

Theoretical Foundation of Teaching and Learning Models

Padauk Win

Educators and school leaders have recognized that the classroom environment and students' interests have evolved in the twentieth century. Simultaneously, the educational system has experienced a significant shift, prompting decision-makers in education to review and reconsider the curriculum. This shift marks a move from the traditional, lecture-focused instructional model to a new learning paradigm. The new paradigm is a holistic, student-centered approach designed to promote learning, develop critical thinking skills, and foster the discovery and construction of knowledge. This approach establishes powerful and effective learning environments. Consequently, such a transformation is both appropriate and necessary (Lantis, 2000, as cited in Saber, 2015).

Experiential Learning Theory

Experiential learning theory draws on the work of many scholars who placed experience at the core of their theories of human learning and development, such as John Dewey, Carl Rogers, and Jean Piaget. They

promoted the development of a dynamic, holistic model of the learning process, emphasizing experience as a stimulus for learners' growth (Armstrong & Fokami, 2008, as cited in Saber, 2015).

According to Pinar et al. (2004), Dewey's impact on curricular and educational thought is immeasurable. His belief in experiential learning permeated his contributions to philosophy and education, as evidenced in works such as *The Child and the Curriculum* (1902, as cited in Pinar et al., 2004), *How We Think* (1910, as cited in Pinar et al., 2004), *Democracy and Education* (1916, as cited in Pinar et al., 2004), *Experience and Nature* (1925, as cited in Pinar et al., 2004), and *Experience and Education* (1938, as cited in Pinar et al., 2004). Dewey (1916, as cited in Pinar et al., 2004) defined experience, within the progressive thought movement, as the reconstruction or reorganization of experiences that add meaning and enhance the ability to direct the course of future experiences.

Dewey, recognized as the father of experiential education, was one of the prominent thinkers of the twentieth century. His theory of experience continues to significantly influence the design of educational methods such as outdoor education, experiential education, and adult training (Saber, 2015). He believed that experience was central to all learning and that children should actively participate in directing their own learning experiences. Throughout his career as an educator and philosopher, Dewey stressed that education should be relevant to students and serve as a means to promote the goals of a healthy society. The teacher's role was to create educational environments that connect to students' interests and guide them toward meaningful learning experiences (Dewey, 1998, as cited in Pinar et al., 2004).

According to Neil (2005, as cited in Saber, 2015), Dewey proposed that understanding the nature of human experience is essential for designing

effective education. His theory of experience is founded on two central principles: continuity and interaction. Continuity refers to the notion that each experience is stored and carried forward into the future, whether one desires it or not. Humans learn from every experience, whether positive or negative, and these experiences shape the nature of future ones. Interaction builds upon continuity, explaining how past experiences interact with present situations to form current experiences. This suggests that teachers must be aware of the prior experiences students bring with them to provide quality education that is relevant and meaningful.

Passel and Kalb (2009, as cited in Saber, 2015) describe experiential learning theory as a dynamic and holistic perspective on learning that involves the whole person. Learning through experience occurs in all human activities at all times, making this theory significant not only in formal education but in all areas of life. Its holistic nature means it operates at every level of human society, from individuals to groups, organizations, and society as a whole.

The 5Es Learning Model

The 5Es Learning Model, also known as the 5E Instructional Model, is a constructivist teaching framework consisting of five phases: Engage, Explore, Explain, Elaborate, and Evaluate. Created by Rodger Bybee and the Biological Science Curriculum Study (BSCS), it aims to guide students through inquiry and discovery, allowing them to construct their understanding of concepts.

Engagement. The engagement stage helps learners connect prior knowledge with current learning experiences. Within the constructivist framework, engagement refers to students' active participation in

pedagogically meaningful processes inside or outside the classroom that aim to produce measurable outcomes (Kuh, 2007, as cited in Mwanda et al., 2017). Krause and Coates (2008) similarly describe it as the extent to which students involve themselves in activities that contribute to learning outcomes. Effective engagement encourages learners to interact thoughtfully with the concept, process, or skill being introduced. They are expected to connect with the problem at hand, actively participate in problem-solving, process and interpret information, formulate hypotheses, and make decisions informed by their cognitive structures. Pratkanis et al. (2014) define cognitive structures as the core mental processes individuals use to interpret and organize information. Ultimately, it is the learner's personal experience that gives meaning to these educational opportunities.

