HOW HUMANS BEST LEARN

Professional Learning Community- Topic 2

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I. EXECUTIVE SUMMARY

As part of Southern Oregon University's strategic planning process, Professional Learning Committee #2 was charged with exploring the question, *What does current research tell us about how humans best learn?*

Current research about teaching and learning can be categorized into three major domains: psychology, education, and neuroscience (Tokuhama-Espinoza, 2011). Educational psychology research focuses on the human mind and includes topics such as cognition, consciousness, perception, behavior, motivation and interpersonal relationships. Education research concentrates on pedagogy: teaching practices, subject matter, and assessment. Neuroscience research emphasizes understanding the brain; for our purposes, the most relevant topics in neuroscience are human memory and learning.

As an organizing framework for our research we chose the article, *Science Supports Education: The Behavioral Research Base for Psychology's Top 20 Principles for Enhancing Teaching and Learning* (Lucariello et al., 2016). We also drew from research in the new interdisciplinary field of study, Mind, Brain and Education Science, particularly with regard to the application of neuroscience. While the principles we uncovered apply to humans in general, for the purpose of this report we have focused on SOU students to the exclusion of K-12 learners. The following are the principles we investigated.

1. ***Growth Mindset.*** Students' beliefs or perceptions about their intelligence and ability affect their cognitive functioning and learning.
2. ***Prior Knowledge.*** Students' prior knowledge is the starting point for their learning, whether for creating new understanding or for correcting misconceptions.
3. ***Knowledge Transfer.*** Students' application of knowledge and skill to new contexts is not automatic, but must be intentionally facilitated.
4. ***Formative Feedback.*** An iterative cycle of practice and high-quality feedback is essential to learning.
5. ***Brain Plasticity and Memory.*** Learning changes the structure of the brain.
6. ***Self-Regulation.*** Students' self-regulation skills can help them learn, and these skills can be explicitly taught.
7. ***Motivation.*** Motivation is fundamental to learning.
8. ***Integrated Learning***. Learning is most effective when co-curricular experiences are intentionally integrated in an educational experience within multiple social contexts.

9. ***Active Learning.*** Engaging in active learning improves student performance.

II. INTRODUCTION

Question #2: ***What does current research tell us about how humans best learn?***

As an organizing framework for our research we chose the article, *Science Supports Education: The Behavioral Research Base for Psychology's Top 20 Principles for Enhancing Teaching and Learning* (Lucariello et al., 2016). We also drew from research in the new interdisciplinary field of study, Mind, Brain and Education Science, particularly with regard to the application of neuroscience. The seminal work of Dewey and Piaget was also included; while not recent, it continues to be relevant.

Once we determined what research we would use and which aspects of learning most concerned us, we drafted an outline of our report, divided the required sections as evenly as possible and began. One or two group members chose particular educational principles to explore and then we built the document section by section. Each group member participated in editing the entire document and we are pleased to present the resulting collaboration.

In preparing to explore the question of how humans learn best, we found it relevant to obtain a general overview of the students SOU currently serves. The SOU Institutional Research website includes resources to answer this question, such as the SOU Fact Book, enrollment data, common data sets, and I-Reports.

These sources indicate that SOU students are predominantly white, female, Oregon residents who are of traditional college age (18-24). Their average high school grade-point average was 3.31 and their average composite SAT score was 1013. The five most popular areas of study are Business, Education, Psychology, Criminology, and Theatre Arts. The percentage of minority students (Native American, Asian, Pacific Islanders, Black, and Hispanic) is growing at SOU and currently stands at 30%. Pell recipients have been increasing at 1.4% per year. First generation students comprise 26% of admitted undergraduates on average over the last four years. Approximately 67% of the students are graduating with an average of $26,000 in federal loan debt. Demographic indicators for students at SOU show that we are similar in these ways to other regional universities in Oregon and COPLAC institutions around the country.

During our study, we realized the natural corollary to ***"How do students best learn?"*** is ***"What implications are there for teaching methodologies and pedagogy?"*** As we explored the learning principles, two questions emerged:

- Are there pedagogical methods or teaching practices based on current research that have proven to be effective for *all* college students?

