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EFFECT OF DIFFERENTIATED APPROACH OF TEACHING BIOLOGY TO CLASS XI STUDENTS WITH SPECIAL FOCUS ON SPATIAL THINKING SKILLS

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ABSTRACT
The researcher made an initiative on trying out this Action Research using GCAT4 tools to experiment implementing new teaching strategies and bring in freshness into classroom transaction. It was decided to experiment it out with a subject of the researcher's choice and interest, that is Biology and wanted to try out the interpretations of assessment tools in relation to the National Curriculum. Performance of seven students of Grade XI ISC (Indian School Certificate) in the subject Biology, was analysed through their school exams and a specially developed pre-test followed by the administration of assessment tools of GCAT4. The findings provided an opportunity to discuss with teachers and students to understand the preferred pattern of learning style of each student and then evolved a plan using differentiated approaches with reference to spatial skills and try out whether it really had any effect on their enhanced performance in Biology. This also gave an opportunity to choose on fundamental concepts and give a differentiated approach to cater to the type of learning profile generated using the GCAT4 tools.

Keywords: Differentiation, Spatial Thinking, Cognitive ability, Biology, differentiated strategies, Verbal Reasoning

INTRODUCTION

The Cognitive Abilities Test (CAT) of British Council, UK is a suite of tests that assesses a student's reasoning (thinking) abilities in key areas that support educational development and academic attainment. CAT4 is the fourth edition of the test and comprises the following sections or batteries which assess different aspects of ability: Verbal Reasoning Battery – thinking with words; Quantitative (or Numerical) Reasoning Battery – thinking with numbers; Non-verbal Reasoning Battery – thinking with shapes; Spatial Ability Battery – thinking with shape and space. CAT4 is a comprehensive and objective test designed for testing students' developed abilities to determine attainment and can be built upon and be developed to improve outcomes. For example, verbal reasoning can be developed by supporting students' reading, comprehension and vocabulary. The teacher guide kit that was given by GL assessment firm also gave scope for the researcher to look into the case studies, reference books and thus could bring in a variety in designing differentiated Formative question papers.

As a teacher trainer and a student of Biology, the researcher was always interested in knowing about providing differentiated instruction based on different levels of learning and learning style of students. As a teacher of Biology, the researcher has always used gestures while explaining spatial concepts like anterior, posterior, lateral, horizontal, into, next to, etc. By performing these gestures, teaching students to develop drawing skills and interpretation and placement of components in it was always a challenge.

Theoretical Background

Inspired by Kolb's Reflective teaching –learning cycle, the researcher wanted to try out on the possibilities of constant acquisition of new Skills, Knowledge and Understanding, and this was materialised when an intimation was received from the British council to try out something new on assessment tools to assess both for and of learning. Using the assessment tools provided by GL and to choose on fundamental concepts and give a differentiated approach to cater to the type of learning profiles. GCAT4 tools helped to get the possible strategies that were worth trying out with the students who were not exposed to this kind of learning in a normal classroom learning.

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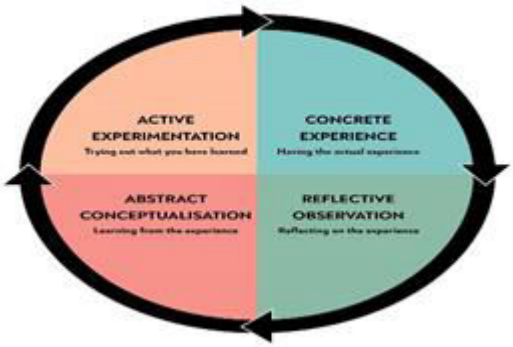

Fig.1 David Kolb's Experiential Cycle

An Operational Definition:
Spatial ability is the capacity to understand, reason and remember the visual and spatial relations among objects or space. Spatial working memory is the ability to temporarily store a certain amount of visual-spatial memories under attentional control in order to complete a task. This cognitive ability mediates individual differences in the capacity for higher level spatial abilities such as mental rotation.

Purpose of the Study
To incorporate questions which would stimulate the students' thinking ability on Mechanical reasoning, Verbal reasoning, Quantitative reasoning and 2D -3D visualization better. This was also planned to take it as a further research technique under the Professional Development practice to help the teacher candidates to come out with effective Professional Development plan under Cambridge Teacher Training program headed by the researcher. This has also given a clue and lead for the STEM studies which is finding a new place in our country's current studies.

