British Journal of Education
Vol.10, Issue 15, 37-45, 2022
Online ISSN: 2054-636X (Online)
Print ISSN: 2054-6351(Print)

University Mathematics Major Students' Ratings of Their Lecturers' Preferred Teaching Methods: A Repeated-Measures Design

Charles Kojo Assuah [a]*, Louis Osei[a], and Gershon Kwame Mantey[a]

[a]Department of Mathematics Education, University of Education, Winneba, P.O. Box 25, Winneba, Ghana

https://doi.org/10.37745/bje.2013/vol10n153745 Published: 5th November 2022

Citation: Assuah C.K., Oseia L., and Manteya G.K. (2022) University Mathematics Major Students' Ratings of Their Lecturers' Preferred Teaching Methods: A Repeated-Measures Design, *British Journal of Education*, Vol.10, Issue 15, 37-45

ABSTRACT: *This study investigates the differences in lecturers' preferred teaching methods based on the ratings of their students. It employed the repeated measures design, where four separate ratings for each participant were taken. The participants comprise eighty-two (82) university mathematics major students, made up of fifty-five (55) males and twenty-seven (27) females, who were selected from a university in the central region of Ghana, using a non-proportionate stratified sampling technique in two third-year cohort mathematics classes. The results indicated that Mauchly's test of sphericity was not significant,* $\chi^2(5) = 10.33, p > .05$, *(i.e., the assumption about the characteristics of the variance-covariance matrix was not violated). Thus, the within-subjects variable of the teaching method was highly significant, F (3, 243) = 468.17, p < .05, indicating that the mean students' ratings differed significantly as a function of the four teaching methods. This was supported by the decrease in the mean students' ratings from guided discovery to direct instruction methods. The pairwise comparisons (with Bonferroni adjustment) among the four teaching methods, showed a significant difference between any pair of teaching methods (p < .05). Thus, the students' ratings for guided discovery were higher than the ratings for cooperative learning (p < .05), ratings for cooperative learning were higher than the ratings for inquiry-based learning (p < .05), and the ratings for inquiry-based learning were higher than the ratings for direct instruction (p < .05). The estimated marginal means for the ratings of guided discovery (M = 8.12; C. I = [7.94, 8.32]) were the highest, followed by the mean ratings for cooperative learning method (M = 6.68; C.I = [6.51, 6.86]), followed by the mean ratings for inquiry-based learning (M = 4 73; C. I = [4.60, 4.87]), and then followed by the mean ratings for direct instruction (M = 3.95; C.I = [3.80,4.11]). The study's implications are that, although many researchers recommend multiple teaching methods for mathematics instruction, lecturers should endeavour to use teaching methods that are popular and acceptable among students. This would enable them to understand the content their lecturers teach. The study concludes that lecturers should focus more on active teaching methods such as guided discovery and cooperative learning and focus less on the direct instruction teaching method.*

KEYWORDS: Repeated measures design, ratings, preferred teaching methods, non-proportionate stratified sampling.

INTRODUCTION

When students rate their lecturers' preferred teaching methods, they do so based on their own experiences and are frequently driven by a set of ideals (Kaltsounis, 1987). Individuals like students, find it challenging to make informed choices during this period. Despite this challenge, their decisions are facts of their life and should be respected (Barker, 1998). People's decisions can sometimes have an impact on others (Allison, Jordan & Yeats, 1992). What motivates an individual to display specific features or attributes during the decision-making process is the establishment of a difficulty that necessitates such decision-making. The decision-making process is triggered by a need or challenge. Before making a decision, the individual weighs two or more options (Adair, 2000). There are alternatives for forming options, analysing options, and determining options during this process (Blunden, 1994). Before making a choice, the person making the decision considers an ideal alternative from multiple options (Adair, 2000). It gives people meaning in life when they make their own decisions about what they do. As a result, the ability to make decisions is critical in establishing an individual's life responsibility (Cote Sparks & Cote, 2012). People make decisions all the time, such as what to dress, what to eat, what television show to watch, and what plans to make for the future (Cote, Sparks & Cote, 2012).