- Are there pedagogical methods or teaching practices that have been identified in the research as especially effective for students with particular characteristics such as transfer students, first-generation students, and students from underrepresented populations?

III. DISCUSSION OF PRINCIPLES

Principle 1: Growth Mindset — Students' beliefs or perceptions about their intelligence and ability affect their cognitive functioning and learning.

How students learn is influenced by a number of factors: past educational opportunities; exposure to role models at home, school, and the larger community that impart the value of education; access to resources (books, technology); and equally as important, students' implicit beliefs about their intellectual ability. Students' perception of their intelligence as fixed (entity theory of intelligence, or fixed mindset) or malleable (incremental theory of intelligence, or growth mindset) has an impact on performance and ultimate success in college (Robins & Pals, 2002). This research suggests that student response to failure or success is linked to their perceptions of their intelligence. The perception of fixed intelligence, measureable by performance (grades), results in students feeling ashamed or distressed when they fail to achieve their intended performance goal and can lead to disengagement and loss of self-esteem. Even when these students succeed, they attribute it to luck, therefore undervaluing their own contribution to their success. Students with a growth mindset measure success by their improvement or mastery of challenging material, resulting in their feeling inspired to work harder when they fail to achieve their goals. Failure by students who measure their success by achieving learning goals has less of an impact on their self-esteem than failure by students who measure their success by performance (Robins & Pals, 2002).

For first-generation students or students from underrepresented populations, group-relevant challenges (experience with negative stereotypes, numerical under-representation, and feelings of cultural misfit) present themselves when students encounter adversity, and they may conclude: "People like me don't belong here." For students with a fixed mindset, regardless of other characteristics, the perception is, "I do not belong here because I am not smart enough." When combined with a perception that "and this isn't likely to get better," students may perform poorly and fail to persist. The good news about these perceptions is that a single, brief intervention targeted at students' beliefs can have lasting positive effects on performance. Such interventions provide: a) scientific evidence that people can become smarter with effort; b) stories from similar students who learned that early difficulties were common, part of the learning process and can be overcome; and c) an opportunity for reflection. Research has shown such interventions offer benefits to all students, with an added benefit for first-generation and underrepresented populations in closing achievement gaps (Yeager et al., 2016).

Principle 2: Prior Knowledge — Students' prior knowledge is the starting point for their learning, whether for creating new understanding or for correcting misconceptions.

What students already know affects their learning, and if what they know is incomplete and/or incorrect, that prior knowledge can compromise their future learning (Lucariello & Naff, 2015, Lucariello et al., 2016). Lucariello and Naff (2015) offer a number of ways educators can deal with the intrinsic misconceptions students bring to a course of study. One suggestion is for educators to first document students' preconceptions about the particular material the course will cover (baseline). The study provides a variety of teaching techniques educators can employ to help students realize their misconceptions: case studies using real world scenarios, diverse instruction, self-explanation, and side-by-side comparisons of their misconceptions with correct concepts (Lucariello & Naff, 2015). Revealing misconceptions serves as a starting point to achieve an accurate understanding of concepts.

Other studies point to additional possible approaches for addressing misconceptions. Nussbaum and Sinatra (2003) found that argumentation was helpful. In their study, students were asked to argue in favor of the correct understanding of a physics problem. Afterwards they had improved reasoning over students who didn't have to formulate these arguments.

Principle 3: Knowledge Transfer — Students' application of knowledge and skill to new contexts is not automatic, but must be intentionally facilitated.

Lucariello et al. argue that "Generalizing learning to new contexts…needs to be facilitated" (2016, p. 58). Generalizing learning describes student prior experience and assumptions that may affect student understanding based on this experience and based on the mode of critical thinking with which the student is most comfortable. Student prior experience, as a whole, is an intersection of academic, social and geographical experiences.

However, little is done to expand students' understanding of how each discipline typically approaches academic problem solving. No foundation is provided to educate students about how academic problem solving differs by subject area or how to adjust their thinking to fully understand the underlying concepts of dissimilar material. For example, a student whose chief discipline is science-centered

might attempt to read a novel and then analyze it in terms of facts and information provided within the story, but fail to make the imaginative leaps necessary to fully grasp a literary analysis. Similarly, a student whose chief mode of inquiry is aesthetic might make assumptions based on assumptions unproven because no one has told them about creating a hypothesis and then proving it in an objective manner. How one's mode of thinking develops depends on the specific influences in one's life.