Components of Attitude towards Spatial Thinking
Study of Watson and Crick's 3D model of DNA, concepts in molecular biology, cellular functions, anatomy of the body etc. Stimulated to understand and study about the following questions:

a) What is spatial thinking?

b) What assessment tools can be used to study students' spatial thinking skills?

c) Is spatial thinking really important for learning Biology?

d) Is it important to recognize spatial intelligence?

e) Would early attention to developing spatial thinking skills increase the students' achievements in biology?

f) Should our schools and our society do more to recognize spatial reasoning as a new kind of intelligence?

g) Is there a relationship between achievable learning outcomes in Biology for grade XI and the related spatial thinking skills? If so, is the grouping as per the intelligence level and school based assessment result in better and enhance performance in Biology?

h) How to bring in differentiated instruction to cater to the slow learners in relation to the spatial thinking skills?

Based on the above questions the researcher wanted to find out whether assessing students' spatial intelligence and grouping them accordingly would help any teacher to adopt different teaching techniques and help them learn better.

OBJECTIVES
How a differentiated approach of teaching Biology focused on spatial thinking skills will have an effect on grade XI students' learning & improvement of academic scores?

The focus was to find out the possibility of enhancing spatial thinking skills by adapting intervention strategies mentioned in the action plan that was submitted by British Council for their purview and approval to take up the research and simultaneously ensuring that the students actively participate and work in effective collaboration.

METHODOLOGY
This study is aimed at introducing the different types of approach in classrooms through the intervention strategies to benefit class XI students and bring about a change for the better in their skills, attitudes and interest

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thereby leading to practice. The Study of Watson and Crick's 3D model of DNA, was taken to test whether it had a positive influence on the attitude and learning experiences of students in Biology. They were assigned to one of seven broad descriptions (Extreme verbal bias; moderate verbal bias; mild verbal bias; no bias; mild spatial bias; moderate spatial bias; extreme spatial bias).

FINDINGS AND DISCUSSION

The GL assessment tool provided an individual report for each child and with profile score of verbal, non-verbal and spatial and the ST (STANINE& Performance Indicator) score helped to understand each student's learning style and needs. This analysis helped to formulate a plan with differentiated teaching methods with extended active learning techniques such as mind mapping, model making, demonstration, video games etc.

The key learning outcomes were: A deeper understanding of what and how effective spatial thinking skills can be in learning Biology as a subject. For students it has been a great understanding through reports generated by GCAT4 assessment tool and this has helped them to understand their own preferential style of learning. The impact of this learning as a practitioner has been to recognize and explore the possibilities of giving better scope for students for enhanced performance not only in Biology but also in other science subjects by different strategies to hone spatial thinking skills. Overall, it definitely had an impact in enhancing learning, highlighting the importance of recognition and testing of spatial intelligence in assessing students' development.

Table 1

Scores for the group (by forename)

		Verbal			Quantitative			Non-verbal			Spatial			Overall	
Student name	Tutor group	No. attempted (/48)	SAS	GR (/7)	No. attempted (/36)	SAS	GR (/7)	No. attempted (/48)	SAS	GR (/7)	No. attempted (/36)	SAS	GR (/7)	Mean SAS	GR (/7)
Akash JS	XiA	47	72	7	31	75	7	42	87	7	36	102	3	84	7
Akhil Anand	XiA	48	91	=5	34	87	=5	48	91	5	36	91	5	90	6
Anirudh Praceep	XiA	48	111	1	35	109	1	47	100	2	36	113	1	108	1
Avani Acharya Chowdhury	XiA	48	106	2	34	104	3	48	89	6	36	88	6	97	=2
Pooja Prem Shankar	XiA	47	98	4	26	91	4	37	92	4	33	107	2	97	=2
Rana Fathima Modeen	XiA	48	91	=5	27	87	=5	48	103	1	32	101	4	96	=4
Varshini Mageish	XiA	35	100	3	26	107	2	26	93	3	17	83	7	96	=4

SUMMARY OF FINDINGS

The inputs from case studies published by GL Education helped the researcher to formulate methods involving spatial thinking skills in teaching learning strategy. The reports generated helped to summarize the learning differences of the students on spatial abilities taken for research. An analysis of scores for each student based on Stanine's group ranking approach helped in taking up differentiated approach to teach Biology with reference to spatial skills that helped to cater to the expectations of the pupil with appropriate learning materials pitched at the right time.

