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Effect of Toulmin's Argument Pattern within TRGSR Teaching Learning Strategy on Students' Metacognition

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Abstract--*The present study aimed to investigate the effectiveness of Toulmin's Argument Pattern (TAP) within Think-Read-Group-Share-Reflect (TRGSR) strategy on 12th grade students' metacognition. A quasi-experimental, pretest posttest control group design was employed with the sample of 50. The experimental group was taught with Toulmin's Argument Pattern (TAP) within Think-Read-Group-Share-Reflect (TRGSR) strategy on the other hand the control group was taught with the traditional teaching approach. Think-Read-Group-Share-Reflect (TRGSR) is a customised teaching learning strategy to integrate TAP. Metacognitive Awareness Inventory (MAI) (Schraw and Dennison, 1994) was used to measure metacognition. After a 9-week long intervention, ANCOVA findings showed that the experimental group significantly performed better over the control group.*

Key Words--*Metacognition; Scientific Argumentation; Toulmin's Argument Pattern (TAP); Think-Read-Group-Share-Reflect (TRGSR).*

I. INTRODUCTION

Education is a complex endeavour in itself. The complexity is further increased when a nation like India attempts to provide the world class education for millions of children with the premise that education is a basic human right that needs to be fulfilled for the constitution of the country. However, in India, a long history of colonialism, diversity of cultures and languages, and a large population (approximately 276 million people) still living under the official poverty make this endeavour extremely challenging, if not impossible (Koul, Verma, &Nargund-Joshi, 2019).

When it comes to science education, traditionally, "science in schools is taught in 'positivist perspective' as a subject in which there are clear 'right answers'. As a consequence, science knowledge is seen as a "finished" product that must be learned as literally as possible (Driver, Newton, & Osborne, 2000). Science learning emphasised on transmission of knowledge and has paid less attention to scientific argumentation. This has given a wrong impression of science as the collation of facts about the nature (Geddis, 1991; Driver *et al.*1996). This pedagogical paradigm has also failed to enable students with the ability to argue scientifically (Solomon 1991, Norris and Phillips 1994).

In an effort to foster the learning experience in science, the domain of science education has been undergoing paradigm changes. The present paradigm of science education posits constructivist, student centered, collaborative, and deep learning ecosystem with digital learning infrastructure. Over the last decade, the concept of

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Toulmin's Argument Pattern (TAP) got a wide range of acceptance to enhance the ability scientific argumentation among students (Erduran, Simon, & Osborne, 2004).Toulmin's seminal book *The Uses of Argument* (Toulmin, 1958) has paved the way for many science educators adapting his framework on argument for teaching and learning purposes (Erduran& Ebru Kaya, 2016). Engaging in science as an argumentative practice can promote students' critical thinking, reflection/ metacognition, and evaluation of evidence (Bathgate, Crowell, Schunn, Cannady, & Dorph, 2015; Erduran & Jimenez-Aleixandre, 2008). The United States introduced scientific argumentation into education standards for literacy, math, and science (Common Core State Standards Initiative, 2010a, 2010b; NGSS Lead States, 2013). The European Union officially recommended incorporating scientific argumentation as a set of key competencies for lifelong learning (European Union, 2006). Furthermore, the Program for International Student Assessment (PISA) considers the ability to use scientific evidence to support claims—a skill that is fundamental for engaging in scientific argumentation (Organisation for Economic Cooperation and Development [OECD], 2006, 2013). The National Research Council (NRC, 2012) identified engaging in argument from evidence as one of the eight essential scientific practices that students should experience in school science education.

The pedagogy of scientific argumentation influences the improvement of higher order thinking skills but the science teachers still considers challenging to integrate argumentation practice in teaching learning process (Simon et al., 2006; Zohar, 2008). Metacognitive knowledge is multidimensional, domain-general in nature, and teachable (Schraw, 1998). There is a dire need to facilitate the learning of metacognitive knowledge explicitly (Pintrich, 2002). Teaching students to use metacognition to understand how they are thinking about biology provides an important step on the path to thinking like a biologist (AAAS, 2011).

The present study aimed to critically discuss the effectiveness of the scientific argumentation-based teaching strategy that is integration of Toulmin's Argument pattern (TAP) within Think-Read-Group-Share-Reflect (TRGSR) strategy on the development of metacognition in the context of learning biology.