Thus, to help students succeed, they need to learn how to identify and practice using problem-solving approaches from different disciplines (e.g. social science, science and humanities). These modes also need to be identified by professors within discipline-specific curriculum. Identifying these processes and providing students the opportunity to distinguish and explore the principles and practices of each will help make them more flexible and comfortable learners.

Principle 4: Formative Feedback — An iterative cycle of practice and high-quality feedback is essential to learning.

Lucariello et al. (2016) highlight that "regular, specific, explanatory, and timely feedback" can increase student learning. It has been established that directed practice coupled with targeted feedback is critical to learning. Effective feedback focuses on the knowledge and skills that you want students to learn, is provided at a time and frequency when students will be most likely to use it, and is linked to additional practice opportunities for students (Ambrose, Bridges, DiPietro, Lovett, & Norman, 2010). Often this type of feedback has been called formative feedback. Much research has been done on formative feedback providing practical applications to teaching throughout the university. Clarity, specificity, tone, and placement of feedback have all been researched and detailed extensively by Brookhart (2008). Additionally, Juwah et al. (2004) detail seven principles of formative feedback that include the following:

1. Facilitates the development of self-assessment (reflection) in learning.
2. Encourages teacher and peer dialogue around learning.
3. Helps clarify what good performance is (goals, criteria, expected standards).
4. Provides opportunities to close the gap between current and desired performance.
5. Delivers high quality information to students about their learning.
6. Encourages positive motivational beliefs and self-esteem.
7. Provides information to teachers that can be used to help shape the teaching.

Principle 5: Brain Plasticity and Memory — Learning changes the structure of the brain.

Brain plasticity is a lifetime process, and "is the epitome of learning. . . Every time the brain learns something, it experiences physical changes and demonstrates its plasticity" (Tokuhama-Espinosa, 2011, p. 120). Permanent cellular changes in neuronal structures and development of relationships among neurons record our learning in memory. In many ways we build our own minds as we learn, and memories are "more than information. They represent fluctuating patterns of associations and connections across the brain from which the individual extracts order and meaning" (Sousa, 2011, p. 91).

The first stage of memory is short-term memory: immediate memory from a sensory stimulus (all information enters the brain through the senses) and working memory. However, unless certain conditions are met, data from short-term memory isn't encoded in long-term memory, and students will not be able to recall it after it "decays" from short-term memory. The brain is constantly receiving stimuli from external and internal sources, and not everything gets encoded to long-term memory. There are four conditions under which short-term memory is encoded to long-term memory for recall: 1) Is this for survival? 2) Is there an emotional dimension? 3) Does this make sense (can it be connected to past experiences—otherwise, why remember it?) and 4) Does this have meaning (is it relevant—otherwise, why remember it?). The importance of relevance, sense-making and construction of meaning has a neurological basis as well as a pedagogical one. Long-term memory about an item is enhanced if there are multiple retrievals (practice) and if multiple senses are stimulated during learning. Since learning is the result of interconnections in the brain, the more interconnections the student has made through multiple pathways, the easier retrieval becomes.

Principle 6: Self-Regulation — Students' self-regulation skills can help them learn, and these skills can be explicitly taught.

Self-regulation is a process that involves the student and his/her/their tactics used to learn. According to Smith (2013), self-regulation is "adopting a learning process where one (1) formulates learning goals, (2) tracks progress towards these goals, (3) identifies gaps in one's knowledge or skills needed to achieve their goals, and (4) searches for relevant information or strategies to help them fill those gaps." While much of this process is based on the efforts of the students, teachers are also involved through teaching the many steps as well as creating courses based on a combination of self-regulatory techniques that include elaborative interrogation, self-explanation, summarization, highlighting (or underlining), keyword mnemonic, imagery use for text learning, rereading, practice testing, distributed practice, and interleaved practice (Dunlosky et al., 2013). Students are taught some of these tactics

throughout K-12, while other techniques are not intuitive or automatically learned. Student Success Centers can help students to match the appropriate techniques with what is being learned and how it is being taught.