The reports generated showed that the plan had effective learning strategies for the topic chosen to enhance the students learning based on the preferences shown for their style done through the GL assessment CAT4 done. As an effort to understand as what can be continued and conveyed to all the colleagues at school, a post test was conducted using a copy of the test to project their talent in spatial thinking (Copy Right American Psychological Association) spatial ability for STEM domain was given where the performance was not up to the mark and there needs to be enough research, practice and inclusions done in the curriculum in Maths and science on teaching spatial thinking in the school level. A relation is found between spatial thinking and STEM education and enthusing the researcher to be taken as extended research at school level too. This paves way for one to think on introducing different strategies for helping a child to learn with a preferred learning style with a precision either on verbal, non-verbal, quantitative and spatial skill irrespective of the curriculum.

The rubrics used for poster making on Blood (qualitative analysis) were: 1) Depiction of blood components in the right proportion 2) Creativity in depiction with a slogan on the value of a drop of blood as a life saver Quantitative analysis 1) How do you think that the components of a blood affect the blood flow velocity? 2) Do you think that the blood cell and the other constituents of the blood are assigned their due positions in the blood stream? An overall summary of my findings attached as an annexure.

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DISCUSSION

Of the 7 members in the group, a student who had no interest in Biology, after attending my sessions, the student started showing some interest in Biology, and this was because of the differentiated approach and the variety in learning. Having understood this, use of Vygotsky's1 Theory of pushing him to one level above was a challenging task ,and now the student has started showing interest in attending exams irrespective of the marks scored. For one more student an opportunity was given during the mind mapping session to express verbally, the consequences of his learning. This helped him to share his views with other members in the group with more verbal expressions which was taken as an extra effort to give him additional push in verbal skills. The students had to be given few links as follow up activity and research work which yielded as effect of designing their own 3D diagrams, andjavagami1and jig saw puzzleshttp://www.simplypsychology.org/Zone-of-Proximal-Development.html