LITERATURE REVIEW

A variety of elements influence decision-making. For example, experience (Juliusson, Karlsson, & Garling, 2005), cognitive biases (Stanovich & West, 2008; Shah & Oppenheimer, 2011), individual differences (Bruin, Parker, & Fischoff, 2007), personal relevance belief (Acevedo, & Krueger, 2004), and cognitive talents are among them (de Bruin, Parker, & Fischoff, 2011; Finucane, Mertz, Slovic, & Schmidt, 2015). An individual resorts to a mental evaluation in order to find solutions to an issue (Zeleny, 1982). The meaning that an individual attaches to a stimulus influences his or her preferences through this process. He or she is given the option of selecting between two preferable stimuli. The descriptive method takes into account the effective factors of an individual's actions, the source of the decisions, and the environmental consequences of such decisions (Scheifele, 2001). Effective decisions are produced fast and simply through lateral thinking (Shah & Oppenheimer, 2009). It is the general decision-making approach that people use based on available knowledge, and it is extremely accurate. It functions as a mental shortcut by lowering the cognitive load associated with decision-making (Shah & Oppenheimer, 2008). It allows people to work because it decreases the stress associated with making decisions. It serves as a guide for them to reduce the amount of work they expend. Together, lateral thinking and decision-making considerations are important components of critical thinking (West, Toplak, & Stanovich, 2009).

Timely, accurate, and appropriate decisions result in good improvements in an individual's life, whereas incorrect decisions have a detrimental effect (Tatlolu, 2014). To be successful, an individual needs to be made aware of the possibilities and be able to choose the best one(s). In this scenario, there is a correlation between decision-making competence and personal accomplishment (Byrnes, 2002). This process is determined by the qualities of the individual's living environment (Deci & Ryan, 1985).

Cooperative learning is active learning in which students interact with one another in the mathematics classroom while learning and applying course content. It gathers students in small, varied, and interdependent groups without continual and direct supervision from the lecturer (Felder & Brent,2001). Assignments and tasks are designed in such a way that every student contributes and that difficulties and rewards are shared. It is frequently regarded as an exceptionally effective learning and teaching method (Felder & Brent,2001). Cooperative learning consists of five fundamental components: Clear positive dependency, face-to-face interaction, individual accountability, an emphasis on interpersonal and small group skills, and group evaluation systems in place to improve efficacy (Vaughan, 2002). Students have longer information retention, better performance in examinations, higher grades, stronger critical thinking and problem-solving skills, more positive attitudes toward the subject and greater motivation to learn it, better interpersonal and communication skills, and higher self-esteem (Baines, Blatchford, & Chowne, 2007).

Inquiry-based learning is a student-centered approach to learning that emphasises questioning, critical thinking, and problem-solving. It all starts when lecturers assign students questions to answer, problems to solve, or observations to explain (Dochy, Segers, Van den Bossche & Gijbels, 2003). Students learn how to formulate effective questions, discover and collect adequate evidence, present results systematically, and analyse and interpret conclusions through this process (Karagiorgi & Symeou, 2005). One of the most successful strategies to help students develop higher-order critical thinking skills is to involve them in inquiry-based learning, which involves students learning via explanation and exploration (Feden & Vogel, 2003).

In discovery learning, students then work mostly independently to complete their given activities and make suitable conclusions from the results (Balm, 2009). Discovery learning takes place in the classroom through planned or directed activities that require students to manipulate, analyse, and explore things that may lead to the discovery of key ideas or correlations (Balm, 2009; Schunk, 2000). Students learn facts for themselves and how to learn (Benedict & Anderson, 2004). When students actively participate in discovery learning, the connections they establish are based on their own past knowledge rather than the prior knowledge of others. The connections are already more important since they are made by students (Bicknell-Holmes & Hoffman, 2000).