Theoretical framework

Most of the researchers of metacognition agree cognition and metacognition differ in that cognitive skills are necessary to perform a task, while metacognition is necessary to understand how the task was performed (Garner, 1987). Metacognition has been defined as referring to "the ability to reflect upon, understand, and control one's learning," (Schraw & Dennison, 1994). A second definition of metacognition is the, "knowledge and awareness of one's own cognitive processes," (Mayer, 2008), and a third is simply how one thinks about his or her own thinking. As per the literature available, there are two components of metacognition, *knowledge of cognition* and *regulation of cognition* (Flavell, 1987).Knowledge of cognition refers to what individuals know about their own cognition. It consists three different kinds of metacognitive awareness: declarative, procedural, and conditional knowledge (Brown, 1987; Jacobs&Paris, 1987; Schraw &Moshman, 1995).

Declarative knowledge refers to knowing about "what" aspect of the things before one gets on to the task. It is also knowledge about one's own abilities and skills. Procedural knowledge deals with the "how" aspect of the things which means the employment of knowledge to complete a process. Conditional knowledge deals with the

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"why" and "when" aspects of cognition which means implementation of declarative and procedural knowledge (Schraw, & Dennison, 1994).

Regulation of cognition help students control their learning. Literature supports the point that metacognitive regulation improves performance in academic achievement and other comprehension breakdowns. The pedagogy of scientific argumentation is another form of inquiry learning and inquiry promotes metacognition (Davis, 2003). Collaborative learning fosters the components of metacognition (Schunk, 1996).

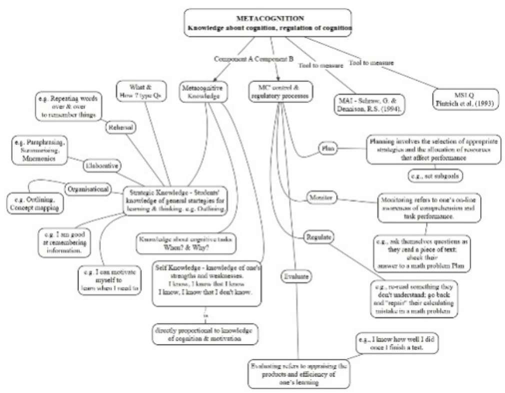

Figure 1. The conceptual framework of metacognition.

Davis (2003) found that elementary school students benefited from general reflection prompts that facilitated metacognitive monitoring. Since the beginning, metacognitive teaching have shown the positive effects on student's performance in diverse fields such as mathematics and problem solving (Palincsar, & Brown, 1987); Georghiades, 2004a; Kramarski&Mevarech, 2003; Zohar & Ben David, 2008). A number of studies report significant improvement in learning when regulatory skills are included as part of classroom instruction (Pintrich, 2000; Zimmerman, 2000). Although there exists a number of regulatory skills in the literature (Schraw & Dennison, 1994), three skills are very essential they are: planning, monitoring, and evaluation (Jacobs & Paris, 1987). Planning involves the selection of appropriate strategies and the allocation of resources that affect performance. Monitoring refers to one's on-line awareness of comprehension and task performance. Evaluating refers to appraising the products and efficiency of one's learning.

II. NEED AND SIGNIFICANCE

Effective science teaching must not only confine to increase conceptual change, but also help students develop the metacognitive skills. In addition, it must help students and teachers become aware of the beliefs they hold about scientific enterprise that influence their learning, or in the case of teachers, affect their curricular and pedagogical decisions (Schraw, Crippen, & Hartley, 2006). Metacognition has the potential effect to improve thinking skills and promoting conceptual change in school students (White and Gunstone, 1989; Georghiades, 2000).Research suggests that students with poor metacognition perform less well academically (Dunning *et al.*,

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2003). But there remains much to be learned about the influence of metacognition on learning within particular disciplinary contexts (Tanner, 2012).

There is a lack of studies that employ controlled research designs that can provide causal evidence regarding the effectiveness of metacognitive instruction for science learning (Zohar, & Barzilai, 2013). Most of the early research was laboratory training studies but recent studies more often examine metacognitive instruction in natural classrooms settings (Veenman, 2011). The implications of these research gaps are motivated the researcher to make the present study.

III. METHODOLOGY

A quasi-experimental pretest posttest, control group design was implemented to collect quantitative data and researcher's observation was employed to collect qualitative data. The tool employed to metacognition is Metacognitive Awareness Inventory (MAI).

