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Developing Advanced Cognitive Apprenticeships Model for Making the Students Creative and Self-Regulated Learners

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Abstract--*The purpose of the study was to develop a model of teaching and instruction that make the science students critical thinker, decision maker and self-regulated life-long and continuous learner as well as user of their cognitive and meta cognitive abilities.*

The main objective of the study was to apply advanced model of Cognitive Apprenticeships as an integrated model for teaching science subjects with application of learning theories at secondary level.

The sample of the study was taken from all the students of class IX in both government and private schools of district swat for the target population of students of class IX in the session 2014 – 2015.

The nature of the study was quasi-experimental. The pre-test post-test non-equivalent experimented group design was used and the data were collected after 16 weeks of teaching by the trained science teachers to plan their lesson according to the training manual designed by the researchers for the Ph.D. Thesis on Cognitive Apprenticeships model.

The collected data were analyzed and Cohen's d and t-test were used for testing the hypothesis and to find the effect size produced by the applied Cognitive Apprenticeships model.

The findings of the study were concluded that the application of advanced Cognitive Apprenticeships as a new applied model for teaching science at secondary school level has produced significantly high effects on students' achievement at Secondary School Level.

Hence, it was recommended on the basis of findings and conclusion that the science teachers must be trained in Advanced Cognitive Apprenticeships during their pre-service and in-service training programs for secondary classes to nourish the students' creativity for combating new challenges in science and technology through their science education with self-regulated and life-long learning qualities.

Key words--*Advanced Cognitive Apprenticeships, Lesson planning, Cognitive – toolkits, Science education, Metacognition, Teaching science, Self-regulated learning*

I. INTRODUCTION

According to Khan (2016); The need to combat new challenges through education requires mechanism that the society is knowledge-based and the individual can use their thinking critically but positively with clear and creative strategies and vision. The individual learn these strategies in their educational institutions or in schools, colleges and universities. But, it is the educational system that must prepare the students to become critical thinker, decision maker and self-regulated, life-long and continuous learners as well as user of their cognitive and meta-cognitive abilities and strategies. The education system in turn depends on the components

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including the methods of instructions and teaching to prepare the students to meet the needs and face the challenges to their personal, social and global lives through the curricular and co-curricular or extra-curricular activities. (ICORE, 2016)

Further Khan (2016) discussed that; The instructional methods become effective when these are based on theories of learning and instructions and applied by the efficient and effective teachers according to the individual students' needs and taste or when individual differences are considered during teaching learning process. (ICORE, 2016)

The literature reviewed by the researchers indicated that most of the teachers in Pakistan use traditional methods of instruction and emphasize rote learning (Behaviouristic Theory Application). However, when they use cognitive and constructivist's theories especially in science subjects, the students can become problem solver and then they can become self-regulated and life-long and continuous learners. Thus, they are enabled with cognition-toolkits (Khan, 2014) to become creative, practical and decision maker in their community of practice and they also become socially competent as well as globally acceptable and competitor in the world market.

According to Khan (2016); The nations and states want that their students become valuable assets and contributors in the country's economy and development, besides; leaving happy, productive and efficient personal and social lives at homes and with friends or other members of the community and society at large. The researchers undertook the study on the topic of the application of learning theories at secondary school level and they used advanced Cognitive Apprenticeships as an integrated teaching model to apply all the basic theories of learning: Behaviouristics, Cognitivists and Constructivists. (ICORE, 2016)

The advanced step included Creativity besides Modelling, Coaching, Scaffolding, Articulation, Reflection and Exploration (Vygotsky's Model). The researchers prepared training manual and also designed model lesson plans for the study. The researchers conducted training sessions for the science teachers to apply these theory-based lesson plans and the pilot study showed that the Advanced Cognitive Apprenticeships have produced good results and positive impact on students achievement as compared to traditional teaching methods. (Khan, 2016 & 2014)

So, the researcher intended to further investigate through meta-analyses the application of Advanced Cognitive Apprenticeships models at Secondary School Level in order to validate its effectiveness for teaching science subjects. (Khan, 2016)

Statements of The Problem

The problem of the study was stated as to investigate the effectiveness of Advanced Cognitive Apprenticeships for developing it as a teaching model to make the students creative and self-regulated learner in order to combat new challenges through education.

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II. OBJECTIVES OF THE STUDY

The purpose of the study was to develop a model of teaching and instruction that can make the students critical thinkers, decision makers and self-regulated life-long and continuous learners as well as user of their cognitive and meta-cognitive abilities and strategies to combat new challenges through education by using mental tools and toolkits.