For self-regulation to succeed, students have to be aware of their own thought processes and be motivated to actively participate in their own learning. One way to readily increase students' self-regulatory ability is to assist students in monitoring their performance, and enhance their skill in self-reflection (Zimmerman, 2001).

Principle 7: Motivation — Motivation is fundamental to learning.

What motivates students? Lucariello et al. (2016) argue that four principles regarding motivation are paramount. These include 1) intrinsic vs. extrinsic motivation; 2) focus on mastery of goals rather than performance goals; 3) opportunity to learn and learning outcomes; and 4) emphasis on short-term (*proximal*) goals over long-term (*distal*) goals. Motivation is probably the most important factor that educators can target in order to improve learning (Williams & Williams, 2011).

Intrinsic vs. Extrinsic Motivation. Intrinsic motivation is characterized as that which comes from within the individual. Extrinsic motivation, in contrast, provides incentive to engage in action which may not be inherently pleasing or engaging, but which may offer benefits in terms of perceived potential outcomes.

Focus on Mastery of Goals. Students persist in the face of challenging tasks and process information more deeply when they adopt mastery goals rather than performance goals. Mastery goals are associated with long-term benefits while performance goals deal with instant gratification. Mastery goals encourage students to strive for a higher objective.

Opportunity to Learn. Teachers' expectations about their students affect students' opportunities to learn, their motivations, and their learning outcomes. The term "self-fulfilling prophecy" is probably an apt description here because once an expectation develops, even if it is wrong, people behave as if the belief were true (Stipek, 2010). By behaving this way, they can actually cause their expectations to be fulfilled.

Emphasis on Short-Term Goals. Goals that are short term (proximal), specific, and moderately challenging enhance motivation more than goals that are long term (distal), general, and overly challenging. It's not just academic ability that determines motivation, but also capacities and character traits like resilience, self-confidence, and tenacity that help students stay the course as the emotional path grows rougher and the learning curve steeper (Headden & McKay, 2015). Lucariello *et al*. highlight three properties of goal setting: 1) short-term goals are preferable to long-term goals; 2)

specific goals are preferable to general goals; and 3) moderate goals are more likely to motivate students than “very hard or easy goals.”

Principle 8: Integrated Learning — Learning is most effective when co-curricular experiences are intentionally integrated in an educational experience within multiple social contexts.

Social context, interpersonal relationships, and emotional well-being are important elements in student learning. Interpersonal relationships and communication are critical to both the teaching-learning process and the social-emotional development of students. Emotional well-being influences educational performance, learning, and development. In light of these well-documented understandings, cited below, curriculum must work in tandem with student-life opportunities to maximize intellectual growth and student success (Lucariello et al., 2016).

University programming that can increase positive interpersonal relationships include deliberate orientation activities, peer mentoring, student clubs and organizations, resource centers (such as queer, women’s, multicultural, military veterans, and commuter), tutoring centers, student wellness and health services, counseling, and focused housing initiatives. Similarly, high impact practices (Kuh, 2008) such as first-year seminars, learning communities, collaborative assignments and projects, service learning, undergraduate research, and internships promote a system of connectedness and educational programming to facilitate the development of social-emotional and cognitive-academic competencies. Students are best viewed as members of various, sometimes overlapping, social contexts such as school, family, neighborhood, athletic team, club, or religious organization. Membership and participation in these social contexts can influence learning, development, and academic success (Lucariello et al., 2016).

Current research indicates a relationship between the social contexts of learning (safety, healthy relationships, engaged teaching, collaborative activities, and school connectedness), and student success (reduction of social-emotional and behavioral problems, absenteeism, suspension, and dropout). There is a direct correlation between positive social contexts, academic persistence, and ultimately graduation (Lucariello et al., 2016).

Principle 9: Active Learning — Engaging in active learning improves student performance.

