

Elizabeth Stojanovski, 2015

Volume 1 Issue 1, pp. 169-177

Year of Publication: 2015

DOI- <https://dx.doi.org/10.20319/pijss.2015.s21.169177>

This paper can be cited as: Stojanovski, E. (2015). *Adjusted Pedagogy For Teaching Statistics*. *PEOPLE: International Journal of Social Sciences*, 1(1), 169-177.

This work is licensed under the Creative Commons Attribution-Non Commercial 4.0 International License. To view a copy of this license, visit <http://creativecommons.org/licenses/by-nc/4.0/> or send a letter to Creative Commons, PO Box 1866, Mountain View, CA 94042, USA.

ADJUSTED PEDAGOGY FOR TEACHING STATISTICS

Elizabeth Stojanovski

School of Mathematical and Physical Sciences, University of Newcastle, Callaghan, Australia,
elizabeth.stojanovski@newcastle.edu.au

Abstract

Traditional styles of teaching used to dominate the classroom for teaching statistics courses at tertiary level. It is proposed that knowledge will more likely be effectively learnt if traditional styles of teaching are supplemented with strategies from the more recent constructivist learning theory. It has the potential to result in increased collaboration in the classroom. When combined with the teacher's role being more of a facilitator, and use of real world applications, it is proposed that this will result in a more effective setting to encourage motivation and interest in learning. In turn, this will potentially provide a greater opportunity for improved learning outcomes.

Keywords

Teaching Statistics, Pedagogy, Active Classroom

1. Introduction

Statistical literacy refers to the ability to understand as well as critically evaluate statistical methods and results. With an increasing abundance of data and information, the people of society need to be statistically literate both in everyday life and the workplace. Employers expect employees to have relevant problem solving skills. Furthermore, it is widely recognised

that statistics is one of the most important quantitative courses in a university degree (Watson & Sullivan, 2008) and that statistics courses affect life-long perceptions and attitudes towards statistics.

Teaching statistics courses is not without its challenges. Many university students enter introductory statistics courses with anxiety about statistics. It is further recognized that statistics can be a difficult subject for students. Students have shown inconsistencies in their reasoning about elementary concepts (Groth & Berger, 2006). Furthermore, service courses often serve students with varying backgrounds and abilities, many with negative experiences of statistics and mathematics (Zieffler et al. 2008). It has also been recognized that the students of today think and learn differently than those from previous generations (Ertman & Newby, 2013), suggesting the need to revisit and potentially update traditional teaching practices. Any change in teaching techniques should aim at promoting learning and hence should be guided by learning theory.

2. Learning Theories

2.1 Traditional Theories

There has been increased attention recently to teaching and learning aspects of statistics education (Tishkovskaya & Lancaster, 2012). Traditional education in statistics has focused on developing knowledge and skills whereby students learnt by absorbing information. An instructor's teaching methods were considered to be effective in this framework if the instructor was able to transfer information clearly. There is concern, however, that research on the teaching and learning of statistics remains disconnected (Zieffler et al. 2008). Research in statistical education over the last ten years has focused on the need for reform in statistics pedagogy and hence in the teaching of statistics (Smith & Staetsky, 2007), which requires an understanding of how students learn.

Learning refers to the acquisition, retainment, and recall of knowledge. Learning theories are principles that explain how learning occurs (Ertman & Newby, 2013). Translating the theory of learning into teaching practice is an important, yet difficult, consideration (Zieffler et al. 2008). The main traditional learning theories include Behaviourism and Cognitive theory. Behaviourism is based on learners being told 'to do' whereby consequences encourage a behaviour. An example is studying for an exam to obtain a high mark. Cognitive theory leads to an understanding based on internally processing or absorbing received information whereby

students learn best when they practice and perform independently of others.

These traditional approaches have strongly influenced teaching for many years whereby learners remain passive and listen to receive knowledge.