The major purpose of direct instruction is to get students to master the concepts before teaching them new ones (Adams & Engelmann, 1996). Direct instruction is a behavioural strategy in which instructions are given explicitly and sequentially when a skill is to be acquired, or instructional models are presented without interruptions. Instead of relying on students' own experience, this technique focuses on the procedures followed by lecturers and the curriculum, identifying exactly and explicitly what abilities must be mastered step by step. This, of course, improves and accelerates student learning (Adams & Engelmann, 1996).

The previously stated active learning strategies are backed by educational theories such as cognitivist, constructivist, and experiential theories, as well as empirical investigations of teaching and learning (Chance, 2005). When mathematics students actively participate in discussing ideas and working together to complete mathematical assignments, learning is most successful (Doerr & Lesh, 2003; Tan, 2004; Tan, 2005). Currently, Ghanaian mathematics lecturers still struggle to effectively use teaching methods that can help their students understand mathematics. This study would help identify the best teaching methods that students themselves feel appropriate for their lecturers to use in the classroom. The purpose of this study was to investigate the differences in lecturers' teaching methods based on the ratings their students assign to these methods. The following research question guided the study: Are there significant differences in lecturers' teaching methods based on their students' ratings?

METHOD

Research Design

A repeated measures design was used for this study. It involves multiple measures of the same variable taken on the same or matched subjects/participants either under different conditions or over two or more time periods. It is appropriate when multiple measures of a dependent variable are taken on the same subjects/ participants or matched subjects/participants under different conditions or over two or more time periods. It varies from conventional between-groups designs in that each measurement or treatment condition requires a separate sample of subjects/participants. In a repeated measures design, observations can come from the same sample or experimental unit from one time to the next or from one condition to the next. Each student rates their teachers on their preferred teaching methods based on a ten (10)-point continuous scale. These teaching methods represent the teaching methods all lecturers use normally for instruction and do not apply to a particular lecturer's teaching method used for instruction.

Participants and Setting

Eighty-two (82) university mathematics major students, made up of fifty-five (55) males and twenty-seven (27) females were selected from a university in the central region of Ghana, using a non-proportionate stratified sampling technique among two third-year cohort mathematics classes, each comprising fifty-one students. Their religious affiliation was Christianity = 45; Islam = 27; African Traditional Religion = 6; and Others = 4, while their ethnicity was Asanti = 18; Fanti = 22; Ga = 15; Ewe = 13; and other ethnicity = 14. Table 3 illustrates the students' demographic characteristics.

Table 3 Students' Demographic Characteristics

Demographic Characteristic	Category	Number of teachers	Percentage
Religion	Christianity	45	54.9
	Islam	27	32.9
	African Traditional Religion	6	7.3
	Others	4	4.9
	Total	82	100.0
Gender	Male	55	67.1
	Female	27	32.9
	Total	82	100.0
Ethnicity	Asanti	18	22.0
	Fanti	22	26.7
	Ga	15	18.3
	Ewe	13	15.9
	Others	14	17.1
	Total	82	100.0

RESULTS

Table 1 Descriptive Statistics

	Mean	Std. Deviation	N
Guided Discovery Method	8.13	.85	82
Cooperative Learning Method	6.68	.80	82
Inquiry-based Learning Method	4.73	.60	82
Direct Instruction Method	3.95	.70	82

Table 1 shows the means and standard deviations of the students' ratings. The guided discovery method had the highest mean rating (*M* = 8.13; *SD* = .85), while direct instruction had the lowest mean rating (*M* =3.95; *SD* = .70). Table 2 shows Mauchly's test of sphericity.

