APPRAISAL OF MATHEMATICAL LEARNING OUTCOMES IN CYBERGOGY ENVIRONMENT

Dr.SIDDURAJU G

LECTURER IN MATHS, GOVERNMENT DEGREE COLLEGE YELLAREDDY DIST

KAMAREDDY TELANGANA STATE -503122 INDIA

ABSTRACT

Intensive document analyses were done related to teaching and learning models, several india higher education policy documents, best practices in effective learning environments both locally and abroad in general and in the field of mathematics education, as well as the literature review on aspect of heutagogical approach. In this context, various new pedagogical concepts appear: heutagogy, paragogy and cybergogy. In line with this development, educators are urged to implement the pedagogical transformations to use these new concepts. Review of literature shows that there are currently no criteria of heutagogy, paragogy or cybergogy that can be used as a guide in designing teaching and learning, especially in learning mathematics. Therefore, the objective of this study will specifically generate the themes and its' items for heutagogy criteria. Significantly, these criteria provide a useful guide for instructors or lecturers to critically analyze each of the items and to better support students in learning mathematics for creating human capital with features such as flexible, creative, innovative and good problem solvers to meet the challenges for the future. The results show that cognitive factor is the most linked pedagogical principle to the four main capabilities of technological learning tools, that is, time, self-related, learning task, and learning community-related.

Keywords: heutagogy, paragogy or cybergogy, to teaching and learning models, mathematics education, pedagogical.

INTRODUCTION

Classroom interaction is regarded as one of the indispensables and influencing variables in mathematics learning environments. Because it is the focal point in teaching and learning settings, it is considered as one of the main factors that contribute to achieving high teaching quality and good learning outcomes among students. Therefore, educators emphasized that the best classroom interactions in mathematics learning are those that focus on the student to be the centered of learning rather than the teacher. Based on the importance of this, the Jordanian mathematics curriculum reform movement identified the importance of activating the role of the student to be a centered in all classroom interactions. Despite the importance of this trend, however, educational studies in the Jordanian environment showed that the teacher is still the centered of learning, with content-overloaded books, where this cannot offer effective classroom interaction. Moreover, the low performance in TIMSS and PISA among school students in Jordan might suggest that teaching methods and learning models are not aligned with the skills that should be learned by students, where classroom social interaction is essential for mathematics learning. In addition, mathematics teachers face challenges in their feedback moves in response to their students' errors, where students should learn from these moves in the learning process and increase the quantity and quality of classroom interaction. Moreover, few studies at the international level have discussed the classroom interaction in relation to mathematical environment supported by error-analysis activities and relevant studies at the national level are of a diagnostic nature.

LITERATURE REVIEW

Adnan Ahmad (2025) The Cybergogy approach is a teaching and learning methodology that integrates technology and pedagogy to promote critical thinking skills and inventive problem-solving among Technical and Vocational Education and Training (TVET) learners. This approach leverages the affordances of digital technologies such as virtual reality, simulations, and gamification to create immersive learning experiences that engage learners and promote higher-order thinking skills. The purpose of this study is to determine the relationship between the use of the cybergogy approach and the development of thinking skills and inventive problem-solving skills among the TVET learners and analyze the correlational strength between Thinking skills and Inventive Problem-Solving skills.

Antos Zariul (2024) This study aims to develop a hybrid learning model based on ethnomathematics with a cybergogy approach to improve mathematical proficiency of prospective elementary school teachers. This study is an R & D (Research and Development) study using the Plomp model (preliminary research stage, development or prototyping stage, and assessment stage). In data collection, researchers used questionnaires, observations, and tests. Based on the validation results by learning design experts, material experts, and practitioners, the learning model developed meets the criteria of being very feasible.

Tressyalina (2024) This research is motivated by the urgency of technology integration in technology-based learning. The integration of technology in learning is expected to be able to answer the challenges of skills in the 21st century education framework. One model that is expected to answer these challenges is the cybergogy-based learning model through the application of blended learning with three domains, namely the cognitive domain, the emotional domain, and the social domain. Based on the findings and discussion in this study, it can be concluded that LMS has proven effective in improving student learning outcomes.

Nur Ashikin Suhaimi (2021) In parallel with the Future Ready Curriculum (FRC) framework, a new teaching and learning pedagogy concept in education has been created, known as cybergogy. However, there are still no cybergogy criteria which can be used as a basis in implementing mathematical teaching and learning at higher education level using the cybergogy approach. Thus, this study aims to generate the criteria of cybergogy approach for mathematical teaching and learning at higher education level. For this approach, the themes and its' characteristics will be determined to inform the mathematics educators the ways to implement the cybergogy approach in class. These inputs on themes and items of the cybergogy approach may promote the mathematical learning transformation in this era and contribute to FRC paradigm.