Exploration. In the exploration phase, learners build a shared foundation of experiences. The instructor adopts an open-ended approach that allows students to identify and develop concepts, processes, and skills (Hanke, 2009, as cited in Mwanda et al., 2017). This stage encourages active investigation—exploring environments, manipulating materials, and making real-world connections through hands-on engagement. Teachers often present problems for learners to examine, guiding them toward uncovering underlying principles or truths (Hirst-Loucks & Loucks, 2013, as cited in Mwanda et al., 2017). Learners are encouraged to pursue answers to their questions (Boud et al., 2013) and to interact with tangible materials that provide authentic, firsthand experiences. In constructivist learning, hands-on exploration is essential, and advancements in technology have made such experiential learning more accessible, dynamic, and engaging.

Explanation. The explanation phase allows learners to uncover the content underlying the concepts they have explored. It provides opportunities to identify relevant skills and behaviors while acquiring

knowledge that is contextually meaningful (Ergin, 2012, as cited in Mwanda et al., 2017). After engaging with a topic, students can anchor new content knowledge to their prior experiences, enabling deeper understanding. This stage involves guiding learners to analyze and synthesize information, recognizing that each individual's comprehension is shaped by their unique background (Knowles et al., 2014, as cited in Mwanda et al., 2017). The teacher's role is to facilitate this process by encouraging dialogue across diverse perspectives and promoting higher-order thinking (Brookfield, 2015, as cited in Mwanda et al., 2017). Strategies include prompting students to articulate concepts in their own words, request and provide evidence, seek clarification, and critically evaluate others' explanations (Hannafin et al., 2014, as cited in Mwanda et al., 2017).

Elaboration. The elaboration phase extends and strengthens learners' conceptual understanding and skills. Within a constructivist framework, educators create opportunities for students to practice and refine their abilities in authentic, real-world contexts (Gregory & Chapman, 2012). Learners are encouraged to deepen their knowledge, integrate it into existing conceptual frameworks, and apply it both inside and beyond the classroom (Quinn et al., 2012). As Fink (2013, as cited in Mwanda et al., 2017) notes, active participation in diverse learning environments is essential for constructing meaning and purpose. During this stage, teachers promote cooperative learning, critical thinking, and collaboration (Prince & Felder, 2006), guiding students to transform insights into action. Learners apply concepts in new yet related situations, using formal terms and definitions with precision. Educators also encourage the consideration of alternative explanations and the evaluation of existing evidence when approaching unfamiliar problems (Bybee et al., 2006).

Evaluation. The evaluation phase enables both learners and educators to assess understanding and track skill development. Students reflect on their progress, recognize areas of mastery, and address concepts still in need of reinforcement (Plotnik & Kouyoumdjian, 2011, as cited in Mwanda et al., 2017). Teachers assess performance through a variety of methods, such as presentations, demonstrations, or other authentic assessments. Evaluation, as defined by Slavin (2009, as cited in Mwanda et al., 2017), involves using systematic approaches to determine the depth and accuracy of a learner's knowledge. Because understanding evolves over time, instructors must make thoughtful, evidence-based judgments about student achievement (Earl, 2012).

Example application of the learning models

Experiential learning in this study was structured around the 5Es Learning Model, which includes the stages of engagement, exploration, explanation, elaboration, and evaluation. In this application, the model was used to teach the physics topic of reflection on plane surfaces. Students drew upon their own experiences to support their ideas, integrating personal insights with new concepts. Findings suggest that incorporating personal experiences and hands-on activities enhances students' understanding of light reflection and strengthens their ability to connect physics principles with real-world situations.

Stage 1: Engagement

Before introducing new concepts, the teacher should first assess students' prior knowledge. The initial step is to guide learners in identifying what they already understand about the topic. To achieve this, the teacher organizes students into small, randomly assigned groups and prompts them

to recall their existing knowledge about the fundamental concept of mirrors. This is facilitated through a series of guiding questions, such as:

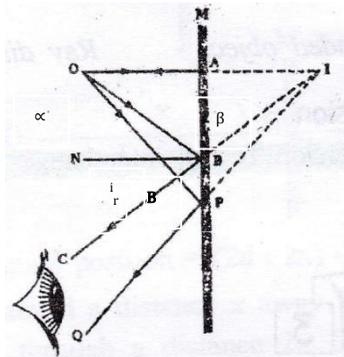
What is a mirror?