Sample

The twoJawahar Navodaya Vidyalayas (JNVs) schools were selected out of 661 schools for the sample of the present study. Jawahar Navodaya Vidyalayas (JNVs) is a system of schools for rural talented students in India. The researcher has chosen Jawahar Navodaya Vidyalaya (JNV) Nagara as experimental group and Mansoon JNV for control group. The rationale for selecting these two schools is that the students of these schools belong to similar socio-economical background and pedagogical process. The average of achievement scores of these two schools also was almost similar as compare to other schools. The sample size of the study is 50, 25 out of 40 are selected randomly for each group, there were 25 students (12 girls, 13boys) in the experimental group and 25 students (12 girls, 13 boys) in the control group. The ages of participants ranged between 16 and 17 years.

Instructional material development

The researcher has designed eight activities for 12th grade students on ecology topic, after a series of prolonged discussions with subject experts. An activity is made in the form of a handout that feature a problem, background information, and few web links for further information, the list of the eight activities designed are provided in the Table 1. A few of the eight activities were piloted with 12th grade students in Demonstration Multipurpose School, Regional Institute of Education, Mysore, India. The major observations made during the pilot study were incorporated on all eight activities.

Table 1: List of activities implemented for experimental group.

Ecology	
S.No	**Name of the activity**
1	**Coral reefs:** Impact of climate change on coral reefs (inshore and offshore) and role of coral reefs in bio-diversity, in tropical coastal regions, and as a national asset.

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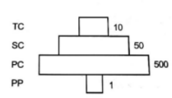
2	**Temperature:** In the recent years, there has been a growing concern about the gradually increasing average global temperatures. How would global warming affect the climate zones (shifting of climate zones) and species distribution (Bio-diversity)? Or What would be the fate of different categories (Megatherms, mesotherms, microtherms, hekistotherms) of organisms with global warming?
3	**Population growth:** Predict number of children per woman for India, Japan, Iraq, China and USA to have a desirable age pyramid.
4	**Population interactions:** What is the effect of invasive species on biodiversity? Or What is the significance of population interactions in agro-ecosystem? And form an argument on the present scenario of population interactions in agro-ecosystem.
5	**Productivity:** The annual NPP of whole biosphere is approximately 170 billion tons of organic matter, aquatic habitat, despite occupying about 70 % of earth surface area, the productivity of aquatic ecosystem is only 55 billion tons whereas it is115 billion in terrestrial ecosystem. Form an argument for the disconnect between area and NPP in the two ecosystems. Or Form an argument on the present trend of NPP.
6	**Food web:** How does food web complexity affect the biodiversity of an ecosystem?
7	**Ecological pyramids:** Form an argument on the type of pyramid of biomass & number you would expect in an ocean, and forest ecosystem. Or Assume the following figure as both the pyramid of number and biomass, and predidct different possible organisms and type of ecosystem (e.g. forest ecosystem) at each level of the pyramid. 
8	**Ecological succession:** In a hydrarch succession which proceeds naturally from pioneers to one or two communities, there is a gradual reduction in the quantity of water in the place of succession, suppose due to natural reasons this area becomes flooded and water is replenished constantly in that place, what effect will it have on ecological succession? Can we expect a climax community in this area? Suppose there is a devastating wild

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	fire in a tropical climax forest (Dry deciduous forest), what effect will it have on climax community? Would physico-chemical characteristics remain same, if it changes what would be the changes? Would expect the same community of organisms to regenerate?

Think-Read-Group-Share-Reflect (TRGSR) Strategy

Suhartoyo, Mukminatien, &Laksmi, (2015) have integrated the Toulmin's argumentation model into Think-Write-Pair-Share (TWPS) in teaching English. The Think-Read-Group-Share-Reflect (TRGSR)Strategy isslightly similar to these approaches becauseit is developed to facilitate collaborative and constructivist learning yet differs with the existing teaching strategies in the steps of operation. Toulmin's Argument Pattern (TAP) within Think-Read-Group-Share-Reflect (TRGSR)Strategy is very systematic, the elements of argument is easily distinguishable and assessable by teachers (Erduran, Simon, & Osborne 2004). The detailed version of Think-Read-Group-Share-Reflect (TRGSR)Strategy is given in the Table 2.

Data collection procedure

To begin with, pretest was administered to both experimental and control group on critical thinking before the intervention.