So, the following objectives were framed for the study

1. To review literature for conceptual clarity of Cognitive Apprenticeships.
2. To summarize learning theories and models for their application in Cognitive Apprenticeships in integrated form.
3. To prepare Advanced Cognitive Apprenticeships Model for teaching science subjects at secondary School level.

Hypothesis of The Study

H_O: There is no statistically significant high impact on students' achievement in science produced by Advanced Cognitive Apprenticeships model at Secondary School Level.

H_A: There is statistically significant high impact on students' achievement in science produced by Advanced Cognitive Apprenticeships model at Secondary School Level.

III. REVIEW OF LITERATURE

According to Liu (2005): The teachers often uses instructional planning as an essential activity to become professional in teaching and experimentally proved that as compared to traditional instructional planning (design) Cognitive Apprenticeships model is more better to improve teacher preferences and attitudes. Liu (2005) also writes that Cognitive Apprenticeship is viewed as "Instructional tool" that is aimed at acquiring thinking skills such as cognitive skills and metacognitive strategies resulting in sustained participation in the community and practice.

Collen et al (1989); proposed a model consisting of six major steps; Molding, Coaching, Scaffolding, Articulation, Reflection and Exploration; while Le Grand et al 1993; Farmer et al 1992; proposed a model consisting of five steps for professional education.

a. Modeling (observing)
b. Approximating (coaching and practicing)
c. Fading (reducing coaching and scaffolding)
d. Self-directed learning (Articulation and reflection)
e. Generalizing (Exploration and creativity)

Cognitive Apprenticeships model is based on Vygotsky's research and is also related to other studies of conventional apprenticeships. (Brone et al, 1989; Lave and Winger, 1991 as cited by Liu, 2005). Web-based Cognitive Apprenticeships model has three phases for pre-service teacher training (Liu, 2005):

1. Modeling-Observing
2. Scaffolding-practicing

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3. Guiding-Generalizing

- According to the theory of Cognitive Apprenticeships; a master of skills when demonstrating to the novices and immature often fails to make all the complex skills and processes explicit. So, it is used to bring tacit to explicit in a skill or knowledge. (Awan, 2009; Collen etal, 1988; Khan, 2014 & 2016; Liu, 2005; Vygotsky, 1978)
- By using processes such as modeling and coaching, Cognitive Apprenticeships also support the three stages of skill acquisition:
    - The cognitive stage (internalization),
    - The Association stage (bond formation), and
    - The autonomous stage (self-regulation). (Awan, 2009; Khan, 2014 & 2016)
- It means that Cognitive A:pprenticeship refers to schooling and understanding of the ideas, concepts, processes, procedures and strategies of skills (toolkits) through mediated intervention from masters or tutors and instructors (web-based or traditional and F2F) in a school related or professional and vocational knowledge and skill (theory + practice) in a subject. (Khan, 2014& 2016)
- Now, we are going to discuss the theoretical bases of Cognitive Apprenticeships in order to understand the concept in the context of theories.

According to Patsula (1999): "Bruner's constructivist theory is based upon the study of cognition." A major theme in this theory is that: "Learning is an active process in which learners construct new ideas or concepts based upon their current/past knowledge." (Patsula, 1999).

A theory of instruction should address the following aspects:

- The most effective *sequence* to present materials.
- The *ways* in which a body of knowledge can be *structured* so that it can be most *readily grasped* by the learner (act small and learn rapidly).

Hence, the practical applications of Bruner's constructivist theory in Cognitive Apprenticeships are:

- Readiness of the learner (physically and psychologically)
- Spiral organization (sequence) of the learning material
- Designing the instruction to facilitate extrapolation and or fill in the gaps. (Going beyond the information given) by using advance organizers (Ausbil's theory) within ZPD (Vygotsky's theory).

Bandura's social learning theory emphasizes the importance of *observing* and *modeling* the behaviors, *attitudes* and *emotional reactions* of others for learning. The processes underlying observational learning are:

a) Attention: (including cognitive organization and motor rehearsal)
b) Retention: (including physical capabilities, self-observation of reproduction and accuracy of feedback).
c) Motivation: (including external or vicarious and self-reinforcement).
d) Observing Characteristics: (such as sensory capacities, arousal level, perceptual set and past reinforcement)(Awan, 2009; Khan, 2014).

Patsula (1999): The Minimalist theory of Carroll focuses on the instructional design of training materials for computer user and has been extensively applied to the design of computer documentation and it is

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based upon studies of people learning to a wide range of computer applications including word processors and data bases.