Table 2 Mauchly's test of sphericity

					Epsilon[b]		
Within subjects effects	Mauchly's W	Approx. Chi-Square	df	Sig.	Greenhouse-Geisser	Huynh-Feldt	Lower-bound
ing methods	.88	10.33	5	.08	.92	.96	.33

Table 2 indicates that Mauchly's test of sphericity was not significant, $\chi^2(5) = 10.33, p > .05$, (i.e., the assumption about the characteristics of the variance-covariance matrix was not violated). Thus, the tests of within-subjects effects could be interpreted. Table 3 shows the tests of within-subjects effects.

Table 3 Tests of within-subjects effects

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Teaching Methods	Sphericity Assumed	880.44	3	293.48	468.17	.00	.85
	Green-Geisser	880.44	2.77	318.23	468.17	.00	.85
	Huynh-Feldt	880.44	2.87	306.31	468.17	.00	.85
	Lower-bound	880.44	1.00	880.44	468.17	.00	.85
Error (Teaching Methods)	Sphericity Assumed	152.33	243	.63			
	Green-Geisser	152.33	224.10	.68			
	Huynh-Feldt	152.33	232.82	.65			
	Lower-bound	152.33	81.00	1.88			

Table 4 shows the tests of within-subjects effects. The results indicated that the within-subjects variable of the teaching method was highly significant, *F* (3, 243) = 468.17, *p* < .05. Thus, the mean students' ratings differed significantly as a function of the four teaching methods. This is supported by the decrease in the mean students' ratings from guided discovery to direct instruction methods. Table 4 shows the pairwise comparisons of the four teaching methods.

Table 4 Pairwise Comparisons of the Teaching Methods

Teaching Methods	(J) Teaching Methods	Mean Difference (I-J)	Std. Error	Sig.	95% C. I for Difference Lower Bound	Upper Bound
1	2	1.45*	.13	.00	1.09	1.80
	3	3.40*	.12	.00	3.07	3.73
	4	4.18*	.14	.00	3.80	4.56
2	1	-1.45*	.13	.00	-1.80	-1.09
	3	1.95*	.12	.00	1.63	2.27
	4	2.73*	.12	.00	2.41	3.05
3	1	-3.40*	.12	.00	-3.73	-3.07
	2	-1.95*	.12	.00	-2.27	-1.63
	4	.78*	.11	.00	.49	1.07
4	1	-4.18*	.14	.00	-4.56	-3.79
	2	-2.73*	.12	.00	-3.05	-2.41
	3	-.78*	.10	.00	-1.07	-.49

$p^* < .05$

Table 4 shows the pairwise comparisons (with Bonferroni adjustment) among the four teaching methods. The results indicated that there was a significant difference between any pair of teaching methods ($p < .05$). Thus, the students' ratings for guided discovery were higher than their ratings for cooperative learning ($p < .05$), ratings for cooperative learning were higher than their ratings for inquiry-based (p < .05), and ratings for inquiry-based learning were higher than their ratings for direct instruction ($p < .05$). Table 5 shows the estimated marginal means for the students' ratings.

Table 5 Estimated Marginal Means of the students' ratings

Teaching Method	Mean	Std. Error	95% C. I. Interval Lower Bound	Upper Bound
Guided Discovery (1)	8.12	.09	7.94	8.32
Cooperative (2)	6.68	.09	6.51	6.86
Inquiry-based (3)	4.73	.07	4.60	4.87
Direct Instruction (4)	3.95	.08	3.80	4.11

Table 5 shows the estimated marginal means of the students' ratings and their respective standard errors and confidence intervals. The highest student' mean ratings started from the guided discovery method and ended with direct instruction. The graph of the estimated marginal means is indicated in Figure 1

