, A.,…Cohen, G. L. (2014). Breaking the cycle of mistrust: Wise interventions to provide critical feedback across the racial divide. *Journal of Experimental Psychology: General*, *143* (2), 804-824. https://doi.org/10.1037/a0033906

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