According to Patsula (1999): The critical idea in Carroll's Minimalist theory is to make the instructional materials minimized so that it should not provide hindrances but, rather to facilitate learning. Course designers must minimize the extent to which instructional materials obstruct learning and focus the design on activities that support learner's directed activity and accomplishment.

It means that the instructional materials may be minimized to make it incremental (Khan,2014,2015,2016) as in Scale agile framework of software development.

Bandura's and Vygosky's theories are both complementary to each other because both emphasize social interaction necessary for learning. Social interaction (MKOs) plays a fundamental role in the development of cognition within ZPD (Patsula, 1999).

An important concept in Vygosky's theory is that: "The potential for cognitive development is limited to a certain time span which he calls the "Zone of proximal development" (ZPD) (Khan, 2013, 2014 & 2015).

- ZPD = Potential for learning – Actual potential
- (Ability test) (Aptitude test) (Achievement

In sum, we can say that for Cognitive Apprenticeships in traditional, blended or e-learning; the tutor or instructor must take help from the theories of learning and their practical implications and applications in e-learning design, instruction, interaction, engagement, motivation, reinforcement and feedback.

According to Awan (2009): The designer of e-learning for Cognitive Apprenticeships has to address many issues relating to organizational strategies and management, *curriculum design and development, coordination* and *planning*, selection of appropriate *technology*, *media*, development of *instructional design*, delivery *system/strategy*, *research methods* and *approaches*, *e-skills*, *assessment/evaluation*, *interface design* and *ethical issues* and there may be many more with the passage of time and new emerging trends in technological world (global and virtual knowledge) in the 21st century (Khan, 2014).

Further Awan (2009) discussed; Several types of learning engagement can encompass an e-learning environment (VLEs) and this includes: Case studies, Problem based learning, Gaming, Simulations and Web Quests (Holmes and Gardner, 2006 as cited in Awan 2009).

Therefore, the elements usually considered as engagements by the e-learning designers are: Activity, Scenarios, Feedback, Delivery (Media), Context and Influence, etc (Awan, 2009). The learner engages with their learning when the above elements are present in e-learning.

- Sulcic and Sulcic (2007): The key elements of the tutorial learning paradigm are interactivity, individualization, adaptability, creativity and collaboration etc.
- Online tutors support e-learners through different roles. Authors and researchers have different classifications of roles tutor perform in e-learning environment. An often cited classification defines four basic roles of an online tutor:

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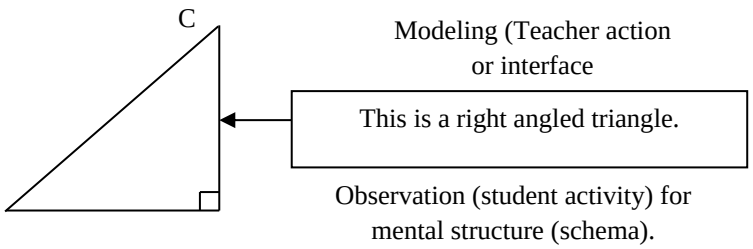
- Pedagogical (Scaffolding and Coaching)
- Managerial (Facilitation)
- Social (Contextualization); and
- Technical (Mechanization) (Sulcic and Sulcic 2007)
- Wikipedia (2016): "Collins, et al developed six teaching methods rooted in Cognitive Apprenticeships theory and claim these methods help students attain cognitive and metacognitive strategies for "using, managing and discovering knowledge".
- The first three (Modeling, Coaching, Scaffolding) are at the core of Cognitive Apprenticeships and help in cognitive and metacognitive developments. The next two (Articulation and Reflection) are designed to help novices with awareness of problem-solving strategies and execution similar to that of an expert. The final step (Exploration) intends to guide the novices towards independence and the ability to solve and identify problems within the domain of their own. The authors note, however, that this is not an exhaustive list of methods and that the successful execution of these methods is highly dependent on the domain or subject (i.e. context of knowledge and skill); and the researcher found that it can be developed to another step of *Creativity* or new P*roductivity* in open and flexible learning environments (Khan 2014 & 2016).

Modeling is the first and pre-requisite step in cognitive apprenticeship when an expert usually a teacher, within the cognitive domain or subject area demonstrates a task explicitly so that novices (usually a student), can experience and build a conceptual model of the task at hand. e.g. a maths teacher might write out explicit steps and work through a problem aloud; demonstrating heuristic and procedural knowledge. Modeling can include modeling of expert performance or processes in the world (Bandura's model).

Example (Modeling):

A teacher demonstrates that:



In the Skinnerian model, the novices task is sculpt to that of the mature person by applying the mechanism of shaping and successive approximation (Behavioristic Model) and Piaget's schemata and structural formation of image in mind.