Figure 1 Graph of the Estimated Marginal Means

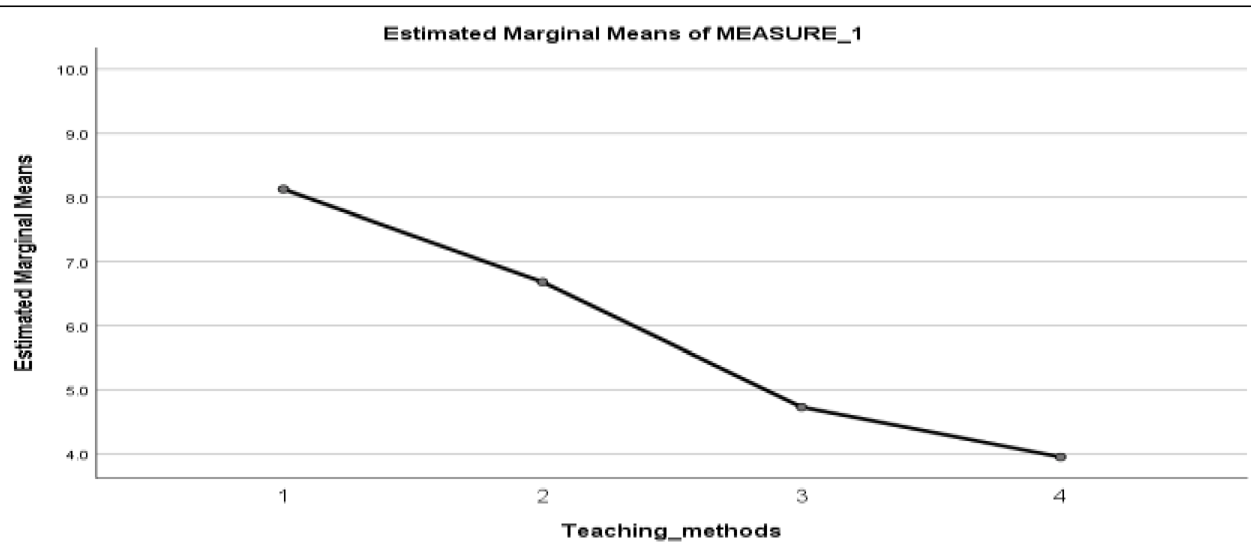

Figure 1 shows the graph of the estimated marginal means of four teaching methods. The mean ratings for guided discovery (M = 8.12; $C. I$ = [7.94, 8.32]) was the highest, followed by the mean ratings for the cooperative method (M = 6.68; $C.I$ = [6.51, 6.86]), followed by the mean ratings for inquiry-based learning (M = 4 73; $C. I$ = [4.60, 4.87]), and then followed by the mean ratings for direct instruction (M = 3.95; $C.I$ = [3.80,4.11])

DISCUSSIONS

The pattern of the students' ratings, which were major decisions they made, was influenced by the effectiveness of their teachers' teaching methods (Juliusson, Karlsson, & Garling, 2007). Generally, people are more likely to make decisions that result in positive outcomes today and in the future if they believe they will experience similar outcomes. People, on the other hand, would avoid past mistakes if they resulted in negative outcomes (Sagi, & Friedland, 2007). People's cognitive biases influence them to rely on or give more credence to expected observations and prior knowledge, but it dismisses information perceived as uncertain. It enables people to make more informed decisions (Stanovich & West, 2008; Shah & Oppenheimer, 2011). People, just like the students in this study, make decisions based on an irrational escalation of commitment (Juliusson, Karlsson, & Garling, 2005). As a result, they expend effort and time to make decisions to which they are fully committed. Furthermore, people make risky decisions when they feel accountable for their efforts and time.

Research has shown that age, socioeconomic status, and cognitive abilities all influence decision-making (de Bruin, Parker, & Fischoff, 2011; Finucane, Mertz, Slovic, & Schmidt, 2005). Therefore, the students' ratings could also have been influenced by their cognitive abilities as well as their lecturers' knowledge and dispositions about the subject matter they teach. Certainly, the confidence and dexterity with which lecturers displayed their teaching skills were a tremendous influence on students' ratings as well. Decision-making ability decreases as cognitive functions decline with age. As people get older, they become more confident in their ability to make decisions, which limits their ability to apply other strategies (de Bruin et al., 2007).