2.2 Limitations of Traditional Theories

Learners who lack understanding often lose interest within the traditional framework. While traditional approaches promote independent learning, the student today is different to the student from two or three decades ago. For example, when many learning theories were developed, few people owned mobile phones (Siemens, 2004). Access to technology today is abundant, implying more people who are technologically advanced and more connected to their peers and the world (Prensky, 2010). It was stated that technology has changed learners' brains (Siemens, 2004), and people think differently based on their experiences (Barone, 2013). Given the digital world of today, regular communication is often in the form of words, images, videos, multi-media, among other forms, forms that are also becoming drivers in learning (Sharples, 2005). Additionally, there are more non-traditional learners, in the form of students commencing university at differing stages of life, who require more varied modes of learning (Cantor, 1995).

2.3 Modern Learning Theory

Piaget's constructivist learning theory defines learning as students actively constructing their own meanings by connecting new information to their prior knowledge (Borich et al. 1995). Unlike the behavioral approach, which restricts learners to be passive recipients of knowledge, active learning is enhanced by social interaction with the constructivist approach (Cooperstein & Kocevar-Weidinger, 2004). The focus of teaching becomes on developing understanding and providing opportunities for students to construct knowledge (Garfield & Ben-Zvi, 2007). The information transfer model is being replaced with a more constructivist view of learning. This shifts the focus of what students do from a practice of listening and reading to one of active participation and has recently become the new dominant educational theory (Karagiorgi & Symeou, 2005). The focus in education is hence shifted from the teacher to the learner.

Within the constructivist learning theory, the teacher's role changes to that of a facilitator. Students learn through active learning activities and problem solving tasks on real world applications or context that can stimulate students' problem formulation and engagement (Libman, 2010). The constructivist learning approach promotes social and communication skills by creating a classroom environment that focuses on the exchange of ideas and group work.

Learners gradually build self-confidence and self-esteem, producing more motivated students. Research shows that students acquire knowledge and hence learn better if they are motivated and engaged with learning.

2.4 Implications for Teaching Statistics

Learning theories are powerful devices. As a statistics educator will emphasise to students the importance of evidence based practices, evidence based practices in learning should also be used to guide statistical educators. Research on different learning theories in several disciplines is well established. The ideas from these different disciplines can be carried across to the study of statistics education. Constructivism has powerful implications for teaching, and there is a recent reform movement in education, including statistics, based on constructivism (Tishkovskaya & Lancaster, 2012). It has been shown that teaching in this framework is beneficial for the acquisition of statistical knowledge.

The goal of many introductory service statistics courses is to assist the student to become statistically literate, to be able to assess information in a meaningful manner and to become better evaluators of data. The goal is not to memories formulas for calculating specific measures such as the standard deviation. The important role of constructivism in the teaching of statistics is supported and is often implemented in statistics education (Tishkovskaya & Lancaster, 2012).

The constructivist model of learning forms part of the author's refined teaching philosophy and pedagogy in the teaching of service courses in statistics. Exclusive use of the traditional model is no longer warranted as effective learning is difficult to convey to the students of today when it is based solely on symbols and formulas, given the different type of student that is taught today in an environment comprising an abundance of technology. The author proposes the incorporation of the constructivist learning pedagogy, which means abandoning an exclusive information transfer model. However, the constructivist approach is not advocated exclusively for the teaching of service statistics courses at tertiary level. A combination of both approaches is proposed given the harm that could result from taking the constructivist approach to its extreme. Statistical competence of a student remains a goal of the instructor. The supplementation or replacement of some traditional cognitive teaching practices already prevalent in most classrooms with new approaches that incorporate pedagogical principles of constructivism is hence implied. It has been suggested that the most effective

learning occurs when content, pedagogy and technology complement each other (Moore, 2000). The revised proposed pedagogy incorporates these components.

3. Incorporating Modern Learning Theory into Teaching of Statistics

3.1 Active Based Learning

The proposed pedagogy focuses on a variety of activities presented in the classroom whereby student discussions are advocated by asking many questions and by smaller group discussions. A more active role in learning would involve applications based on real life data from everyday situations, which has the potential to improve the quality of learning statistics by improving the interest and thus motivation of students. Implementation of the new pedagogy in practice would involve supplementing some presentation in the traditional classroom with these methods.