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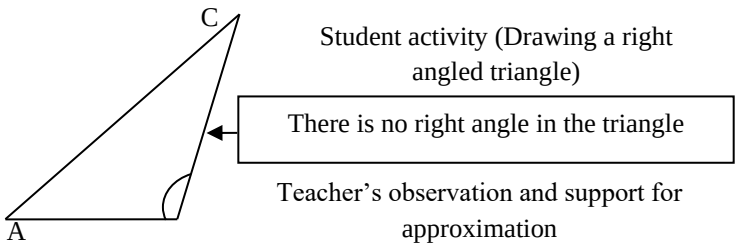
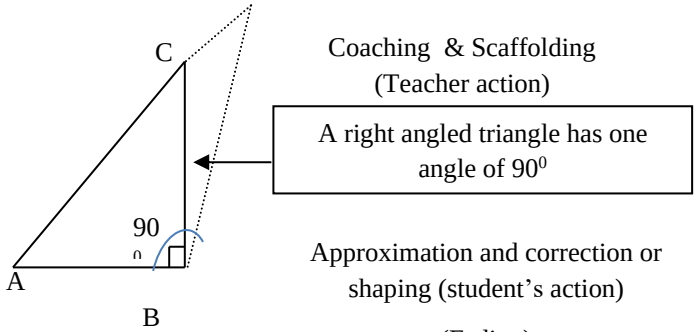
Example (Coaching & Scaffolding):

A student draw right angled triangle as: (Khan, 2014):



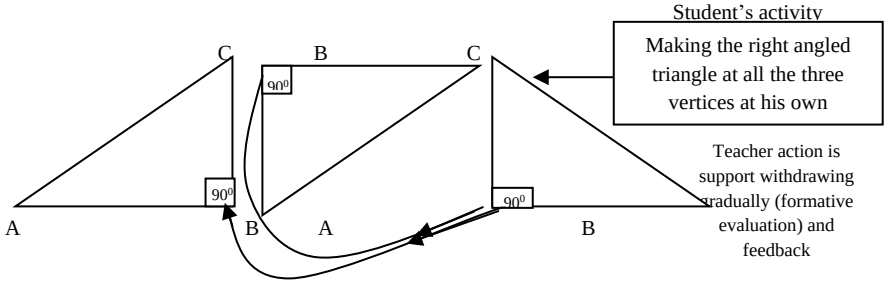
The coach helps to make it as shown below:



In the step of scaffolding the novice is provided guidance and supports by the expert or teachers helps the student so that his or her action becomes perfect. The gradual removal of support is called fading. This requires the teacher (tutor) to have the skill to analyze and assess student's abilities at the moment (formative evaluation), "Fading" is used to *withdraw the support gradually*. *Scaffolding* is followed by "fading" to withdraw support gradually for mastering the skill. In this step the student is provided reinforcement and feedback (Behavioristic Model) on the basis of formative assessment (Khan, 2017)

Example (Articulation):

Draw right angled triangle such as:



In articulation, the person can demonstrate his own action in a domain or in a given context. (Cognitive Model)Here the context is geometrical figures (right angled triangles) in geometry / maths subject (Khan, 2014 & 2016).

