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# GRADE 12 LIFE SCIENCES TEACHERS' UNDERSTANDING OF SMARTBOARD AFFORDANCES IN TEACHING GENETICS

**Esther Ntombifuthi Gumede, & Lydia Mavuru**
*Department of Mathematics, Science and Technology Education, University of Johannesburg (South Africa)*

## Abstract

Genetics, the study of heredity and inheritance, is a fundamental discipline in modern biology. Its significance extends far beyond the classroom, influencing various aspects of life from medicine, agriculture to biotechnology and forensic sciences. Understanding genetic concepts is crucial for addressing pressing global challenges such as disease diagnosis and treatment, crop production, and conservation of biodiversity, hence it is fundamental for learners to understand genetics. However, genetics concepts are often complex and abstract, posing challenges for both teachers and learners when teaching these concepts. Traditional teaching methods fail to provide dynamic and interactive learner engagement opportunities during the learning process, leading to difficulties in conceptual understanding of genetics concepts. To address these challenges, innovative technologies such as smartboards have been found to enhance the teaching and learning of genetics. Smartboards offer a range of interactive tools and multimedia capabilities that can facilitate immersive and interactive learning experiences. The study herein reported explored grade 12 teachers' understanding of the affordances of smartboards for teaching genetics concepts. The study was framed by the Technological Acceptance Model as the theoretical framework in interpreting findings of the data collected. Through a quantitative research approach, 40 grade 12 life sciences teachers were purposefully selected to participate in the study. These teachers used smartboards and were presumed to possess the requisite content knowledge in genetics as stipulated by the South African Curriculum and Assessment Policy Statement. To collect data a questionnaire designed by researchers was administered to the teachers to determine their understanding of smartboards affordances and their competencies in using the smartboards to teach genetics concepts. Data analysis involved computation of descriptive statistics. The findings revealed that teachers have limited understanding of the usefulness of smartboards to teach genetics concepts due to insufficient technological knowledge and skills. This is despite them holding positive perceptions on smartboard affordances, citing its potential to promote collaborative learning, autonomous learning, and learner-centred approaches. The findings showed that insufficient technological knowledge hinders teachers' ability to effectively utilise and explore the interactive tools that smartboard can provide when teaching genetics. The findings provide implications for the design of focused interventions and teacher professional development and provision of technical support to enable meaningful utilisation of smartboards in teaching abstract science concepts.

***Keywords:*** *Genetics, grade 12 teachers, life Sciences, smartboards, teacher understanding.*

## 1. Introduction and background

Genetics is a fundamental field of study that occupies a paramount position in contemporary society, permeating various aspect of everyday life, such as agriculture, health, and biotechnology (Thörne, 2018). Consequently, acquiring a robust understanding of genetics concepts is essential for learners to critically engage with the complex socio-scientific issues that arise from advancements in genetics (Ezechi, 2021). The effective teaching and learning of genetics concepts in South African schools, particularly in grade 12 Life Sciences, is hindered by a significant conceptual knowledge gap in biological concepts. This challenge is evident in learners' sub optimal performance on genetics-related examination questions, as highlighted in the Department of Basic Education Diagnostic Report (2023).

Research suggests that both teachers and learners perceive genetics as a challenging topic due to its abstractness, which leads to learners lacking conceptual understanding (Moll & Allen, 2014). Thörne (2018) further suggests that conceptual gap on genetics can be attributed to the pedagogical approaches and resources used by Life Sciences teachers in the classrooms. To address this challenge, the integration of

smartboards in the classroom can be beneficial, enabling teachers to utilise visual aids and illustrations to facilitate deeper understanding of the concepts.

A smartboard is an interactive, touch-sensitive display board that connects to a computer, enabling the projection of digital content through built-in or overhead projector (Mihai, 2020). The Department of Basic Education in South Africa installed smartboards in schools and provided teacher training to harness the potential of smartboards to improve quality of teaching and learning across various subjects (Tefo, 2020). Research has shown that smartboards enhance teacher-learner interactions in the classrooms and conceptual understanding of abstract concepts through multimedia presentations (Aktas & Ayden, 2016). The dual display feature facilitates collaborative learning, enabling learners to work in pairs on activities, (Tefo, 2020) for example when solving Mendelian genetics problems. Domain-specific external representations such as animations on the smartboard improve visual literacy and enable learners to create mental models of abstract genetics concepts, enhancing conceptual knowledge and learners' academic performance (Bayar & Kurt, 2021).