What is a plane mirror?

How often do you look at yourself in a mirror each day?

What observations do you make when you do so?

Each group draws upon its prior knowledge about mirrors to respond to the teacher's questions. The teacher then provides each group with an image to examine, prompting them to investigate how an object's reflection is formed.



Each group will investigate the picture as follows:

$i = r$ (by laws of reflection)

$i = \alpha$ (alternate angles)

$r = \beta$ (corresponding angles)

$\alpha = \beta$

$\Delta OAB \cong \Delta IAB$ and

$OA = AI$

Through this activity, each group will discover that the image appears the same distance behind the mirror as the object is in front, with both positioned at equal perpendicular distances from the mirror's surface.

Stage 2: Exploration

The teacher provides each group with a looking glass to investigate the properties of an image in a plane mirror, while actively monitoring and guiding their activities. Each group demonstrates, discusses, and shares observations as students examine their own reflections. A looking glass is a flat, smooth surface that reflects light. Students conduct their observations by:

Moving two steps away from or toward the mirror

Moving the looking glass two feet away from or toward themselves

Raising their left hand, then their right hand

Stage 3: Explanation

If necessary, the teacher asks guiding questions and supports each group in completing key points. Each group then presents and explains their findings, which highlight the following principles:

The image is the same size as the object (the viewer).

The image appears as far behind the mirror as the object is in front. The distance between the viewer and the mirror is called the object distance, while the distance of the image behind the mirror is the image distance.

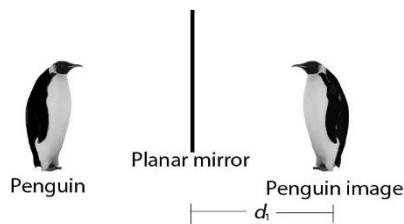
If the viewer moves two steps away from or toward the mirror, the image moves the same distance.

If the mirror is moved two feet away from or toward the viewer, the image shifts twice that distance.

The image is laterally inverted: when the viewer raises the left hand, the image appears to raise the right.

Stage 4: Elaboration

The teacher then displays a chart illustrating the properties of an image formed in a plane mirror, using the example of a penguin observing its own reflection.



The teacher asks each group to examine the differences between real and virtual images, using the chart as a reference. The discussion highlights one practical method of distinction: imagining a piece of paper placed at the location of the image. If the image is real, light rays actually converge at that point and the image can be projected onto the paper. If the image is virtual, light rays do not pass through the apparent location, and no image will appear on the paper. Thus, when students place a sheet of paper behind a plane mirror at the position of the virtual image, nothing is projected.

Stage 5: Evaluation

To assess understanding, the teacher poses questions related to the lesson:

What is meant by lateral inversion?

What are the differences between real and virtual images?

What are some important applications of plane mirrors?

Each group discusses and presents their answers. The teacher then introduces problem situations for the groups to solve, encouraging application of the concepts learned.

A pin, 2 cm high, is placed 6 cm in front of a plane mirror. If the pin is moved 1.5 cm closer to the mirror, by how much is the distance between the pin and its image reduced?

A man 5 ft 6 in tall, with an eye level 5 ft 2 in above the ground, looks at his image in a mirror. What is the minimum vertical length of the mirror required for him to see his entire body?

Each group will solve the given problems correctly. Thus, experiential learning in accordance with the 5Es model enhances students' understanding of key physics concepts.

Team-Based Learning in Constructivism

An important question to consider is: *“To what extent does group learning align with the principles of constructivist learning theory?”* Small-group learning is widely recognized as a valuable educational strategy, offering more opportunities for active participation and engagement than traditional lectures. Personal involvement fosters motivation and heightens interest in the subject matter, while collaborative work encourages learners to share and test their ideas, as well as to consider multiple perspectives on issues. For educators, small groups provide a practical avenue to understand students more deeply, observe their responses to course materials and activities, identify learning challenges, and address misconceptions through timely clarification.