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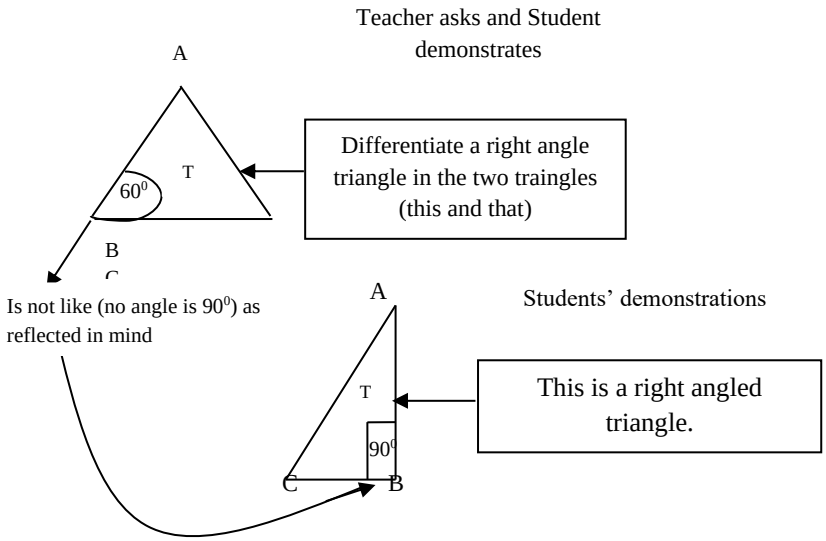
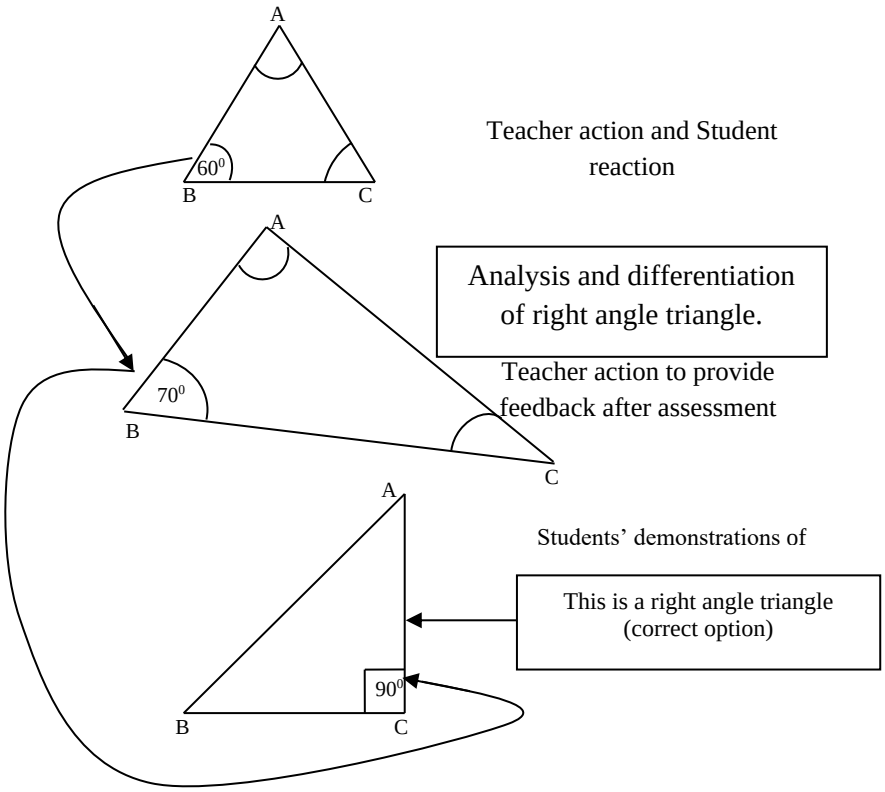
Example (Reflection):

To differentiate that:



Assessment is needed for Summative evaluation (reflection stage) e.g to separate right angled triangle from the following trainagles (Khan, 2014, 2016 & 2017).



In reflection the person moves towards perfection by applying his own thinking strategies for comparison and criticizing his /her actions (Cognitive - Constructivist Model).

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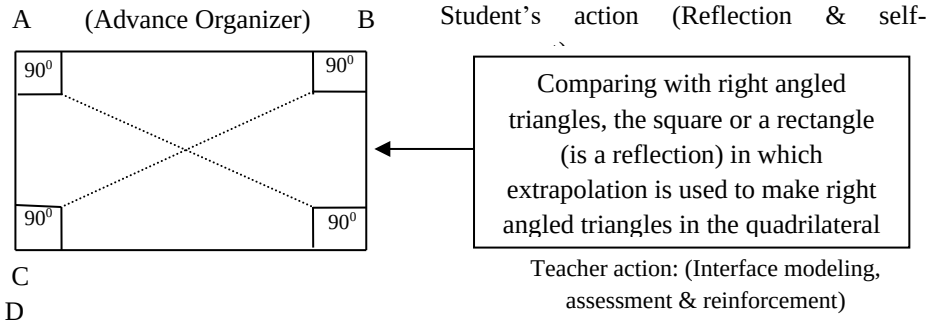
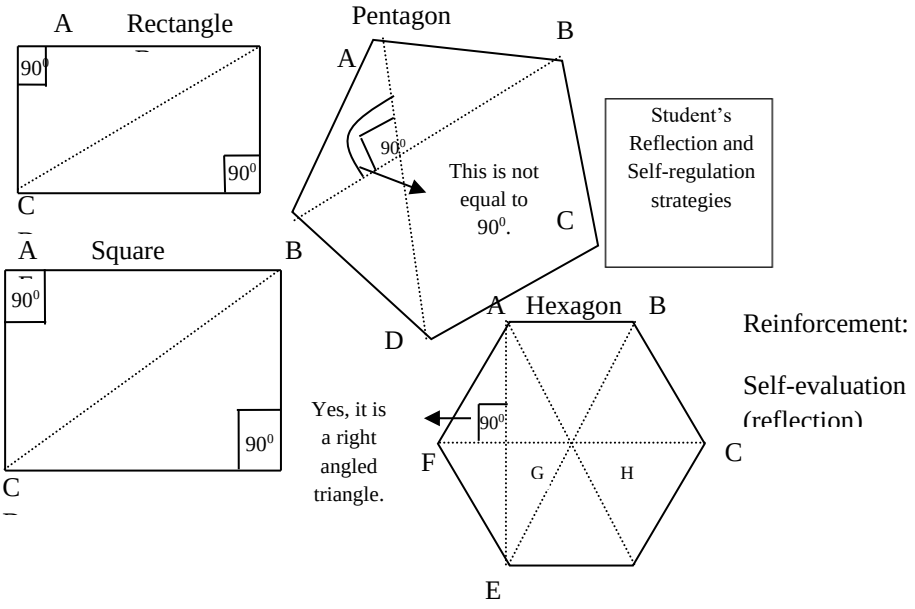
Example (Exploration):