Orientation to the Toulmin's model of argumentation: After administering the pretest, the author of the present study oriented the students on Toulmin's model of argumentation and scientific argumentation based strategy that is Think-Read-Group-Share-Reflect, a detailed procedure of the strategy is provided in Table 2. Intervention based on scientific argumentation strategy: After the orientation of students to the scientific argumentation strategy, Biology lessons were conducted with experimental group through Toulmin's Argument Pattern (TAP) within Think-Read-Group-Share-Reflect (TRGSR)Strategy by the researcher. The study was conducted for about 9-week duration on the activities given in Table 1. The steps of the Think-Read-Group-Share-Reflect (TRGSR)Strategy are presented in the Table 2.

Table 2. Sample self-questions and prompts for promoting metacognition through TRGSR strategy.

Learning activities	**TRGSR steps**
What do I already know about this problem? (Planning). Do I like this problem? Why or why not? How could I contextualise this problem? (Monitoring).	**Think** Teacher poses the problem and Students think about the given problem.
Who should I join with and what task should I	**Read**

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take to best support my group? What questions do I already have about this problem that I want to explore here? (Planning). Can I choose crucial information from the hand-out? If not, what to do? (Monitoring). What do I need to actively do now to get my doubts answered? (Evaluating)	Students read the given hand out individually pertaining to the problem.
How did the ideas of today's class relate to previous class? (Evaluating). What do I need to complete the task? (Planning). How much time do I need to complete the task? (Planning). What other resources could I be using to complete this task? What action should I take to get these? What is most challenging for me about this task? Most confusing? What could I do differently mid assignment to address these challenges and confusions? (Monitoring) How my ideas are different from the other group ideas? What is the most part of the argument that we formed?	**Group** a) Formation of the groups. b) Browse: Students explore to collect information using internet. c) Migrate: After initial exploration, students visit other groups to exchange the ideas and to avoid the duplication of argument. d) Formation of argument: After detailed research, all groups form the argument based on Toulmin's model of argumentation that is shown in Figure 1.
What was the main reason for forming this argument? And why didn't you form some other argument? What is the authenticity of the data that you connect to your claim? How confident are you with this argument? Why? What else would you need to increase your confidence?	**Share** Presentation of the argument (argumentation) by each group to the whole class.
How "scientific argumentation" is different from the other approaches of learning? To what extent did I successfully accomplish the goals of the task? (Evaluating) How can I still modify it?	**Reflect** Each group reflects and modifies the argument based on the feedback obtained during their argumentation.

Inspired by Kimberly D. Tanner (2012).

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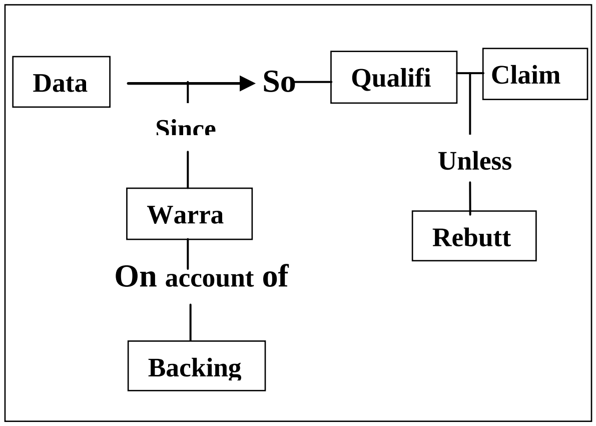

Figure 1. Toulmin's Argument Pattern, (1958).

Procedure of instruction for control group: After a series of classroom observations, and interviews with students, the researcher presents that the learning process in control group mostly confined to regular classroom activities, for instance, the facilitator presents the content on power point presentation, during this process if the students has any doubt they are free to raise. It is observed that the facilitator allows the peer to respond to the doubt raised and then the facilitator figures in if the concerned party is not so clear of the doubt. Thus, control group didn't have much scope for problem solving, collaborative learning, and technology utililisation as much as experimental group activities had.

Metacognitive Awareness Inventory (MAI)

Metacognitive Awareness Inventory (MAI) (Schraw and Dennison, 1994) was used to measure metacognition. The test is composed of 52 items, 17 of them assess knowledge of cognition (KC) and 35 assess regulation of cognition (RC). The knowledge of cognition part, which measures the reflective aspect of learning, includes the following sub factors: (1) Declarative knowledge, (2) procedural knowledge and (3) conditional knowledge. On the other hand, the regulation of cognition part includes a number of sub processes that facilitate the control aspect of learning like (1) planning, (2) information management strategies, (3) monitoring, (4) debugging and (5) evaluation. The inventory uses a bipolar scale response format. The left end of each scale indicated that the statement is "Always false" (1) and the right end, "Always true" about the participant. Schraw and Dennison (1994) report that in a factor replication analysis, the coefficient alpha derived reached .88 and .90 in the final set of items.