Lecturers could use the following order of instruction to improve their teaching: guided discovery, cooperative, inquiry-based instruction, and direct instruction (Assuah, 2019). These students' ratings corroborate Assuah's (2019) earlier finding that highly rated teaching methods corresponded to those in which students performed well, after instruction. While research on the best mathematics teaching method is still inconclusive, strong evidence suggests that teachers can improve students' conceptual mathematics understanding by giving them opportunities to develop their own ideas of the underlying concepts through exploration, but this is best achieved when teachers provide some reasonable degree of guidance to students (Marshal & Horton, 2011; Lazonder & Harmsen, 2016).

It could be argued that guided discovery received the highest mean ratings and direct instruction received the lowest because the former incorporates a balance of direct instruction and inquiry-based learning, in some cases, while maintaining high levels of cognitive thinking and learning. It also promotes critical thinking, problem-solving, and collaboration and allows students to work at their own pace by demonstrating their learning in various ways (Kroesbergen & Van Luit, 2003). Again, many teachers have demonstrated a distinct and exemplary teaching strategy, allowing students to rank some teaching methods higher than others (Wilson, Floden, & Ferrin-Mundy, 2001). Furthermore, the classroom environment and seating arrangement may have influenced students' ratings (O'Conner & Michaels, 1996).

The students' ratings may have also been influenced by an appropriate learning environment that encourages mathematics learning and encourages divergent opinions and viewpoints. It is worth noting that understanding and recognising connections in mathematics comes from attempting to achieve the same result in multiple ways. Students learn best when lecturers create a trusting environment in which students can easily seek explanations for mathematical concepts. The social environment provided by lecturers while using these teaching methods is just as important as the physical environment. However, the quality of instruction makes a difference, and it is the interaction between lecturers and students, particularly the feedback the students receive, that is critical (Hattie, 2003).

Students may rate some teaching methods highly because lecturers believed mathematics learning required risk-taking and that mistakes were a natural part of the learning process. Students will trust and have confidence in lecturers who can provide informed, genuine, and encouraging responses to them (Boykin & Noguera, 2011). While lecturers can create learning environments and demonstrate learning strategies, the strategies must actively engage students for effective learning to occur. The content must be engaging enough for students to actively participate. Effective lecturers provide students with purposeful learning experiences by solving problems in relevant and meaningful contexts (Boykin & Noguera, 2011). There is ample evidence that problem-solving should be integral to all mathematics learning. However, problem-solving teaching means that students learn mathematics through real-world contexts, problems, situations, and models.

IMPLICATION FOR TEACHING AND LEARNING

The active learning process fosters students' critical thinking and problem-solving abilities, as well as their ability to make relevant connections between course content and broader contexts. It promotes analysis, synthesis, and evaluation of class content by engaging students in learning activities such as reading, discussion, and problem-solving. It also allows students to receive informal feedback on how well they understand the course material. Hands-on activities allow students to learn from real-life experiences and extend their problem-solving and thinking to make connections to different contexts, thereby developing their creativity and imagination. Students benefit from active learning in a variety of ways, including improved attitudes toward learning, increased motivation, increased retention of course material, and improved academic performance. Furthermore, active learning methods provide a platform for lecturers to assess students' comprehension of course content.

CONCLUSION

In their proper order, lecturers could use the following teaching methods to improve their teaching: guided discovery, cooperative, inquiry-based instruction, and direct instruction. While research on the best mathematics teaching method remains inconclusive, strong evidence suggests that teachers can improve students' conceptual mathematics understanding by giving them opportunities to develop their ideas of the underlying concepts through exploration, but this is best achieved when lecturers provide some reasonable degree of guidance to students (Assuah, 2019; Marshal & Horton, 2011; Lazonder & Harmsen, 2016).