To understand that right angled triangle have one angle 90^0 and a *triangle* have only one angle 90° at maximum and a *square* have four angles of 90^0 at maximum (Khan, 2014, 2016 & 2017).



In exploration stage (Constructivist Model) the person actions become self-regulated and these are movement towards problem solving, innovations and generalizations. Hence, the person can demonstrate his own testing of hypothesis and experimental verification as explained in the following diagram.



The researcher has suggested that the next stage is creativity (using integrated theories) in school subjects or professional cognitive and metacognitive skills and strategies (toolkits using for new production). This step makes the model in a new form and the researcher named it "Advanced Cognitive Apprenticeships Model". (Khan, 2014, 2016 & 2017)

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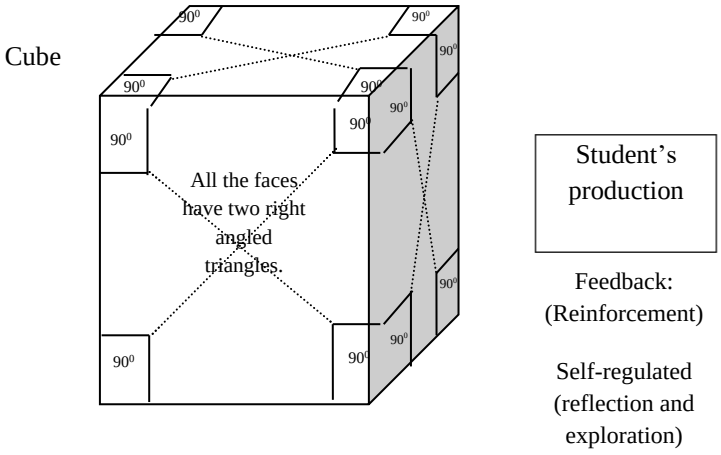
Example (Creativity):

To draw a diagram of cube and show the right angled triangles in it:



In conclusion, we can say that Advanced Cognitive Apprenticeship is a theory of learning processes where the master of a skill (tutor) teaches that skill (tutoring) to an apprentice (student or novice) through different techniques and methods (toolkits) and through different activities and interactions or engagements; utilizing different theories of learning and motivation as well as making different learning designs according to learning models and environment. According to different *abilities*, *capacities*, *learning styles* and *domains* of the students; to enable them to *master*, *articulate*, *reflect*, *explore* and *create* in their respective domains and achieving the objectives of learning to make learning open and flexible; effectively and efficiently in Virtual Learning Environment Framework (VLEF) and in face to face classrooms (Khan, 2014, 2016, 2017 & 2018).

It also needs the skill and utilization of ICT and online or web based techniques and technologies (toolkits) both on the part of the learner and the tutor confronted with different issues and challenges in education (Khan, 2014, 2016, 2017 & 2018).

But, the most important point to be considered while designing a programme of learning for Cognitive Apprenticeships is the "Zone of proximal development" (ZPD) as the starting point for optimum development; and *modeling* and *coaching* for the required components to be mastered through *scaffolding* and *fading* i.e. gradually withdrawing the support of the master or trainer and making the student *self-regulated* and *skillful* to *articulate*; *reflect*, *explore* and *create* the new areas and develop the related domain of knowledge or cognition and skill through different learning strategies and methods for effective learning environment in distance and traditional institutions as well as in open and flexible learning environments frameworks (VLEF) by utilizing toolkits of e-learning, web-based or online education and training at school level or any practical and skill related domain of knowledge (schooling) such as professional and vocational knowledge and skill in face to face classrooms (Khan, 2014, 2016, 2017 & 2018).