Teachers generally perceive themselves as competent in using smartboards (Mihai, 2020). However, limited teaching experience and inadequate training can lead to lower self-efficacy and limited utilisation of smartboard features (Tefo, 2020). The limited use of smartboard features in Life Sciences highlights the importance of teachers' technological skills and knowledge, which influences their perceptions of smartboard usefulness in teaching genetics (Mahdum, Hadriana, & Safriyanti, 2019). It is against this backdrop that the study sought to explore teachers' understanding of smartboard affordances in making genetics concepts accessible to grade 12 Life Sciences learners. The study sought to answer two research questions: 1. What are teachers' understandings of the affordances of smartboards as digital tools to make genetics concepts more accessible to grade 12 learners? 2. What are teachers' perceptions of their competencies of using smartboards as digital tools to make genetics concepts more accessible to grade 12 learners?

## 2. Theoretical framework

Technology Acceptance Model (TAM) by Davis (1989) served as the underlying framework for this study, which investigates teachers' willingness to adopt and utilise emerging technologies in the classroom. According to TAM, two key factors influence an individual's intention to use technology: perceived usefulness and perceived ease of use. Perceived usefulness refers to the extent to which teachers believe that technology will enhance learner performance and understanding of concepts, while perceived ease of use pertains to the simplicity and user-friendliness of the smartboard (Eze, Obi Chukwu & Kesharwani, 2021). In this study TAM provides the basis for interpreting teachers' understanding and willingness to adopt smartboard utilisation in their Life Sciences classrooms.

## 3. Methodology

This study employed a quantitative research design, enabling computation of descriptive statistics (Creswell & Creswell, 2018). Quantitative data centres on a single belief and understanding of a phenomenon rather than the varying opinions of participants regarding the subject under investigation (Creswell & Creswell, 2018).

### 3.1. Selection of participants

Using purposive sampling technique (Patton, 2002) forty grade 12 Life Sciences teachers from Gauteng West District in South Africa, were selected. The sampling method allowed for deliberate selection of participants based on their accessibility and experience in using smartboards in their schools. The selected teachers were presumed knowledgeable about genetics concepts as outlined in South African Curriculum and Assessment Policy Statement (CAPS).

### 3.2. Data collection and analysis

To collect data a closed-ended 4-point Likert scale questionnaire was administered to the 40 selected grade 12 Life Sciences teachers through Google forms. The questionnaire was adopted from Mahdum et al. (2019) and modified to suit the objectives of the study. The questionnaire sought grade 12 Life Sciences teachers' understanding of the affordances (perceived usefulness) of smartboards in teaching genetics; perceived ease of use of smartboards in teaching genetics; and their efficacy in using smartboards to make genetics concepts more accessible to learners. All the 40 teachers responded to the questionnaire items. Collected data was analysed using Statistical Package for Social Sciences (SPSS) and descriptive statistics were computed.

## 4. Findings

The study findings addressed two research questions which sought teachers' understandings of the affordances of smartboards as digital tools to make genetics concepts more accessible to grade 12 learners; and their perceived competencies of using smartboards as digital tools to make genetics concepts more accessible to grade 12 learners. Grade 12 is the last level in high school in the South African education system. The results are presented under teachers' perceived usefulness of smartboards; teachers' perceived ease of use smartboards; teachers' perceived affordances of smartboards; teachers' perceived self-efficacy in using smartboards to teach genetics concepts; and teachers' trainings needs on smartboard use. The sample comprised 57.5 % females (n=23) and 42.5 % males (n=17).

### 4.1. Teachers' perceived usefulness of smartboards

Table 1 shows teachers' responses regarding their understanding of the usefulness of smartboards in teaching genetics concepts.