Team-based learning (TBL) represents a distinctive and highly effective form of small-group instruction. It integrates the strengths of collaborative and social learning with well-defined accountability structures and systematic instructional sequences, thereby producing consistently strong learning outcomes. TBL is particularly suited for large classes, which are divided into smaller teams designed to maximize internal diversity while maintaining relative balance across groups. This is achieved by identifying key learner characteristics that contribute to team success and distributing individuals with these attributes evenly among the teams (Michaelsen et al., 2008, as cited in Hrynychak & Batty, 2012). In doing so, each team draws upon a wide range of knowledge and experiences, enriching collaborative problem-solving and fostering deeper analytical engagement.

TBL is firmly rooted in constructivist theory and offers a promising approach to enhancing education. In TBL, the teacher assumes the role of facilitator by setting learning objectives, preparing study materials and assessments, and designing authentic problems for groups to solve. Rather than emphasizing passive strategies such as traditional lectures, TBL minimizes direct instruction and promotes active learner engagement. Constructivist learning theory highlights student-centered principles and scaffolding as essential supports, and TBL reflects this by encouraging learners to compare their own understandings with those of their peers, negotiate meaning, and debate differing viewpoints during readiness assurance tests and application exercises (Hrynychak & Batty, 2012). This process embodies the constructivist view that learning occurs through the integration of new experiences into existing mental schemas, resulting in deeper comprehension and transferable knowledge.

Essential elements of team-based learning

In a TBL course, students are intentionally organized into permanent groups for the duration of the term, and the course content is structured into major instructional units. Prior to class sessions, students are required to engage with assigned materials, as each unit begins with the Readiness Assurance Process (RAP). The RAP involves an individual test on key concepts, followed by a team retake of the same assessment in which members collaborate to reach consensus on their answers. Immediate feedback is provided on the team test, and students may submit evidence-based appeals for answers they believe are justifiable. The process concludes with a short, focused lecture designed to address common misconceptions revealed during the assessments and appeals. After completing the RAP, the remainder of the unit is devoted to application-oriented activities and problem-solving tasks that encourage students to actively apply their learning in authentic contexts (Michaelsen et al., 2009).

In TBL, careful attention is devoted to the creation and orientation of small groups to ensure effective collaboration. Accountability is reinforced through graded Individual Readiness Assurance Tests (iRAT) and team Readiness Assurance Tests (tRAT), both of which are scored immediately to provide real-time feedback for students and instructors. Continuous feedback is further sustained during the application phase through both peer and instructor input. Assignments are designed to be significant, with their purpose and relevance clearly explained to students. To maximize collective learning, all teams are given the same assignments, thereby emphasizing shared engagement with core concepts rather than isolated group outcomes. Moreover, tasks require students to make specific choices among plausible alternatives, promoting critical thinking and decision-making skills. Finally, simultaneous reporting of team decisions

ensures that groups work independently and mitigates the risk of teams being influenced by others' responses (Hugget, 2010).

According to Sibley et al. (2014), four essential elements underpin the effectiveness of team-based learning: (a) teams must be properly formed and effectively managed to ensure balanced group dynamics, (b) students must be motivated to come to class well-prepared, (c) learners must actively apply course concepts to analyze and solve problems, and (d) students must be held genuinely accountable for both individual and team contributions.

Element 1: Properly formed and managed teams. Research on team formation underscores the value of teacher-created, criterion-based groups in achieving optimal educational outcomes. Evidence indicates that instructor-formed teams consistently perform better than either randomly assigned or student-selected teams (Sibley et al., 2014). While students may prefer working with friends, studies reveal that self-selected groups often underperform because they tend to function as “social entities,” where pre-existing relationships and cliques interfere with group cohesion (Brickell et al., 1994, as cited in Sibley et al., 2014).

According to Michaelsen et al. (2009), team-based learning requires instructors to carefully oversee group formation in order to manage three key variables. First, groups must be provided with adequate and balanced resources to successfully complete assignments. Second, instructors should prevent the formation of membership coalitions that could undermine group cohesion. Finally, teams must be given the opportunity to grow and develop into effective, collaborative learning units.

It is recommended that team-based learning groups consist of five to seven students, a size slightly larger than that typically suggested in cooperative or collaborative learning, to match the complexity of the problems being addressed. Groups must be large enough to possess the

intellectual capacity to solve challenging tasks, while ensuring that each member remains accountable both to the instructor for preparation and to teammates for meaningful contributions. Team membership should remain consistent throughout the course to allow relationships and dynamics to strengthen over time. As teams typically progress through Tuckman's stages of group development, forming, storming, norming, and performing, cohesion is built through shared activities, common goals, and mutual accountability. The structured sequence of team-based learning activities and accountability mechanisms supports and reinforces this process (Sibley et al., 2014).