3.2 Social Interaction and Technology

Social interaction represents a means for learning in active based activities, also encouraging cooperative and collaborative learning (Garfield, 1995). Students work together and build on each other's responses, further enabling possible cognitive conflict to be reduced (Wadsworth, 1996). A source of cognitive conflict can motivate students to learn (Bhattacharya b& Han, 2001). Another form of social learning occurs via group discussion interaction that enables transferring of ideas and thus learning from individuals to the entire class. Hearing other perspectives helps students judge and improve the quality of their own thinking (Barrett, 2005). Students regularly work in smaller groups to discuss an exercise, enabling building of knowledge by assessing multiple views, further enhancing the ability to explain, communicate and hence improve teach (Moore, 2000).

Technology has become a major part of everyday life and is increasingly being used as a teaching tool to enhance the motivation of learners. For example, in a second year course taught by the author, the use of interactive hand-held devices, also referred to as clickers, in the previous two deliveries of the course, during lectures, has received positive feedback from students with comments suggesting that the interactive resources help to learn statistics... These clickers were incorporated as a means of regularly revising content and providing staff with a method to interactively poll students with multiple choice questions to gauge prior knowledge and understanding and to provide students with immediate feedback. The hand-held device

comprises a separate button for responses A-J. Students are asked to select the response using the hand-held device for the best answer to each of several multiple choice questions presented during lectures. As responses are anonymous, students are more encouraged to participate, and responses are automatically collated using the corresponding software and displayed directly to students via a computer. Students are sometimes asked to work in small groups to answer this question, which encourage further interaction and discussions.

3.3 Problem Solving

Solving problems in an active learning environment enables the learning of problem solving skills that remain life-long skills (Barrett, 2005). A form of active learning is problem based learning. It is proposed that a problem be presented to the class at the start of the learning process, preferably soon after the lecture commences, before other statistical concepts are introduced, with the intention to start engagement with students early. The active learning environment should then be implemented to maintain engagement of the students. Once the engagement is attained, and brainstorming has occurred, the instructor is then in a position to present information in a mini-lecture style that builds on the knowledge of students, as sourced from the brainstorming session.

The effectiveness of problem based learning approach within medical education is well established (Albanese & Mitchell, 1993) and has since extended to other disciplines including statistics. Examples in statistics courses indicate students to be more engaged with the subject, hence contributing to a greater potential to learn with this approach. This process has been effective in terms of improving student motivation and engagement as demonstrated via improved feedback when these methods were implemented in the teaching of statistics service courses at first year level.

3.4 Real Life Examples

A learning scenario that encourages the personal investigation in a real life context that does not necessitate one correct way of learning about reality or a single correct answer is more likely to hold the learners' interests and hence motivation of students (Garfield & Ben-Zvi, 2007). Real world problems are designed to engage student interest. The real life context of a problem that is relevant to students enables the student to personally evaluate the studied concepts in the context of a relevant and interesting example.

3.5 Motivation and the Beginning of Class

Experience with solving real life problems using the constructivist approach is useful to help learners transfer the attained skills to the real world. If learners can problem solve, they may better apply these skills to new problems (Garfield & Ben-Zvi, 2007). Problem solving requires well developed reasoning and knowledge (Watson & Sullivan, 2008) that can be achieved by focusing on linking concepts in a specific context which then increases the potential to seek solutions when confronted with new problems. In summary, the proposed learning approach provides students with the opportunity to apply theory to real life situations and bring concepts and theories to life, thereby further contributing to the enhancement of student learning.

4. Conclusion

Traditional teaching styles that used to dominate the classroom for teaching statistics courses at tertiary level are now being replaced with the new constructivist styles. It is proposed that knowledge will be more effectively learnt if traditional styles of teaching are supplemented with and not replaced exclusively with strategies from the more recent learning theory. Learning, by incorporating strategies from the new learning theory framework, will likely still result in understanding but knowledge is more likely to occur as a result of methods that offer improved opportunities for students to construct knowledge to meet the expectations and needs of today's learners. The methods proposed to supplement the traditional style of teaching include a combination of active based learning, with the teacher's role being more of a facilitator to increase the potential for collaboration in the classroom, use of real world examples, and the incorporation of technology within lectures to help promote learning. A combination of strategies from both the traditional and new constructivist frameworks has been implemented in first and second year service delivery statistics courses with positive outcomes. Students responded favorably to the implementation of these methods, with improved satisfaction outcomes over previous offerings. It is proposed that this will result in a more effective setting to encourage motivation and interest in learning. In turn, this will potentially provide a greater opportunity for improved learning outcomes.