IV. RESULTS

The Descriptive Statistics of mean, standard deviation minimum, and maximum scores of the Pretest and Posttest in the Experimental and the Control Groups are provided in the Table 3.

Table 3: The Descriptive Statistics Analysis of the Pretest and Posttest in the Experimental and the Control Groups, N=25.

Pretest	Posttest

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Descriptive statistics	Groups		Groups	
	Experimental	Control	Experimental	Control
Mean	37.76	38.84	43.24	37.60
SD	3.98	6.08	4.40	5.65
Min	29	28	32	27
Max	43	51	50	49

A posttest was administered after 9 weeks of intervention. Based on the overall descriptive statistical analysis, the post-test scores of the experimental group were higher than the control group's but it is found that the posttest mean score of control group is one point less than the pretest mean score.

Table 4: Descriptive Analysis towards Pre-Test, Post-Test, and N-Gain of Metacognition Awareness Indicators of experimental group, N=25.

Group	Scores	Metacognition Awareness Indicators							
		DK	PK	CK	P	IMS	M	D	E
Experimental group	Pretest	5.44	2.52	3.84	5.16	6.84	5.64	4.16	4.28
	Posttest	6.56	3.20	4.24	5.44	8.60	5.88	4.48	4.84
	Gain	1.12	0.68	0.4	0.28	1.76	0.24	0.32	0.56

Declarative knowledge (DK), Procedural knowledge (PK), Conditional knowledge (CK), Planning (P), Information management (IMS), Monitoring (M), Debugging (D), and Evaluating (E) – (Schraw and Dennison, 1994).

The statistical technique ANCOVA was employed to find out if the experimental group is significantly greater over the control group, and the pre-test was employed as the covariate. Assumptions analysis for this statistic was the test of homogeneity and normality (Leech et al., 2005). Homogeneity Testing: The analysis of the homogeneity test of variance showed that the significance value or *p*-value was 0.714. It meant that the *p*-value was greater than the level of significance $\alpha = 0.05$ (Sig. 0.714> Sig. 0.05). In other words, equal variances are assumed. Test of Normality:The p-Values of Shapiro-Wilk test of normality greater than the level of significance $\alpha = 0.05$. To be more specific, the significance value for of normality test is(Sig. 0.82> Sig. 0.05), In other words, the sample is normally distributed. As the two assumptions are fulfilled, a parametric test ANCOVA is employed to test the hypotheses. The posttest scores are analysed with statistical technique ANCOCA, where pretest scores are considered as covariate. As per the data showed in the table 4, the p-value of ANCOVA, is lower than $\alpha = 0.05$, (Sig. 0.000> Sig. 0.05), so, the null hypothesis, which states there is no significant difference between experimental and control group in terms of metacognition was rejected. Thus, the experimental group which is exposed to TAP within TRGRS strategy teaching performed significantly better than traditional group in developing metacognition.

Table 5: The Computation of Main Hypothesis, ANCOVA.

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Source	**Sum of squares**	**Df**	**Mean square**	**F**	**Sig.**
Group	487.07	1	487.07	28.98	.000

ANCOVA result indicates that experimental group significantly outperformed the control group, it means that scientific argumentation approach effective in developing metacognition among 12th grade students. A similar study conducted by Duran, M., &Dökme, I. (2016) indicated that students taught through inquiry based learning improved critical thinking. Argumentation is a similar learning process like inquiry based learning (Sampson, Grooms, & Walker, 2011). Both critical thing and metacognition are higher order thinking processes (Kuhn, 1999). Hence, here in this case inquiry based learning is considered for argumentation approach and critical thinking for metacognition.