Element 2: Readiness assurance to ensure pre-class preparation.

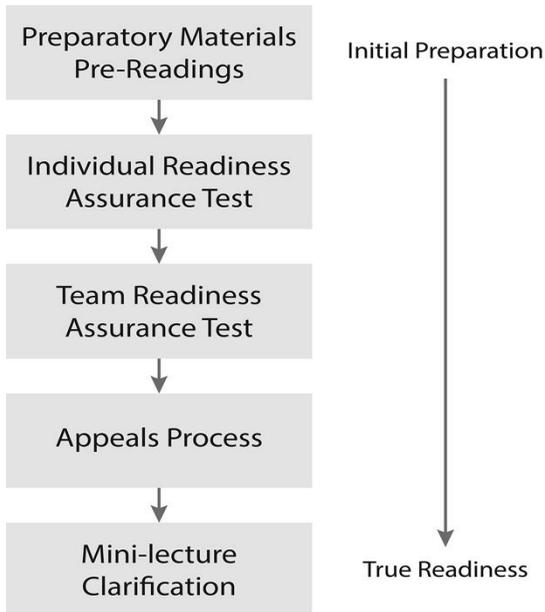
The second essential element of team-based learning is the Readiness Assurance Process (RAP), which ensures that students come to class well-prepared. Conducted at the beginning of each major instructional unit, the RAP holds students accountable for completing pre-class readings while confirming that they possess the foundational knowledge necessary for active in-class engagement (Tweddell, 2013). According to Sibley et al. (2014), this process not only reinforces students' initial preparation but also transforms it into genuine readiness for higher-level application activities.

Each instructional module in team-based learning begins with assigned preparatory materials, such as newspaper articles, journal articles, or textbook readings, which students are expected to complete before class. At the start of the module, the Readiness Assurance Process (RAP) is implemented through a sequence of multiple-choice assessments based on the readings. Students first complete the test individually (iRAT) and then take the same test collaboratively in their teams (tRAT). Following the team test, groups may submit structured written appeals if they find ambiguities in the questions or the assigned materials. The process concludes with a

brief instructor-led mini-lecture or clarification to resolve any remaining misunderstandings (Sibley et al., 2014).

Figure 1

The Readiness Assurance Process Stages



Source: Adapted from Sibley & Spiridonoff (2012)

During this five-stage process, which occurs at the start of each module, students move systematically from initial preparation to genuine readiness for problem-solving. The progression from pre-class preparation, to individual testing, team testing, structured appeals, and instructor clarification ensures that learners not only engage with the material independently but also consolidate their understanding through collaboration and feedback (Sibley et al., 2014).

Pre-class preparation. Students are assigned preparatory materials to review before the start of each module. These resources are designed to

emphasize key vocabulary and essential concepts that provide the foundation for problem-solving. Importantly, the materials focus only on what students need to get started, rather than covering all the content they are expected to master by the end of the module.

Individual Readiness Assurance Test (iRAT). To begin the classroom portion of the RAP, students take a 15–20-item multiple-choice test. They first complete the test individually (iRAT) and then repeat the same test with their team (tRAT). The iRAT ensures individual accountability by requiring students to demonstrate that they have acquired the essential foundational knowledge from the preparatory materials. Test questions are typically designed at Bloom’s lower to mid-levels—remembering, understanding, simple application, and analysis—providing a solid base for the more complex problem-solving activities that follow.

Team Readiness Assurance Test (tRAT). The tRAT is identical to the iRAT. If a team’s first choice is incorrect, members continue discussing the question and sequentially select other options until they arrive at the correct answer. This process fosters peer teaching and collaborative reasoning, turning the tRAT into a dynamic, high-energy learning event where students actively engage with the material and with one another.

Appeals. After the team test, the instructor circulates around the room and encourages teams to submit a written appeal for any questions they answered incorrectly. This process directs students back to the preparatory materials, reinforcing areas where they may still be struggling. To complete an appeal, the team researches the correct answer and submits a written form that includes: (a) a clear statement of their argument and (b) supporting evidence drawn directly from the preparatory readings. The instructor then collects and reviews these appeals after class, ensuring that student reasoning is acknowledged and misconceptions are clarified.