Mazlini Adnan (2021) The mathematics curriculum of higher education teaching requires changes to produce highly qualified graduates, who can respond quickly and creatively to economic change. In fulfilling this aspiration, the criteria of the heutagogy, paragogy and cybergogy approaches can explain the role of mathematics educators in educating students on future life preparation. This study aims to generate the criteria of heutagogy, paragogy and cybergogy approaches for mathematical teaching and learning at Higher Education level. This study has successfully generated the criteria of heutagogy, paragogy and cybergogy approaches for mathematical teaching and learning at Higher Education level.

Creating a Classroom Culture that Values Math

Mathematics is more than just numbers and equations; it's a way of thinking and problem-solving that can enrich students' lives far beyond the classroom. To foster this understanding and appreciation, it's crucial to create a classroom culture that truly values math.

Establishing Norms and Expectations

Respect and Collaboration: Promoting a culture of respect and collaboration among students. In a supportive math learning environment, respect and collaboration are paramount. Teachers should establish clear guidelines for how students interact with each other during math lessons. This includes active listening when others are speaking, offering constructive feedback, and valuing diverse problem-solving approaches.

To foster this culture of respect and collaboration, teachers can implement several strategies:

- **Establish Clear Ground Rules:** At the beginning of the school year or semester, work with students to create a set of classroom norms. These might include rules like "We listen to understand, not to respond" or "We celebrate different approaches to problem-solving." By involving students in this process, they take ownership of these rules and are more likely to adhere to them.
- **Model Respectful Behavior:** Teachers should consistently model the behavior they expect from their students. This includes demonstrating active listening, asking thoughtful questions, and showing appreciation for different ideas and approaches.
- **Implement Structured Collaboration:** Use collaborative learning structures that require students to work together respectfully. For example, the "Think-Pair-Share" method encourages individual thinking, paired discussion, and then sharing with the larger group, ensuring all voices are heard.
- **Encourage Peer Feedback:** Teach students how to give and receive constructive feedback. This could involve creating a feedback protocol that students follow, such as "Two Stars and a Wish" where peers identify two strengths and one area for improvement in a classmate's work.
- **Celebrate Diverse Approaches:** Regularly highlight different methods for solving problems. This reinforces the idea that there's often more than one valid approach in mathematics and helps students appreciate diverse thinking.
- **Address Disrespectful Behavior Promptly:** When instances of disrespect occur, address them immediately and use them as teaching moments to reinforce the importance of respect in the classroom.

- **Create a Safe Space for Questions:** Encourage students to ask questions without fear of judgment. Implement a system where students can anonymously submit questions, ensuring that all students feel comfortable seeking clarification.

For example, when a student presents their solution to a problem, others should be encouraged to ask thoughtful questions and offer alternative perspectives respectfully. This not only reinforces mathematical concepts but also develops important social skills. A teacher might facilitate this by:

- Asking the presenting student to explain their thinking process.
- Inviting other students to ask clarifying questions.
- Encouraging students to offer alternative solutions prefaced with phrases like "Another way to approach this might be..." or "I saw it differently. Here's what I did..."
- Guiding the class in a discussion about the strengths of each approach and how they might be applied in different situations.

By consistently reinforcing these practices, teachers create an environment where students feel safe to take risks, share their ideas, and learn from one another. This collaborative atmosphere not only enhances mathematical understanding but also prepares students for future academic and professional environments where teamwork and respectful communication are crucial.

Moreover, a respectful and collaborative math classroom can help break down stereotypes and biases about who can excel in mathematics. When students see their peers from diverse backgrounds contributing valuable ideas and approaches, it challenges preconceptions and fosters a more inclusive view of mathematical ability.

Environmental Science: Climate Change and Ecosystem Modeling

In environmental science, mathematical models play a pivotal role in understanding climate change and its impacts. Climate models are complex simulations that incorporate atmospheric, oceanic, and terrestrial processes to predict future climate conditions. They help in assessing the effects of greenhouse gas emissions and guide policymakers in making informed decisions to mitigate climate change. Similarly, ecosystem models are used to study the interactions within ecosystems. This math modeling example helps in understanding the impact of human activities on biodiversity, the effects of invasive species, and the dynamics of natural resources management. It facilitates contextualizing mathematics Many students wonder why math is important in the real world.