*Table 1. Teachers' perceived usefulness of the smartboard to teach genetics concepts.*

| Items | Strongly disagree (%) | Disagree (%) | Agree (%) | Strongly agree (%) |
|---|---|---|---|---|
| 1. The use of smartboard can increase learners' motivation in learning genetics concepts. | 0 | 0 | 47.5 | 52.5 |
| 2. The use of a smartboard enables learners to become active learners and work in pairs during genetics lesson. | 0 | 0 | 52.5 | 47.5 |
| 3. The use of smartboard can make genetics concepts more accessible to learners for better understanding of the topic. | 0 | 0 | 59.0 | 41.0 |
| 4. The use of a smartboard can improve my teaching of genetics concepts. | 0 | 0 | 46.2 | 53.8 |

All the 40 grade 12 Life Sciences teachers in this study perceived smartboards indicated that smartboards were useful in teaching genetics. They perceived smartboards as useful digital tools to motivate and engage learners; in making learners active as they work in pairs; making genetics concepts more accessible to learners; and hence enhancing their teaching practices.

### 4.2. Teachers' perceived ease of use smartboards when teaching genetics

Table 2 shows the teachers' perceptions on the ease of use of smartboards when teaching concepts in genetics.

*Table 2. Teachers' perceived ease of use of smartboards when teaching genetics concepts.*

| Items | Strongly disagree (%) | Disagree (%) | Agree (%) | Strongly agree (%) |
|---|---|---|---|---|
| 1. The use of a smartboard makes it easy for teachers to explain the genetics concepts during a lesson. | 0.0 | 0.0 | 42.5 | 57.5 |
| 2. Technical problems are experienced when using smartboards to teach genetics concepts. | 22.5 | 35.0 | 35.0 | 7.5 |
| 3. The use of a smartboard provides convenience in communication when teaching genetics concepts. | 0.0 | 0.0 | 42.5 | 57.5 |
| 4. The use of a smartboard can make the learners have a better understanding of how genetics affects their lives. | 15.0 | 10.0 | 42.5 | 32.5 |

All teachers view smartboards as user-friendly digital tools for explaining complex genetics concepts (100%). Many teachers perceive smartboard as a digital tool that makes it easy to communicate the content to the learners (57.5%); and enhancing learners' understanding and appreciation of the practical applications of genetics concepts (75%). However, 42.5% of teachers encountered technical problems when using smartboards to teach genetics concepts, meaning that they view smartboards as digital tools that are not easy to use.

### 4.3. Teachers' perceived affordances of smartboards

Table 3 shows teachers' perceived benefits of using smartboards as digital tools to make genetics concepts more accessible to grade 12 learners.

*Table 3. Teachers' perceived affordances of smartboards.*

| Items | Strongly disagree (%) | Disagree (%) | Agree (%) | Strongly agree (%) |
|---|---|---|---|---|
| 1. The use of a smartboard can facilitate learner-centred learning of genetics concepts. | 0.0 | 0.0 | 41.0 | 59.0 |
| 2. The use of a smartboard provides an opportunity to improve my teaching strategies of genetics concepts (differentiated teaching) | 0.0 | 0.0 | 48.7 | 51.3 |
| 3. The use of a smartboard can improve learners' understanding of genetics concepts. | 0.0 | 2.5 | 50.0 | 47.5 |
| 4. The use of a smartboard can make learning of genetics concepts more meaningful to learners. | 0.0 | 0.0 | 67.5 | 22.5 |

Teachers have a positive attitude towards utilising smartboards to teach genetics, citing its potential to facilitate learner-centred approaches. Smartboards also capture learners' interest and enhance understanding by enabling active engagement in knowledge construction of genetics concepts.

## 4.4. Teachers' perceived competencies of using smartboards to teach genetics concepts

Table 4 shows teachers' perceived competencies of using smartboards as digital tools to make genetics concepts more accessible to grade 12 learners.