References

- Albanese, M. & Mitchell, S. (1993). Problem-based learning: a review of literature on its outcomes and implication issues. *Academic Medicine*, 68, 52-81.
- Barone, M. (2013). Medical students, mindsets and learning behaviour change, *Medical Education*, 47(11), 1053-1055.
- Barrett, L. (2005). The social nature of primate cognition. *Proceedings of the Royal Society of London B: Biological Sciences*, 272(1575), 1865-1875.
- Bhattacharya, K. & Han, S. (2001). Piaget and cognitive development. In M. Orey (Ed.), *Emerging perspectives on learning, teaching and technology*. Retrieved from <http://epltt.coe.uga.edu/>.
- Borich, G., Mason, R. & Tombari, M. (1995). *Educational Psychology: A Contemporary Approach*. New York: Harper Collins College, 1995.
- Cantor, J. (1995). Experiential learning in higher education: Linking classroom and community, *ASHE-ERIC Higher Education Report*, 24(7), 1–102.
- Cooperstein, S. & Kocevar-Weidinger, E. (2004). Beyond active learning: a constructivist approach to learning. *Reference Services Review*, 32(2), 141-148.
- Driscoll, M. (1994). *Psychology of learning for instruction*. Boston: Allyn and Bacon.
- Ertmer, P. & Newby, T. (2013). Article update: Behaviorism, cognitivism, constructivism: Connecting Yesterday's theories to today's contexts. *Performance Improvement Quarterly*, 26(2), 65-71.
- Garfield, J. (1995). How students learn statistics. *International Statistics Review*, 64, 25-34.
- Garfield, J. & Ben-Zvi, D. (2007). How Students Learn Statistics Revisited: A Current Review of Research on Teaching and Learning Statistics. *International Statistical Review*, 75: 372–396.
- Groth, R. & Berger, J. (2006). Theoretical lenses for examining undergraduate students' statistical thinking. *Joint Annual Meeting of the American Mathematical Society and the Mathematical Association of America*, San Antonio, TX.
- Karagiorgi, Y. & Symeou, L. (2005). Translating Constructivism into Instructional Design: Potential and Limitations. *Educational Technology and Society*, 8 (1), 17-27.
- Libman, Z. (2010). Integrating Real Life Data Analysis in Teaching Descriptive Statistics: A Constructivist Approach. *Journal of Statistics Education*, 18(1).

- Moore, A. (2000). *Teaching and Learning Pedagogy, Curriculum and Culture, Key Issues in Teaching and Learning*. Routledge.
- Prensky, M. (2010). *Teaching Digital Natives: Partnering for Real Learning*. Thousand Oaks, Corwin Press.
- Sharples, M. (2005). Disruptive devices: mobile technology for conversational learning, *International Journal of Continuing Engineering Education and Life Long Learning*, 12(5/6), 504-520.
- Siemens, G. (2004). A learning theory for the digital age. Retrieved from <http://www.elearnspace.org/articles/connectivism.htm>.
- Smith, T. & Staetsky, L. (2007). The Teaching of Statistics in UK Universities. *Journal of the Royal Statistical Society, Series A*, 170, 581-622.
- Tishkovskaya, S. & Lancaster, G. (2012). Statistical Education in the 21st Century: a Review of Challenges, Teaching Innovations and Strategies for Reform. *Journal of Statistics Education*, 20(2).
- Wadsworth, B. (1996). *Piaget's Theory of Cognitive and Affective Development*. Foundations of Constructivis. Longman.
- Watson, A. & Sullivan, P. (2008). Teachers learning about tasks and lessons. In Tirosh, D. & Wood, T. (Eds.) *Tools and resources in mathematicsteacher education* (pp. 109–135). Sense Publishers: Rotterdam.
- Zieffler, A., Garfield, J., Alt, S., Dupuis, D., Holleque, K. & Chang, B. (2008). What does research suggest about the teaching and learning of introductory statistics at the college level? A review of the literature. *Journal of Statistics Education*, 16(2).