REFERENCES

Acevedo, M., & Krueger, J. I. (2004). Two egocentric sources of the decision to vote: The voter's illusion and the belief in personal relevance. *Political Psychology*, *25*(1), 115–134. https://doi.org/10.1111/j.1467-9221.2004.00359.x

Adair, J. (2000). *Karar verme ve problem çözme*. (Çev: Kalaycı, N.). Ankara: Gazi Kitabevi

Adams, A.B., Kayes, D.C. & Kolb, D.A. 2005. Experiential learning in teams. *Simulation and Gaming*, 36(3), 330-354.

Allison, S. T., Jordan, A. M. R., & Yeatts, C. E. (1992). A cluster-analytic approach toward identifying the structure and content of human decision- making. *Human Relations*, *45*(1), 49-72.

Assuah, C. K. (2019). Using a Latin square design to determine the most effective mathematics teaching method. *International Journal of New Technology and Research*, 5(7), 64-69.

Baines, E, Blatchford, P. & Chowne, A. 2007. Improving the effectiveness of collaborative group work in primary schools: Effects on science attainment. *British Educational Research Journal*, 33(5), 663 – 680.

Balım, A.G. 2009. The effects of discovery learning on students' success and inquiry learning skills. *Eurasian Journal of Educational Research*, 35, 1-20.

Barker, A. (1998). Daha İyi Nasıl Karar Verme. (A. Çimen, Çev.). İstanbul: Timaş Yayınları.

Benedict, J.O. & Anderson, J.B. 2004. Applying the just-in-time teaching approach to teaching statistics. *Teaching of Psychology*, 31, 197-199.

Bicknell-Holmes, T. & Hoffman, P.S. 2000. Elicit, engage, experience, explore: Discovery learning in library instruction. *Reference Services Review*, *28*(4), 313-322.

Blunden, R. (1994). The concept of choice in health and social services: An overview. In creating opportunities for choice for people with learning difficulties. *Proceedings of a conference held in Southampton, 10-11 November*. Southampton: University of Southampton Institute for Health Policy Studies.

Boykin, A. W. & Noguera P. (2011) *Creating the opportunity to learn: moving from research to practice to close the achievement gap*. ASCD

Bruine de Bruin, W., Parker, A. M., & Fischhoff, B. (2007). Individual differences in adult decision-making competence. *Journal of Personality and Social Psychology*, *92*(5), 938–956. https://doi.org/10.1037/0022-3514.92.5.938

Byrnes, J., P. (2002). The Development of Decision-Making. *Journal of Adolescent Health*, *31*(6), 208-215.

Chance, P. 2005. *Learning and behavior: Active learning* (5th Ed). Wadsworth Publishing.

Cote Sparks, S. & Cote, D.L. (2012). Teaching choice-making to elementary students with mild to moderate disabilities. *Intervention in School and Clinic, 47*(5), 290–296.

Deci, E. L., & Ryan, R. M. (1985). *Intrinsic motivation and self-determination in human behavior*. Springer Science & Business Media. https://doi.org/10.1007/978-1-4899-2271-7.

Doerr, H. & Lesh, R. 2003. Foundations of models and modeling perspective on mathematics teaching, learning, and problem-solving. In H. Doerr & R. Lesh (Eds.), *Beyond constructivism: A models and modeling perspective*. Erlbaum and Associates, Inc.

Dochy, F., Segers, M., Van den Bossche, P., & Gijbels, D. (2003). Effects of problem-based learning: A meta-analysis. *Learning and Instruction, 13*(5), 533–568. https://doi.org/10.1016/S0959-4752(02)00025-7

Felder, R.M. & Brent, R. (2001). Effective strategies for cooperative learning. *Journal of Cooperation and Collaboration in College Teaching*, 10(2), 69–78.

Feden, P. & R. Vogel. 2003. *Methods of teaching: Applying cognitive science to promote student learning*, McGraw Hill Higher Education.

Finucane, M.L., Mertz, C.K., Slovic, P. & Schmidt, E.S. (2005). Task complexity and older adults' decision-making competence. *Psychology andAging*, *20*(1).