Analysis of Cat4 Scores

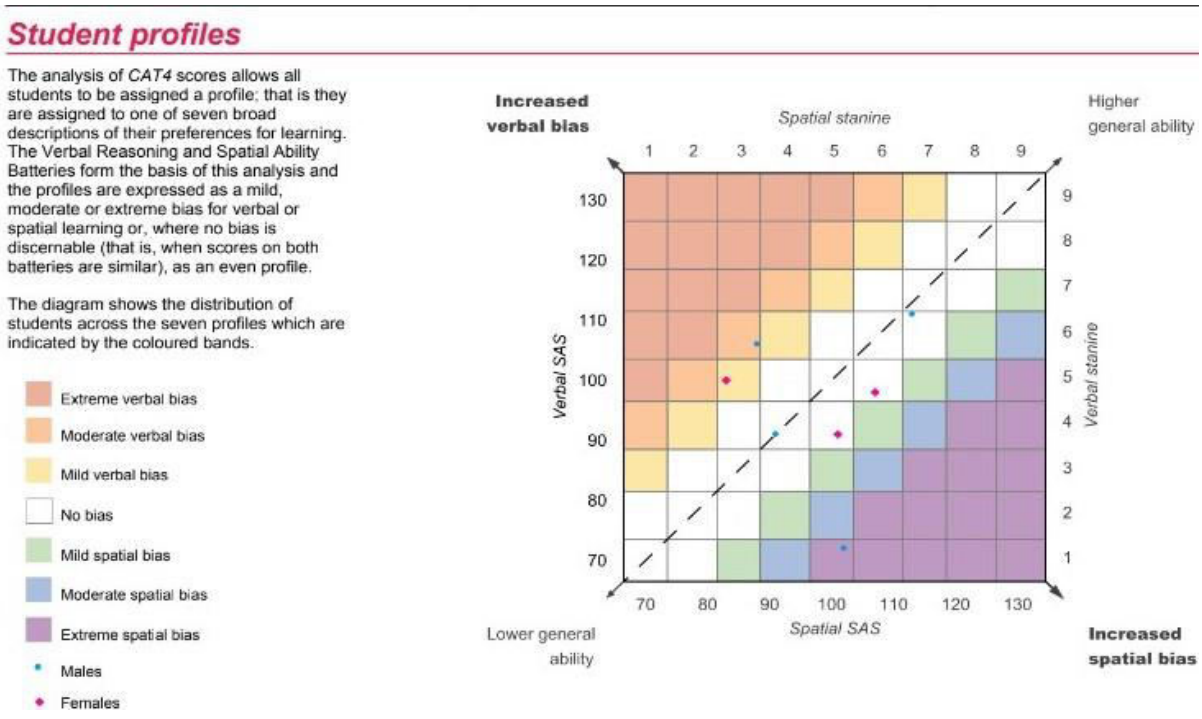

Table 2: Indicators on the Preferences for Learning:

	National	Group	
	%	%	No. of students
Extreme verbal bias	2%	0%	0
Moderate verbal bias	4%	14%	1
Mild verbal bias	11%	14%	1
No bias or even profile	66%	57%	4
Mild spatial bias	11%	0%	0
Moderate spatial bias	4%	0%	0
Extreme spatial bias	2%	14%	1

Extreme Verbal Bias

These students should excel in written work and should enjoy discussion and debate. They should prefer to learn through reading, writing and may be very competent independent learners. They are likely to be high achievers in subjects that require good verbal skills such as English, modern foreign languages and humanities. They may prefer to learn step-by-step, building on prior knowledge, as their spatial skills are relatively weaker, being in the low average or below average range.

Moderate Verbal Bias

Students in this group will have average to high scores for Verbal Reasoning and relatively weaker Spatial Ability with scores in the average range. These students are likely to prefer to learn through reading, writing and discussion. Step-by-step learning, which builds on prior knowledge incrementally, is likely to suit these students.

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Mild Verbal Bias
Some students with this profile will have low average or below average scores for Verbal Reasoning and relatively weaker Spatial Ability, but the gap between scores will be narrow. A slight bias for learning through reading, writing and discussion may be discerned in the students in this group.

No Bias or Even Profile
Scores for students with this profile will be very similar for both Verbal Reasoning and Spatial Ability but will be across the range from low to high. Students with high even scores will excel across the curriculum and will learn through the range of media and methods. Students with low even scores, conversely, may require significant levels of support to access the curriculum but will be open to a range of teaching and learning methods.

Mild Spatial Bias
Some students with this profile will have low average or below average scores for Spatial Ability and relatively weaker Verbal Reasoning skills, but the gap between scores will be narrow. A slight bias for learning through visual media may be discerned in the students in this group.

Moderate Spatial Bias
Students in this group will have average to high scores for Spatial Ability and relatively weaker Verbal Reasoning with scores in the average range. These students are likely to prefer to learn through visual and kinaesthetic media and will need to use diagrams, pictures, videos and objects to learn best. Students with above average or high Spatial Ability are often characterised as ‘intuitive’ or ‘big picture’ learners: attention to detail may be a weakness. Owing to a relative weakness in verbal skills, attainment may be uneven and they are likely to need support in subjects where the emphasis is on the written word.

Extreme Spatial Bias
These students should excel in problem solving and will grasp concepts quickly and intuitively. They will not enjoy rote learning and may arrive at a correct solution to a task without demonstrating the steps along the way. They are likely to be high achievers in subjects that require good visual-spatial skills such as maths, physics and technology. Owing to a relative weakness in verbal skills, attainment may be uneven and they may need support in subjects where the emphasis is on the written word.

CONCLUSION

On reflecting the researcher felt that apart from the GL tools administered, GCAT 4 the candidates should be tested on Tests of some kind of spatial thinking. The researcher has come to a conclusion that effect of differentiated approach of teaching Biology to class XI with special focus on Spatial thinking skills has definitely shown deep involvement in learning the subject and understanding of the subject have shown a progress to a considerable extent. The summary of the overall results can be found on clicking the link :

https://drive.google.com/drive/folders/1Y6Td_EhpjIodQxdTNysTLGU8ZAFudXVS?usp=sharing

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