V. DISCUSSION AND CONCLUSION

The findings of the present study indicate that Toulmin's Argument pattern (TAP) within TRGSR teaching learning strategy was effective on the development of metacognition in the context of learning biology. In the present study, Toulmin's Argument pattern (TAP) within TRGSR teaching learning strategy is the pedagogy of scientific argumentation. The scientific argumentation focuses on process of thinking that foster scientific argumentation skills (Songsil, Pongsophon, Boonsoong, & Clarke, 2019) and conceptual knowledge (KabataMemis, E &EzberciCevik, 2017), whereas this study provides the empirical findings of improved metacognition among 12th grade students. Metacognition strategies provide opportunities for students to monitor learning being conducted and to adapt the same strategy to overcome new problems as needed (Yusnaeni et al., 2017). The teaching learning process of TAP within TRGSR strategy facilitates Previewing, predicting, verifying, self-questioning, drawing on prior knowledge, goal setting, summarising and drawing on mental images as shown Table 2. Thus, the inquiry learning environment of scientific argumentation pedagogy improves higher-order thinking skills (Arends, 2012), which includes metacognition.The argumentation strategy has the potential to foster epistemic foundation for the criteria for how evidence is evaluated, how reasoning is developed, and how theories are selected (D'Souza, 2018). Muhali (2018) reveals that the practice of the reflective-metacognition learning model can consistently improve metacognition awareness. Thus, the researcher concludes that scientific argumentation is very significant pedagogical strategy to foster metacognition. The present research recommends the implementation of scientific argumentation pedagogy TAP within TRGSR strategy at school level.

REFERENCES

1. American Association for the Advancement of Science (2011). Vision and Change: A Call to Action, Final Report.Washington, DC: AAAS.http://visionandchange.org/finalreport.
2. Arends, R. (2012). *Learning to Teach.* Ninth Edition. New York: McGraw-Hill.
3. Bathgate, M., Crowell, A., Schunn, C., Cannady, M., & Dorph, R. (2015). The Learning Benefits of Being Willing and Able to Engage in Scientific Argumentation. *International Journal of Science Education, 37*(10), 1590–1612. https://doi.org/10.1080/09500693.2015.1045958.
4. S. Rohini, M. Sharanya, A. Vidhya, S. Viji and P. Poornima. "Proximity Coupled Microstrip Antenna for Bluetooth, WIMAX and WLAN Applications." International Journal of Communication and Computer

DOI: 10.37200/IJPR/V24SP1/PR201263
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Technologies 5 (2017), 48-52. doi:10.31838/ijccts/05.02.03
5. Brown, A. L. (1987). Metacognition, executive control, self-regulation, and other more mysterious mechanisms. *Metacognition, Motivation, and Understanding*, 65–116.
6. Common Core State Standards Initiative. (2010a). Common core state standards for English languagearts& literacy in history/social studies, science, and technical subjects. Retrieved from http://www. corestandards.org/assets/CCSSI_ELA%20Standards.pdf
7. Common Core State Standards Initiative. (2010b). Common core state standards for mathematics. Retrieved from http://www.corestandards.org/assets/CCSSI_Math%20Standards.pdf
8. Davis, E. A. (2003). Prompting middle school science students for productive reflection: Generic and directed prompts. *The Journal of the Learning Sciences, 12*(1), 91–142.