Most of the principles above are based on constructivist theory, a conceptual framework that builds on the human need to make sense of the world, to understand and resolve uncertainty. Active learning is grounded in constructivist theory, based on years of research demonstrating that "to truly learn, we need to make an idea, a concept or a solution our own by working it into our personal knowledge and experience" (Barkley, 2010, p. 16). In active learning, students learn with each other, through inquiry, and by doing. Rather than being passive recipients of information transmissions, they are actively engaged in the learning process through in-class activities and structured interactions.

Active learning instructional strategies include collaboration, experiential learning, problem-based activities, and peer review. Interactive lectures—pausing every 15 minutes for a two to five minute activity such as a paired or small group discussion, an individual quick write, or a mini case study—represent another active learning instructional strategy (Major, Harris, & Zakrajsek, 2016).

IV. Conclusion and Recommendations

We suggested in the introduction that the natural corollary to ***"How do students best learn?"*** is ***"What implications are there for teaching methodologies and pedagogy?"*** Our conclusions follow.

Question 1: *Are there pedagogical methods or teaching practices (based on current research) that have proven to be effective for all college students?*

As described in the research above, course design and teaching practices that operationalize the nine principles we explored during our study improve academic success for all students. The implications of the learning principles that focus on *growth mindset*, *prior knowledge*, *knowledge transfer* and *motivation* highlight our responsibility to meet students where they are. The principle of *formative feedback* reflects an understanding of learning as an iterative process, not merely as a product or outcome. When we apply the principle of *integrated learning*, we create a learning environment that supports the whole student, in and out of the classroom. Use of instructional strategies based on *active learning* is grounded in insights gained from neuroscience about *brain plasticity and memory*. Finally, while *self-regulation* is ultimately the responsibility of the student, student success depends on our commitment to facilitating its development.

Question 2: *Are there pedagogical methods or teaching practices that have been identified in the research as especially effective for students with particular characteristics (first-generation students, and students from underrepresented populations, for instance)?*

While all students benefit from the application of these learning principles, there are three which are of particular benefit to first-generation and underrepresented students. These include growth mindset, formative feedback, and active learning.

The work of Yeager et al. (2016) exploring growth mindset has demonstrated that student success can be improved through a single, simple intervention aimed at addressing students' sense of belonging, their understanding of intelligence as malleable, and their perception that early challenges are part of the learning process for everyone. The positive effect is even stronger for students from racial, ethnic and socioeconomic populations with historic gaps in completion of college. These interventions can result in "31-40% reductions of the raw (unadjusted) institutional achievement gaps between students from disadvantaged and non-disadvantaged backgrounds" (n.p.). Other effects included "increased full-time enrollment rates, improved grade point averages, and reduced the overrepresentation of socially disadvantaged students among the bottom 20% of class rank" (n.p.), as well as increased use of student support services. SOU is participating in a related project, the College Transition Collaborative.

As part of an AAC&U project aimed at testing a methodology for assignment design, Winkelmes et al. (2016) reported an increase in sense of academic confidence, sense of belonging and perceived mastery of employer-valued skills, and suggest a relationship between these changes and a difference of 16% in persistence for full-time, first-year students involved in the experiments. The methodology involves re-designing two take-home course assignments to address the purpose of the task involved (beyond the course, beyond the major, and beyond college), an accessible description of the task (tested through review by another instructor not in the discipline), and a clear statement of criteria for evaluation (including an example of quality work). SOU is one of the institutions now involved in the research.

Finally, Freeman et al. (2014) completed a meta-analysis of 225 studies of the results of the use of active learning instructional strategies in large STEM lecture classes, finding that "average examination scores improved by about 6% in active learning sections, and that students in classes with traditional lecturing were 1.5 times more likely to fail than were students in classes with active learning" (p. 8410). The SOU Course Design Academy is focused on active learning instructional strategies.

The three teaching practices described above are interventions that are relatively small: one growth mindset assignment, as few as two assignment redesigns in a course, and incorporation of as few as four in-class assignments to make lectures more interactive. Yeager and Walton call such interventions "persuasive yet stealthy" (p. 267) and suggest they are successful because they "operate with the

context of existing structures to make them more effective" (2011, p. 274). Applications of the learning principles we have identified during the course of our study may not necessarily involve major educational reform; however, they can have profound positive effects on academic outcomes and student success.

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