3. Digital math tools increase student engagement

The learning process can become more dynamic and interactive thanks to the appropriate use of technology in the math classroom. Multimedia resources like animations and quizzes can make your lessons more exciting. For example, we enhance our digital textbooks with interactive Geogebra visualizations. These visually engaging graphics can be manipulated by students and help them better understand the theory. Technology in the math class bolsters personalized learning No two students are the same. Integrating technology in the math classroom will aid you in creating tailored learning experiences and supporting everybody. Sowiso makes personalizing your assignments and tests possible.

You can give extra time to a student with special learning needs or adapt the exam hours for students who live in other countries.

5. Instructional technology will simplify your life

These digital tools can't replace mathematics teachers. Instead, they can become a helping hand in upgrading your teaching while reducing your workload. As you will see in the examples below, using technology in the math classroom will allow you to work smarter.

How to use technology in the math classroom

There is a wide range of available EdTech resources for every mathematics level. But, obviously, using technologies shouldn't be an end in itself. Being critical in evaluating the alternatives is fundamental to making strategic choices tailored to the class' needs. As this blog post from Edutopia points out, while technological tools are commonly used passively in the classroom, they should be adopted to foster active learning and boost the learners' agency. Here you can find some ideas to successfully integrate technology into your math lessons.

1. Automate the most repetitive tasks

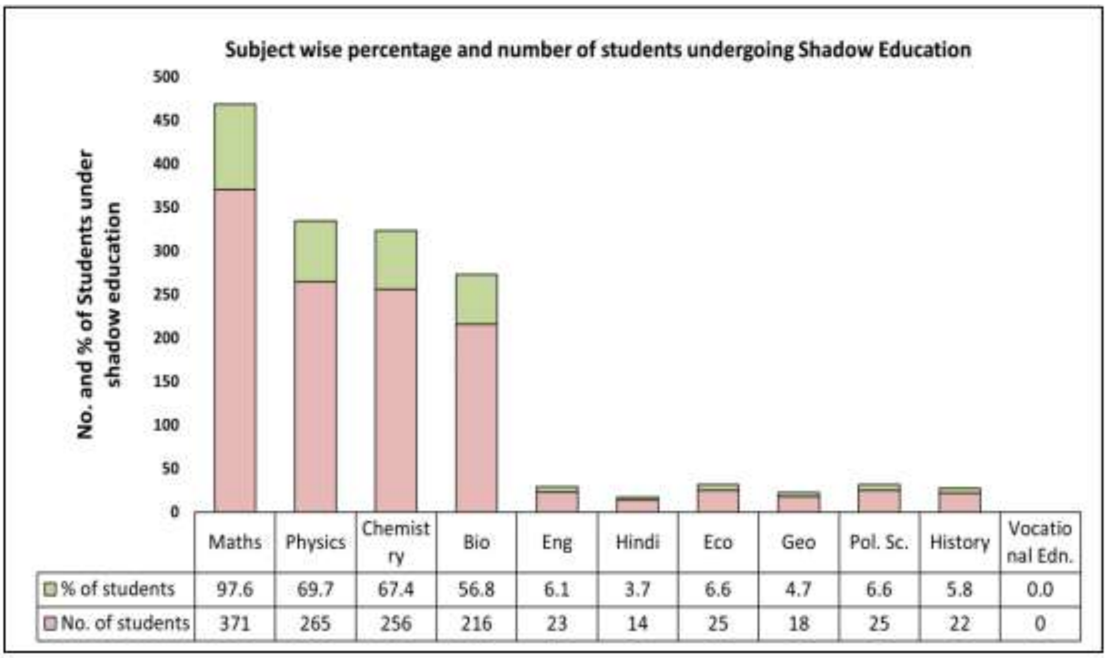
Online teaching tools can take care of the most repetitive functions of your job so you can save valuable time. Our platform grades the students and gives them feedback automatically. In this case, we can see how Dr. Michael McAssey used Sowiso to administer tests. Thanks to the randomization feature, every user got the same question but with different variables. This teacher found out that the automated feedback and the platform interactivity led the students to be more motivated to engage with the subject material. And they achieved higher passing rates!

RESEARCH METHODOLOGY

Research methodology is a way to systematically solve the research problems. It may be understood as a science of studying how research is done scientifically. In it we study the various steps that are generally adopted by a researcher in studying his research problem along with the logic behind them. This questionnaire was a self-administering tool and very much suitable for individual administration. In order to get the satisfactory results, good rapport with the respondents was established. There was no time limit for the respondents to record the responses in the questionnaire. At the backdrop of above discussion, we can say that research methodology has many dimensions and research methods constitute a part of the research methodology. The scope of research methodology is wider than that of research methods. When the collected information was explained in terms of opinion that were held by students on causes responsible for increasing rate of shadow education in the district and perceptions of parents in regard of shadow education, a blend of quantitative the qualitative technique was used and when it came to assess the attitude of students towards shadow education and its effect on their mathematics achievement, the quantitative techniques was used. Following tools were prepared and standardized to collect data on various aspects of Shadow education. While developing the information schedule the investigator first of all consulted related literatures on the subject under investigation and then consulted the supervisor for the construction and development of the information schedule.