9. Driver, R., Newton, P., & Osborne, J. (2000). Establishing the norms of scientific argumentation in classrooms. *Science Education, 84*(3), 287-312.
10. Fedelicashishtoppo, rajeshsinghpawar (2015) novel drug delivery strategies and approaches for wound healing managements. Journal of Critical Reviews, 2 (2), 12-20.
11. Driver, R., Leach, J., Millar, R. and Scott, P. (1996) *Young People's Images of Science* (Buckingham: Open University Press).
12. Dunning D, Johnson K, Ehrlinger J, Kruger J (2003).Why people fail to recognize their own incompetence. Curr Directions Psychol Sci *12*,83–87.
13. Duran, M., &Dökme, I. (2016). The Effect of the Inquiry-Based Learning Approach on Student's Critical-Thinking Skills. *Eurasia Journal of Mathematics, Science and Technology Education*, *12*(12), 2887–2908.
14. Duschl, R. A., & Osborne, J. (2002). Supporting and promoting argumentation discourse in science education.
15. Manasa Veena Valupadasu, Uday Venkat Mateti. "Advanced Malarial Vaccines: A Promising Approach in the Treatment of Malaria." Systematic Reviews in Pharmacy 3.1 (2012), 31-36. Print. doi:10.4103/0975-8453.107136
16. D'Souza, A. N. (2018). Enhancing and evaluating scientific argumentation in the inquiry oriented college chemistry classroom. *Dissertation Abstracts International Section A: Humanities and Social Sciences*. Retrieved from https://search.proquest.com/docview/2007155938?accountid=48425
17. Erduran, S., & Ebru Kaya, (2016). Argumentation and Deliberative Democracy: An Incompatible Mix in School Science?. *Theory Into Practice*, *55* (4), 302-310.
18. Erduran, S., & Jimenez-Aleixandre, J. (2008). Argumentation in Science Education: Argumentation in Science Education Perspectives from Classroom-Based Research. United Kingdom, Springer.
19. Erduran, S., Simon, S., & Osborne, J. (2004). TAPping into argumentation: Developments in the application of Toulmin's Argument Pattern for studying science discourse. *Science Education*, *88*(6), 915–933.
20. European Union. (2006). Recommendation ofthe European Parliament on key competences for lifelong learning. Official Journal oftheEuropeanUnion, 30-12-2006,L394/10-L 394/18.
21. Flavell, J. H. (1987). Speculations about the nature and development of metacognition. *Metacognition Motivation and Understanding*, 21–29.
22. Garner, R. (1987). *Metacognition and Reading Comprehension*. Norwood, NJ: Ablex Publishing.
23. Geddis, A. N. (1991). Improving the Quality of Science Classroom Discourse on Controversial Issues. *Science Education*, *75*(2), 169–183.
24. Georghiades, P. (2004). From the general to the situated: Three decades of metacognition. *International journal of science education*, *26*(3), 365-383.
25. Georghiades G (2000). Beyond conceptual change learning in science education: focus on transfer, durability, and metacognition. Educ Res*42*, 119–139.
26. Jacobs, J. E., & Paris, S. G. (1987). Children's Metacognition About Reading: issues in Definition, Measurement, and Instruction. *Educational Psychologist*, *22*(3), 255–278.
27. KabatasMemis, E. &EzberciCevik, E. (2017). Examination of students' small groups discussion in argumentation process: Scientific and socio-scientific issues. *Journal of Education in Science, Environment and Health (JESEH), 3*(2), 126-137. DOI:10.21891/jeseh.325788
28. Kuhn, D. (1999). A Developmental Model of Critical Thinking. *Educational Researcher*, *28*(2), 16–46.
29. Koul, R., Verma, G., &Nargund-Joshi, V. (Eds.). (2019). *Science Education in India: Philosophical, Historical, and Contemporary Conversations*. Springer Nature.