*Table 4. Teachers' perceived competencies of using smartboards to teach genetics concepts.*

| Items | Strongly disagree (%) | Disagree (%) | Agree (%) | Strongly agree (%) |
|---|---|---|---|---|
| 1.I believe in my knowledge to use smartboard in designing genetics learning activities. | 7.5 | 20.0 | 50 | 22.5 |
| 2. I like to make use of a smartboard in teaching genetics concepts learning activities because I am certain that I can get benefits**.** | 2.5 | 5.0 | 62.5 | 30.50 |
| 3.I can search and choose smartboard features that are appropriate to support my teaching and learning activities of genetics concepts. | 0.0 | 27.5 | 60.0 | 12.5 |
| 4. I have certain strategies to solve problems I face when using a smartboard to teach genetics concepts. | 2.5 | 7.5 | 67.5 | 22.5 |

Most teachers felt proficient in using smartboards to teach genetics. There are however 27.5% who lack technical skills and confidence in using smartboards. There are also a few teachers who are not convinced of the benefits of using smartboards (7.5%) and those that have no knowledge of solving problems they encounter when using smartboards (10.0%). Teachers' proficiency levels impact their perceived benefits and confidence in using smartboards.

## 4.5. Teachers' developmental needs on smartboard use

In the questionnaire, teachers were also asked about the kind of development they received on the use of smartboards and also its adequacy in equipping them with the necessary skills. Table 5 shows teachers' responses.

*Table 5. Teachers' developmental needs on smartboard use.*

| Items | Strongly disagree (%) | Disagree (%) | Agree (%) | Strongly agree (%) |
|---|---|---|---|---|
| 1. The training held by the Department of education motivated me to use a smartboard in teaching genetics concepts. | 2.5 | 10.0 | 42.5 | 45.0 |
| 2. I use a variety of smartboard features that were shown during the training when I teach genetics concepts. | 10.0 | 42.5 | 32.5 | 5.0 |
| 3. I need more training on how to use a smartboard in teaching and learning of genetics concepts. | 10.0 | 10.0 | 40.0 | 40.0 |

Most teachers (87.5%) credited the Department of Education for the motivation and equipping them with all the necessary skills they were using in teaching genetics concepts with smartboard. However, despite enthusiasm, many teachers indicated that they still struggled to utilise various smartboard features (52.5%), highlighting a need for additional training to fully leverage its capabilities (80.0%). A small percentage (12.5 %) reported never receiving training, possibly due to joining the profession after smartboard integration in Gauteng province.

## 5. Discussion

This study reveals that Grade 12 Life Sciences teachers recognise the potential of smartboards to enhance learner engagement and conceptual understanding of genetics concepts. The findings align with Kırbas' (2018) assertion that the multimodal representation feature of smartboards facilitates learner knowledge retention through multisensory experiences. Teachers' responses also demonstrate the perceived usefulness of smartboards in enhancing learning outcomes and learner motivation which was also echoed in previous studies (e.g. Mihai, 2020; Kırbas, 2018). However, challenges with ease of use persist, largely due to inadequate training that result in the grade 12 Life Sciences teachers failing to fully utilise the advanced features of the smartboard to teach genetics. This aligns with Bayar and Kurt's (2021) assertion that effective utilisation of smartboards is contingent upon teachers' self-confidence and belief in their technological abilities. As such some of the affordances of smartboards are not realised particularly in catering for diverse learning styles when teaching abstract genetics concepts.

## 6. Conclusion

This study explored grade 12 Life Sciences teachers' understanding of smartboards' potential in teaching genetics concepts. Findings revealed that while teachers recognise and appreciate smartboards' affordances in enhancing learner engagement and accessibility, their limited technical training and support hinders the effective utilisation of advanced smartboard features. Despite positive perceptions, a gap exists between teachers' attitudes and actual smartboard use in the Life Sciences classrooms. Developing teachers' technological knowledge and ICT efficacy is crucial to unlock smartboards' full potential in teaching genetics concepts. Targeted training is needed to provide regular, hands-on training sessions for teachers to develop their skills in using smartboard features, addressing specific challenges and subject-specific needs. Furthermore, there is need for provision of ongoing technical support and resources to teachers to ensure proficient utilisation of smartboards.

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