RESULTS AND DISCUSSION

In consonance with the methodology and procedure of data collection of the study as discussed in chapter-III, the data were collected by administering various tools on a sample of 600 class-X students, 200 class-XII(Sc.) students and 100 parents of the students. The analysis and interpretation of the data have been done on the basis of objectives and hypotheses set for the study.



Graph 1: Showing Subject Wise Number and Percentage of Class-X Students Undergoing Shadow Education

As described above 380 (63.3%) students out of 600 opted for private supplementary tutoring in all subjects. The above bar diagram reflects that out of 380 students 371 (97. 6%) class-X students opted to go for private supplementary tutoring for the subject mathematics only. which is indeed a very huge graph.

On the hierarchical stepped down ladder, the second place was reserved by the science subject i.e., physics (69.7%), Chemistry (67.4%) and Biology (56.8%).

The graph also delineates that the proportion of secondary level students engaged in shadow education sector for social studies subject and Hindi is the least i. e Economics (6. 6%), Geography (4. 7%), Pol. Science (6. 6%), History (5. 8%), Hindi (3. 7%). No student was found to be engaged for tutoring in vocational education. Thus, it can be concluded that a major proportion of students are engaged in receiving mathematics tuition.

Table 1: Showing Subject Wise Number and Percentage of Class-XII (Science) Students Undergoing Shadow Education

No.	Subject	No. of Class-XII (sc.) Students out of 140	% of Class-XII Students
1	Math's	136	97. 1
2	Physics	117	83. 6
3	Chemistry	104	74. 3
4	Bio	20	14. 3

5	Eng	5	3. 6
6	Hindi	0	0. 0
7	Eco	0	0. 0
8	Geo	1	0. 7
9	Pol.Sc.	0	0. 0
10	History	0	0. 0
11	Vocational Edn.	0	0. 0

The above table depicts that out of 140 (70%) receivers of shadow education classes in all subjects, majority of students 136 (97. 1%) students opted to go for private supplementary tutoring in mathematics, which is obliviously a very huge figure. It means, most popular subject opted for private supplementary tutoring was mathematics among class-XII(Sc.) students. On the hierarchical stepped down ladder, the second place was reserved by the science subjects i.e., physics (83. 6%), Chemistry (74. 3%) and Biology (14. 3%). The table also delineates that the proportion of senior secondary level science students engaged in shadow education sector for English (3. 6%) and Geography (0. 7%) are very few in numbers. No student was found to be engaged for tutoring in vocational education.

Table 2: Showing Duration of Engagement of Class-X Students in the Shadow Education Sector

Duration	Number	% Students
For 6 months	127	33%
for last 1 year	130	34%
For last 2 years	63	17%
For last 3 years	18	5%
For last 4 years	16	4%
For more than 4 years	13	3%
Right from grade-1	13	3%

It is clearly depicted by the above that the phenomenon of shadow education starts accelerating after class-VIII. When it was asked from the class-X students, who were undergoing shadow education classes, for how long they had been in shadow education system, 33% of the students replied that they had been undergoing private supplementary tutorials for last 6 months,34 % students were under shadow education classes for the last 1 year and 17% were in the shadow education system for last two years. It supports the view of the investigator that most of the students start taking private tuitions right form class-VIII. However, some of the students (3% to 5%) were found to be undergoing paid private tuitions right form grade -1.

CONCLUSIONS

Shadow education has become a widespread phenomenon throughout the globe and now it appears it has become an unavoidable learning space for majority of students. However, shadow education may be useful and problematic both. As a part of its usefulness, shadow education may tell observers about the features of the mainstream system of schooling of a place or region and alongside it also indicates the shortcomings of the formal schooling system. The present study which was conducted to study the status of shadow education and its impact on academic outcomes in mathematics learning of class-X and Class-XII(Sc.) Students revealed that a large proportion of students' population is engaged in shadow education sector. The main subjects in which students were found to be receiving private supplementary tutoring were Mathematics and Science. The majority of shadow education providers were from the teachers in mainstream system who were also responsible for the same students in the formal classroom instruction in the schools. It was very painful to note that the parents were forced to pay twice for the single cause, once in schools and second time as tuition fees. This has posed extra financial burden on the family income of the students. The prominent causes responsible for increasing rate of shadow education in the district, as expressed by students were its assistance and ability to help students pass in the examinations at different level and for getting admission into institutes of national importance.

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