DOI: 10.37200/IJPR/V24SP1/PR201263
Received: 20 Jan 2020 | Revised: 08 Feb 2020 | Accepted: 27 Feb 2020

30. Kramarski, B., &Mevarech, Z. R. (2003). Enhancing mathematical reasoning in the classroom: The effects of cooperative learning and metacognitive training. *American Educational Research Journal*, *40*(1), 281-310.
31. Mayer, R. E. (2008). Learning and Instruction. New Jersey: Pearson Education, Inc.
32. Muhali. (2018). Pengembangan Model PembelajaranReflektif-MetakognitifuntukMeningkatkanKemampuanMetakognisiSiswa SMA [Depelovement of reflective-metacognitive learning model to improve senior high school students' metacognition ability]. Doctoral Disertation. Universitas Negeri Surabaya.
33. National Research Council. (2012). A framework for K-12 science education: Practices, crosscutting concepts and core ideas. Washington, DC: The National Academies Press.
34. Norris, S. P. and Phillips, L. M. (1994) Interpreting pragmatic meaning when reading popular reports of science. *Journal of Research in Science Teaching*, 31, 947–967.
35. Organisation for Economic Cooperation and Development (OECD). (2006). Assessing scientific,
36. Reading and mathematical literacy:A framework forPISA2006. Paris: OECD.
37. Organisation for Economic Cooperation and Development (OECD). (2013). PISA 2015 Draft Science Framework. Paris: OECD.
38. Palincsar, A. S., & Brown, D. A. (1987). Enhancing instructional time through attention to metacognition. Journal of learning disabilities, 20(2), 66-75.
39. Pintrich, P. (2000). The role of goal orientation in self-regulated learning. In M. Boekaerts, P. Pintrich, & M. Zeidner (Eds.), *Handbook of self-regulation* (pp. 452–501). San Diego, CA: Academic Press.
40. Sampson, V., Grooms, J., & Walker, J. P. (2011). Argument-Driven Inquiry as a way to help students learn how to participate in scientific argumentation and craft written arguments: An exploratory study. *Science Education*, *95*(2), 217–257.
41. Sampson, V., & Grooms, J. (2010). Generate an Argument: An Instructional Model. *The Science Teacher*, *77*(5), 32–37.
42. Schraw, G. (1998). Promoting General Metacognitive Awareness. *Instructional Science*, *26*(1), 3–16.
43. Schraw, G., Crippen, K. J., & Hartley, K. (2006). Promoting Self-Regulation in Science Education: Metacognition as Part of a Broader Perspective on Learning. *Research in Science Education*, *36*(1), 111–139.
44. Schraw, G., & Dennison, R. S. (1994). Assessing Metacognitive Awareness. *Contemporary Educational Psychology*, *19*(4), 460–475.
45. Schraw, G., &Moshman, D. (1995). Metacognitive theories. *Educational psychology review*, *7*(4), 351-371.
46. Schunk, D. (1996). Goal and self-evaluative influences during children's cognitive skill learning. *American Educational Research Journal*, *33*(2), 359–382.
47. Simon, S., Erduran, S., & Osborne, J. (2006). Learning to teach argumentation: Research and development in the science classroom. *International Journal of Science Education*, *28*(2-3), 235-260. https://doi.org/10.1080/09500690500336957
48. Solomon, J. (1991) Group discussions in the classroom. *School Science Review*, 72, 29–34.
49. Songsil, W., Pongsophon, P., Boonsoong, B., & Clarke, A. (2019). Developing scientific argumentation strategies using revised argument-driven inquiry (rADI) in science classrooms in Thailand. *Asia-Pacific Science Education*, *5*(1). https://doi.org/10.1186/s41029-019-0035-x
50. States, N. L. (2013). Next generation science standards : for states, by states.
51. Suhartoyo, E., Mukminatien, N., & Laksmi, E. D. (2015). The Effect of Toulmin's Model of Argumentation Within TWPS Strategy on Students' Critical Thinking on Argumentative Essay. *Jurnal Pendidikan Humaniora*, *3*(2), 143–153. Retrieved from http://journal.um.ac.id/index.php/jph
52. Tanner, K. D. (2012). Promoting Student Metacognition. *CBE- Life Sciences Education*, *11*(2), 113–120.
53. Toulmin, S. E. (1958). *The Uses of Argument*(Cambridge: Cambridge University Press).
54. Veenman, M. V. (2011). Alternative assessment of strategy use with self-report instruments: A discussion. *Metacognition and learning*, *6*(2), 205-211.
55. White RT, Gunstone RF (1989).Metalearning and conceptual change. Int J Sci Educ*11*, 577–586.
56. Zimmerman, B. (2000). Attaining self-regulated learning: A social-cognitive perspective. In M. Boekaerts, P. Pintrich, & M. Zeidner (Eds.), *Handbook of self-regulation* (pp. 13–39). San Diego, CA: Academic Press.

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57. Yusnaeni, Corebima, A. D., Susilo, H. &Zubaidah, S. (2017). Creative Thinking of Low Academic Student Undergoing Search Solve Create and Share Learning Integrated with Metacognitive Strategy. *International Journal of Instruction*, 10(2), 245-262.
58. Zohar, A. (2008). Science teacher education and professional development in argumentation. In S. Erduran & M. P. Jiménez-Aleixandre (Eds.), Argumentation in science education: Perspectives from classroom-based research (pp. 245–268). Dordrecht: Springer.
59. Zohar, A., & Barzilai, S. (2013). A review of research on metacognition in science education: Current and future directions. *Studies in Science education*, *49*(2), 121-169.
60. Kasthuri, Dr.VenkatIyengar,S., and Balaji,S. (2017). CFD and Structural Analysis of an Optically Accessible Combustor Sector Rig. *Bonfring International Journal of Power Systems and Integrated Circuits*, 7(2), 27-38.
61. Katahra, K. (2015),Review of Organic Solar Cells. *International Scientific Journal on Science Engineering & Technology*, 18(2), 39-47.
62. Fracasso, C., Franco, Z., Macdonald, D., Friedman, H. Measuring the transpersonal: The research and mentoring contributions of harris friedman (2011) NeuroQuantology, 9 (3), pp. 499-514.
63. Mender, D. Modes of dissipation: The green episteme and its Not-So-Green psychopathologies (2011) NeuroQuantology, 9 (3), pp. 572-576

DOI: 10.37200/IJPR/V24SP1/PR201263
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