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IV.METHODOLOGY

The nature of the study was quasi-experimental based on pre-test and post-test non-equivalent group design. The population of the study was all the science students of class 9th and all the science teachers of secondary and higher secondary school in district Swat. The sample of the study consisted of 160 students (including both genders boys = 100 and girls = 60 of class 9th in proportion of 5 : 3 with stratified random sampling technique) of 8 sections (n = 20 in each section) from government and private schools (boys, girls and co-education) during academic session 2014 – 2015. The experiments were conducted through trained science teachers in Advance Cognitive Apprenticeship for the study in the selected schools. The data collected were analysed using t-statistics and Cohen's d, r and r^2 as inferential statistics for interpretation of data analysis.

Data Analysis

Hypothesis – 1: H_1

There is significantly different impact on students achievement by Advanced Cognitive Apprenticeships model in science teaching at secondary school level.

Table 1: Rank order of experimental group in pre-test and post-test (n = 20)

Category	S.No	Mean	Sp*	T	d	r	r^2	Ranking
Pair – 1	1	9.3	3.20	6.34	2.91	0.8	0.64	High
	2	4.85	3.08	3.4	1.58	0.61	0.37	High
Pair – 2	3	4.5	2.17	4.54	2.07	0.71	0.50	High
	4	5.4	1.63	7.23	3.32	0.86	0.74	High
Pair – 3	5	6.9	1.62	9.26	4.25	0.90	0.81	High
	6	1.3	2.45	1.20	0.55	0.27	0.07	Low
Pair – 4	7	0.6	0.66	2.07	0.95	0.43	0.18	Low
	8	0.95	0.87	2.37	1.09	0.48	0.23	Low
Pair – 5	9	2.7	1.05	5.71	2.62	0.80	0.64	High
	10	3.4	1.53	4.86	2.23	0.74	0.54	High
Pair – 6	11	1.85	1.31	3.0	1.41	0.58	0.33	Medium
	12	3.95	1.40	6.16	2.83	0.82	0.67	High
Pair – 7	13	-0.15	0.56	-0.58	-0.27	-0.13	0.01	Low & Negative
	14	7.7	1.63	4.94	2.27	0.75	0.56	High
Pair - 8	15	5.8	1.27	9.96	4.57	0.92	0.84	High
	16	2.85	1.63	3.81	1.75	0.66	0.43	High

Interpretation:

Table 1 shows that the effect size produced is significantly high in 69 % cases; medium in 6 % cases while it is low in 25 % cases with only 6 % has produced negative or zero effect in experimental group. So, the positive evidence is 94 % high & 6 % for negative (low). Moreover, there is consistency in most of the pairs.

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Hence, we reject H_O and accept H_A that there is statistically different impact produced on students achievement by the application of Advanced Cognitive Apprenticeships model in teaching science at secondary school level.

Hypothesis – 2: H_2

There is statistically significantly and high impact on students' overall achievement by Advanced Cognitive Apprenticeships model.

Table 2 Paired sample t-statistics and effect size for the overall achievement test score (n = 15)

Category	Mean	SD	t	df	P	d	r	r^2
Pair - 1	4.667	4.835	-3.738	14	0.002	-1.73	0.65	0.422
	11.47	2.70	16.48	14	0.000			
Pair - 2	0.133	3.852	0.86	14	0.412	4.306	0.90	0.81
	13.07	1.792	28.25	14	0.000			
Pair - 3	3.867	3.889	-3.851	14	0.002	3.04	0.835	0.70
	12.87	1.552	32.10	14	0.000			
Pair – 4	0.467	1.187	1.522	14	0.150	3.89	0.86	0.74
	7.73	2.789	10.73	14	0.000			
Pair – 5	0.533	1.727	1.196	14	0.0251	3.32	0.86	0.77
	9.87	3.583	10.66	14	0.000			
Pair – 6	2.133	2.167	3.813	14	0.002	2.46	0.78	0.60
	8.47	2.924	11.21	14	0.000			
Pair – 7	3.867	1.9222	-7.790	14	0.000	3.31	0.86	0.73
	11.00	2.360	18.04	14	0.000			
Pair- 8	3.20	2.21	-5.607	14	0.000	4.11	0.899	0.80
	11.13	1.6	26.99	14	0.000			

Interpretation:

Table 2 shows that Cohen's d of all the pairs is high ($r_1 = 0.65$, $r_2 = 0.90$, $r_3 = 0.835$, $r_4 = 0.86$, $r_5 = 0.86$, $r_6 = 0.78$, $r_7 = 0.86$, $r_8 = 0.899$). Hence, the ANCOVA indicates that the 90 % effect size produced by the experimental group achievement is high with no significant difference in sample and population means in t – statistics.