Hattie, J. (2003, October). *Teachers make a difference: What is the research evidence*? Paper presented at the Australian Council for Educational Research Annual Conference on Building Teacher Quality, Melbourne.

Jullisson, E.A., Karlsson, N., Garling, T. (2005). Weighing the past and the future in decision-making. *European Journal of Cognitive Psychology, 17*(4), 561-575. DOI: 10.1080/09541440440000159.

Kaltsounis, T. (1987). *Teaching social studies in elementary school*. New Jersey: Prentice Hall.

Karagiorgi, Y. & Symeou, L. 2005. Translating constructivism into instructional design: Potential and limitations. *Educational Technology & Society*, 8(1), 17-27.

Kroesbergen, E.H., Van Luit, J.E.H. & Maas, C. M. 2004. Effectiveness of explicit and constructivist mathematics instruction for low-achieving students in the Netherlands *Elementary School Journal*, *104*, 233-251.

Lazonder, A. W., & Harmsen, R. (2016). Meta-analysis of inquiry-based learning: Effects of guidance. *Review of Educational Research, 86*(3), 681–718. https://doi.org/10.3102/0034654315627366

Marshall, J. C., Smart, J., & Horton, R. M. (2010). The design and validation of EQUIP: An instrument to assess inquiry-based instruction. *International Journal of Science & Mathematics Education*, *8*(2), 299-321.

O'Connor, M.C., & Michaels, S. (1996). Shifting participant frameworks: Orchestrating thinking practices in group discussion. In D. Hicks (Eds.), *Discourse, learning, and schooling* (pp. 63-103). Cambridge University Press

Sagi, A., & Friedland, N. (2007). The cost of richness: The effect of the size and diversity of decision sets on post-decision regret. *Journal of Personality and Social Psychology*, *93*, 515-524. https://doi.org/10.1037/0022-3514.93.4.515

Shah, A. K., & Oppenheimer, D. M. (2011). Grouping information for judgments. *Journal of Experimental Psychology: General*, *140*(1), 1–13.https://doi.org/10.1037/a0021946.

Schiefele, U. (2001). The role of interest in motivation and learning, In J. M. Collis and S. Messick (Eds.). *Intelligence and personality: Bridging the gap in theory and measurement*. Erlbaum.

Schunk, D. 2000. *Learning theories: An educational perspective* (3rd Ed.). Prentice-Hall.

Stanovich, K.E., & West, R.F. (2008). On the relative independence of thinking biases and cognitive ability. *Journal of Personality and Social Psychology*, *94*(4), 672-695. DOI: 10.1037/0022-3514.94.4.672.

Tan, A. 2005. A review of the effectiveness of problem-based learning. *The Korean Journal of Thinking and Problem Solving*, 15, 29-46.

Tan, O.S. 2004. Students' experiences in problem-based learning: Three blind mice episode of educational innovation. *Innovations in Education and Teaching International*, *41*, 169-184

Tatlılıoğlu, K. (2014). Üniversite öğrencilerinin karar vermede öz-saygi düzeyleri ile karar verme stilleri arasindaki ilişkinin bazi değişkenlere göre incelenmesi. *Akademik Sosyal Araştırmalar Dergisi*, *2*(1), 150-170.

Vaughan, W. 2002. Effects of cooperative learning on achievement and attitude among students of colour. *The Journal of Educational Research*, *95*(6), 359-366

West R. F., Toplak M. E., Stanovich K. E. (2008). Heuristics and biases as measures of critical thinking: Associations with cognitive ability and thinking dispositions. *Journal of Educational Psychology*, *100*, 930–941 10.1037/a0012842.

Wilson S. M., Floden, R. E., & Ferrini-Mundy, J. (2001). *Teacher preparation research: Current knowledge, gaps, and recommendations* (Research Report No. R-01-3). Center for the Study of Teaching and Policy.

Zeleny, M. (1982). *Multi-criteria decision-making*. McGraw-Hills, New York.