Mini-lecture. To conclude the RAP, the instructor delivers a concise mini-lecture that targets only the concepts students continue to find challenging, thereby reinforcing key ideas without repeating material already understood (Sibley & Spiridonoff, 2012).

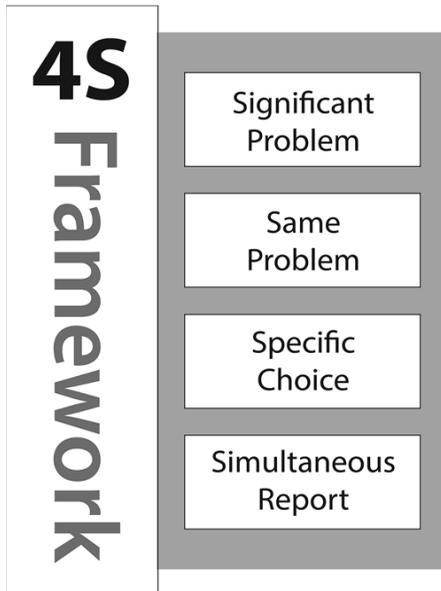
Element 3: Learning how to apply course concepts. The primary goal of any team-based learning course is to enable students to apply course concepts in solving significant and relevant problems. To achieve this, team-based learning employs the 4S framework, which guides the design and implementation of effective problem-solving activities. These application activities build directly on students' preparation and the foundational knowledge strengthened during the Readiness Assurance Process.

In each application activity, all teams engage with the same significant problem, ensuring that every student wrestles with the core concepts of the module. By applying the 4S framework, instructors can design activities that consistently foster engagement and stimulate rich, meaningful discussions during the reporting phase.

In the TBL classroom, most class time is devoted to student teams solving, reporting, and discussing solutions to relevant and significant problems. Using the 4S Framework to structure these problems harnesses the strengths of team processing while minimizing many of the challenges common in other small-group learning approaches (Sibley & Spiridonoff, 2012). This structure provides both individuals and teams with repeated opportunities to make decisions and receive timely feedback not only on the accuracy of their answers but also on the reasoning and processes they used to reach them.

Figure 2

The 4S Framework



Source: Sibley et al. (2014)

Significant problem. In TBL, a significant and relevant problem that captures students' interest is essential. The quality of the problem largely determines the effectiveness of the application activity. For the activity to be meaningful, the problem must challenge students to apply course concepts actively in developing a solution.

Same problem. Teams work on the same problem. In TBL, all teams work on the same problem, ensuring comparability of solutions and sparking meaningful discussion. A common task motivates students to defend their reasoning, challenge alternative viewpoints, and analyze one another's problem-solving approaches. This shared focus keeps students engaged, as each team becomes invested in the decisions and outcomes of others.

Specific choice. Teams select the best option from a limited set of choices, allowing easy comparison of decisions across groups. This comparability fuels rich reporting discussions, as teams critique one another's choices while defending their own reasoning.

Simultaneous report. When one team notices that another has chosen a different answer, they are naturally compelled to question and challenge that decision. This process sparks meaningful dialogue as teams defend their reasoning and critique others. Through reporting, teams must clearly articulate their thought processes, which strengthens understanding and deepens long-term learning (Sibley & Spiridonoff, 2012).

Element 4: The Importance of Accountability. TBL incorporates multiple levels of accountability. Students are individually accountable to the instructor through the iRAT, but what often proves most motivating is accountability to their teammates. A formal peer evaluation process further reinforces this responsibility. According to Sibley et al. (2014), while extrinsic motivators such as grades can encourage preparation, intrinsic motivation driven by accountability to peers is even more powerful and effective in promoting engagement and learning.

The cornerstone of success in TBL lies in the natural accountability embedded in its processes: students, teams, and instructors are all responsible for actions that promote learning. Students are accountable for attending class, preparing beforehand, and actively contributing to their team's work. Instructors, in turn, are responsible for providing the cognitive foundation students need to tackle meaningful problems and for offering opportunities to practice and develop their application skills (Parmelee & Michaelsen, 2010).