Hence, we can infer that the experimental group overall achievement is high and significant with the application of Advanced Cognitive Apprenticeship Model.

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V. FINDINGS, DISCUSSION AND CONCLUSION

The data analysis interpretations resulted in the following finding:

1. The experimental group (Application of learning theories in Cognitive Apprenticeships) has proved the hypothesis that: the application of Advanced Cognitive Apprenticeships has produced statistically significant impact on students achievement at secondary level in pre-test and post-test comparison. (Table 1)
2. The experimental group (Application of learning theories in Cognitive Apprenticeships) has proved the hypothesis that the application of Advanced Cognitive Apprenticeships has produced statistically significant and high impact on students overall achievement at secondary level.(Table 2)

The prominent psychologists who presented learning theories, discussed the implications and application of learning theories and presented models for instruction as identified in literature review include: Ausbel (1963), Bandura (1977), Bruner (1966), Gegne (1964), Pavlov (1939), Piaget (1985), Skinner (1968), Thorndike (1939), Tolman (1948) Vygotsky (1978) and Watson (1928), etc.

This research study has tried to convert the theoretical notions into practice in teaching science subjects at Secondary School Level through experimental procedures in actual classrooms and laboratories.

The base to this study is provided by the prominent Theories and models of Learning: Behaviouristic, Cognitivists and Constructivists etc. and the Theories of Instruction: Expository, Discovery; Induction and Deduction etc.; While the model to apply these theories of learning and instruction in integrated form as identified in literature is: Cognitive Apprenticeships as discussed by Collins et al (1996), Lui (2004) and other Researchers and Educationists and supported by the studies of Khan (2014, 2016, 2017 & 2018).

So, the findings of the study support all the previous Theories, Models and Strategies adopted for effective teaching and learning and it confirms all the previous Observations for Effective Science Teaching in which Programmed Learning, Concept Attainment Model and ICT-based Instructions (Blended and Online Learning); are supported through Cognitive Apprenticeships in integrated form.

Al-Rsa'i (2013) has discussed that: "ICT provides many tools and resources that can be utilized through Constructivist Learning Strategies in teaching science where the students can perform several tasks and activities at their own (self-regulated); and be responsible for their learning process". This study also supports the argument as it has suggested "Cognitive Apprenticeships" as an effective model to make the students self-regulated learners through the use of ICT and web-based technologies, services and resources.

Al-Rsa'i (2013) study also confirmed that employing ICT in physics teaching was effective for acquisition of scientific concepts among students. Secondary school level is considered as most important for further education in science and technology student; as to choose the career in science at this stage.

Hence, the Application of Learning Theories in teaching science subjects at Secondary School Level will require the use of ICT in classrooms (Face-to-Face, Blended or Online). It also requires further research to validate the findings of the study in larger settings and to be generalized. It has significant implications and applications for Teaching Science Subjects at Secondary School Level.

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The findings and discussion resulted in conclusion of the study to prove the research hypothesis that: The application of Advanced Cognitive Apprenticeships model has statistically significant and high impact on students achievement at secondary school level.

VI. RECOMMENDATIONS

On the basis of findings, discussion and conclusion it is recommended to all stallholders that:

1. The science teachers (both pre-service and in-service) must be trained in Advanced Cognitive Apprenticeships model at secondary school level to become creative and self-regulated learners them and promote creativity in students.
2. The curriculum of teacher training and education programs must be revised for the application of learning theories and Advanced Cognitive Apprenticeships in learning and instruction in order to make the students creative and self-regulated, life-long and continuous learners to combat the new challenges of 21st century.
3. The students and teachers as well as teacher educators must be trained to develop problem solving, decision making and self-regulated cognitive and meta-cognitive skills (toolkit) through effective science instructions and teaching methods.
4. The planner of education system in Pakistan must plan for preparing students to combat the new challenges through education and practical skills of becoming life-long and continuous learners when using cognitive toolkits for problem solving.

Further Research

The researcher suggests further research to apply Advanced Cognitive Apprenticeships model at all levels of education: primary, secondary and territory. The researcher also suggests to further develop the new methods of creativity in advanced Cognitive Apprenticeships in various disciplines and subjects (curriculum development).

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