Peer Discussion

Peer discussion, which promotes active learning, is grounded in Piaget's theory of cognitive development and Vygotsky's sociocultural theory of learning, both of which are rooted in constructivism.

Constructivism is an educational approach designed to maximize student understanding by emphasizing the active role of learners in constructing knowledge. It is described in various ways: as teaching that highlights learners' active engagement in making sense of information (Woolfolk, 2006, cited in Cruickshank et al., 2009); as learners constructing knowledge while attempting to understand their environment (McCown, 2001, cited in Cruickshank et al., 2009); and as learning that occurs when students collaboratively formulate questions, explain phenomena, tackle complex issues, or solve problems (Gagnon & Collay, 2001, cited in Cruickshank et al., 2009). Constructivism draws on cognitive psychology, social psychology, educational research, and neuroscience, and its most profound impact has been to shift the focus of learning from teacher-centered instruction to student-centered engagement. In this framework, learning occurs when students actively apply the content and skills they are being taught (Adams & Burns, 1999, cited in Bell & Kahrhoff, 2006).

In recent years, the work of John Dewey, Jerome Bruner, and Lev Vygotsky, along with Jean Piaget's research on developmental psychology, has significantly shaped the broad framework of constructivism. Constructivism is commonly understood in two main forms: cognitive constructivism and social constructivism.

Cognitive constructivism is primarily based on Piaget's theory of cognitive development, which emphasizes the learner's active engagement. Learning is most effective when individuals interact with peers of equal status, fostering cooperation and creating a foundation for meaningful,

long-lasting understanding. Piaget also argued that learners must construct their own knowledge, building it through experiences that form mental models and facilitate learning (Piaget, 1985).

Social constructivism emphasizes the social context of learning. Vygotsky's sociocultural theory highlights the active involvement of peers, adults, and teachers in the learning process. He argued that cultural history, social context, and language significantly influence the patterns and pace of children's development. Central to his theory is the zone of proximal development, which posits that individuals can master concepts and skills beyond their independent capabilities with guidance from a more knowledgeable peer or instructor (Vygotsky, 1978, cited in Smith, 2007).

According to constructivist theory, effective teaching builds on students' prior knowledge, enabling them to connect new information to existing cognitive structures. It encourages learners to become active, self-directed participants, provides authentic learning opportunities, and promotes collaboration through small-group activities (Smith, 2007). In this approach, learners are the creators of meaning and knowledge, fostering critical thinking and developing motivated, independent thinkers. The learner acts as a sense-maker, while the teacher serves as a cognitive guide, modeling and supporting authentic academic tasks. Instructional designers play a key role in creating learning environments that allow students to interact meaningfully with content, including processes for selecting, organizing, and integrating information (Siddiqui, 2009).

Procedures for peer discussion

The impact of peer interaction is evident in the instructional method known as Peer Discussion. In this approach, students first respond individually to a conceptual question and then engage in discussion with their peers before answering again. Research by Mazur (1997) demonstrates

that such discussions not only increase the percentage of correct responses but also boost students' confidence in their understanding of the concepts.

In the Peer Discussion Method, as described by Mazur (1997, cited in Muise, 2015), classes move away from a traditional lecture-and-problem-solving format toward a more active learning approach. Course material is broken into brief mini-lectures, each followed by peer discussions (Muise, 2015). The format used in this study is summarized in Table 1. During discussion periods, students were instructed to explain not only which answer they selected but also the reasoning behind their choice. Peer groups were formed informally according to seating arrangements, typically consisting of one or two nearby students. To maintain the pace of traditional-style classes, each lesson included only two or three concept-focused questions per unit.

Table 1

General format for peer discussion method

Element	Time allotment
Grouping	5 min
Giving Brief Lecture	4 min
Posing a Conceptual Question	5 min
Discussion between Peers	15 min
Presenting the answer	5 min
Evaluating	5 min
Providing Feedback	6 min

Source: Harvey (2013)

Bibliography

- Bell, D., & Kahrhoff, J. (2006). *Active learning handbook*. Webster University. <http://www.cgs.pitt.edu/sites/default/files/Doc6-GetStarted-ActiveLearningHandbook.pdf>
- Boud, D., Keogh, R., & Walker, D. (2013). Promoting reflection in learning: A model. http://www.apjce.org/files/APJCE_17_2_135_147.pdf
- Bybee, R. W., Taylor, J. A., Gardner, A., Van Scotter, P., Powell, J. C., Westbrook, A., & Landes, N. (2006). *The BSCS 5E instructional model: Origins, effectiveness, and applications*. <http://www.bsos.umd.edu/biomechs/sites/default/files/legacy/BSC5EInstructionalModelExecutive.pdf>
- Cruikshank, D. R., Jenkins, D. B., & Metcalf, K. K. (2009). *The act of teaching* (5th ed.). McGraw-Hill.
- Harvey, N. C. (2013). *The effects of peer instruction on ninth grade students' conceptual understanding of forces and motion* (Master's thesis, Louisiana State University). https://www.digitalcommons.lsu.edu/gradschool_theses
- Hrynchak, P., & Batty, H. (2012). The educational theory basis of team-based learning. *Medical Teacher*, 34(10), 796–801. <https://doi.org/10.3109/0142159X.2012.687120>
- Hugget, K. N. (2010). Team-based learning (TBL). <https://www.creighton.edu/sites/www12.creighton.edu/files/TL-Pedagogies-Team%20Based%20Learning.pdf>
- Krause, K. L., & Coates, H. (2008). Students' engagement in first-year university. http://www.iojes.net/userfiles/Article/IOJES_429.pdf
- Michaelsen, L., Sweet, M., & Parmelee, D. (2009). The essential elements of team-based learning. <http://medsci.indiana.edu/c602web/tbl/reading/michaelsen.pdf>
- Muise, J. M. (2015). *Using peer instruction to promote conceptual understanding and problem solving in high school physics classes* (Master's thesis, Montana State University). <https://www.scholarworks.montana.edu/xmlui/bitstream/handle/1/9280/MuiseJ0815.pdf?sequence=1>
- Mwanda, G., Odundo, P., & Midigo, R. (2017). Towards adoption of constructivist instructional approach in learning biology in secondary school students in Kenya: Addressing learner attitude. *International Journal of Secondary Education*, 5(1), 13–28. <http://article.sciencepublishinggroup.com/pdf/10.11648.j.ijsedu.20170501.11.pdf>

- Parmelee, D. X., & Michaelsen, L. K. (2010). Twelve tips for doing effective team-based learning (TBL). <https://www.appd.org/meetings/2012SpringPres/WS21Handout.pdf>
- Piaget, J. (1985). *Equilibration of cognitive structures*. University of Chicago Press.
- Pinar, W. F., Reynolds, W. M., Slattery, P., & Taubman, P. M. (2004). *Understanding curriculum*. <http://www.khuisf.ac.ir/DorsaPax/userfiles/file/motaleat/0805848274.pdf>
- Pratkanis, A. R., Breckler, S. J., & Greenwald, A. G. (2014). Attitude structure and function. <https://prcfoundry.info/attitudes.4014938pdf>
- Prince, M. J., & Felder, R. M. (2016). Inductive teaching and learning methods: Definitions, comparisons, and research bases. [http://www4.ncsu.edu/unity/lockers/users/f/felder/public/Papers/Inductive\(JCST\).pdf](http://www4.ncsu.edu/unity/lockers/users/f/felder/public/Papers/Inductive(JCST).pdf)
- Saber, N. (2015). *The effect of experiential learning on improving the performance of EFL students as perceived by teachers of English in the northern governorates of Palestine*. <https://scholar.najah.edu/sites/default/files/Noor%20Saber%20Abd%20Alkareem%0Abu-Assab.pdf>
- Sibley, J., Ostafichuk, P., Roberson, B., Franchini, B., & Kubitz, K. (2014). *Getting started with team-based learning*. Stylus Publishing.
- Sibley, J., & Spiridonoff, S. (2012). Introduction to team-based learning. https://www.nyack.edu/files/Team_Based_Learning.pdf
- Siddiqui, M. H. (2009). *Advanced educational psychology*. A.P.H. Publishing Corporation.
- Smith, R. S. (2007). Experiencing the process of knowledge creation: The nature and use of inquiry-based learning in higher education. <https://akoaootearoa.ac.nz/sites/default/files/IBL-Report-Appendix-Review.pdf>
- Tweddell, S. (2013). Team-based learning: Student study guide. https://www.reading.ac.uk/web/files/cqsd/Team_Based_Learning_Introductory_Student_Study_Guide.pdf