International Journal of Science and Research (IJSR)
ISSN: 2319-7064
ResearchGate Impact Factor (2018): 0.28 | SJIF (2019): 7.583

Didactic Strategy: Interactive Digital Board in Teaching Learning Heat Capacity for High School

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Abstract: ***In the case of Chemistry subjects at the higher middle level, students tend to have a low performance in terms of academic exploitation, either because of lack of motivation or lack of preparation in previous courses. In order to improve not only the academic performance of students in sometopics of thermodynamics, but also the quality of teaching, this work proposes the use of some technological tools and practices combined with a constructivist methodology for teaching learning the subject heat capacity at constant pressure. A didactic sequence is designed that includes the use of interactive board as a learning teaching tool, as well as a teaching sequence that did not include the use of the board, to determine the influence of this tool on academic performance. To assess the scope in learning teaching, a questionnaire was designed, which was previously validated with groups of university students. The evaluation was designed for the topic of heat capacity, thus identifying the main alternative conceptions of students, the degree of learning regarding thermodynamic concepts in order to compare the pre- and post-teaching knowledge applied. The results of the post-didactic sequence evaluation, from the point of view of the student who learned using the interactive board, identify an improvement in understanding the main topics, a better willingness to work in the classroom, the ability to molecular representation of phenomena and an improvement in their verbal expression.***

Keywords: Didactic strategy, ICT'S, Interactive Digital Board, Heat capacity, High school

1. Introduction

Today, new horizons have been opened in the use of interactive digital board, online resources and the use of i-pads, even a new theory of modern learning has been defined as "Connecting" to the collaborative learning environment that arises from the use of the internet either in online classrooms, social networks and virtual realities or simulated communities as means to share information dynamically between educators and students.(Head, 2013) (El Miniawiand Brenjekjy, 2015).

The interactive board seen as a versatile tool, currently not only uses have been reported in the schooled educational field as in physics, in geometry, in engineering, have also been reported its use in sentences, in music learning as well as in special education for the teaching of people with hearing impairment and cerebral palsy as well as in the medical field for the management of hospitalized patients. (Pérez Santos, 2011)(Sierra Vazquez, 2011).

Due to the difficulties presented in teaching learning some basic concepts of thermodynamics at the upper middle level, this work proposes the design of a didactic sequence that includes the use of interactive board to identify the alternative conceptions of students in addition to stimulating their skills and facilitating the learning process.(Coelho Lopes, 2009) (Warrior Barrier , 2009)(Ali Alwan, 2011)(G. Herrington, 2011)(Sokrat, 2014)(Head, 2013) (Daza Pérez, 2009).

2. ICT'S and Interactive Digital Board

Today, students between the ages of 6-26 have at their fingertips multiple electronic tools and devices that are part of their daily lives and who have sensitively marked their way of thinking, acting and conceiving the world, giving rise to the "NET Generation", as they are now called.

This new generation of "digital natives" think and process information differently than its predecessors ("digital immigrants"), so they need to develop skills from autonomous learning. However, teachers working with these new generations are not prepared to adapt teaching to the demanding needs of "digital natives". Faced with this new landscape, the functions of the updated teacher are rethinked (Obaya, et al, 2019), and the need arises to facilitate the inclusion of collaborative learning environments where the ability to use different forms of communication with students such as online classrooms, social networks and virtual reality bring him closer to sharing information over the Internet in a movement that is already known as "Conectivism" , (Presky, 2001)(Kropf, 2016)

The characteristics of students of the NET generation (Edel Navarro, 2004) are:

1) Its development is intimately linked to the emergence of software that allows them to perform activities not only school, entertaining communication, purchase, services, etc., resulting in them preferring the computer over radio and television.
2) Being born in the historical context of the Internet, they develop a skill for interactive and symbolic communication that allows a common understanding, transcending cultural barriers, being able to express "virtual emotions" from the computer keyboard.
3) They are self-employed apprentices who acquire information from a number of nodes, and then share their experience with other individuals (Connectivism).

4) His development of thinking skills revolves around observation, search, comparison, classification, analysis and synthesis of information, stimulating to some extent his creative thinking.
5) They can develop different activities simultaneously (listening to music, doing homework, etc.) this determines their great sensory responsiveness.

From the context in which students are currently developed not only in Higher Middle Education, but at all levels, it is understandable that traditional teaching and learning methods have little scope and far from motivating students, they are taken away from the idea of enjoying subjects such as Chemistry.

Some previous research on the use of digital and interactive material in learning teaching processes facilitates the nanoscopic representation of phenomena, greatly increasing learning in students. (Milenković, Segedinac, & Hrin, 2014) (Lopez Carrasco, 2013)

3. Interactive Multimedia Whiteboard

An Interactive Multimedia Whiteboard is defined as a technological system, usually composed of a computer, a video projector and a pointer control device, which allows to project digital content on an interactive surface in a format ideal for group viewing.

It can interact directly on the projection surface, allowing you to write directly on it and control the software with a pointer or stylus. (Belenguer Alventosa, 2011)

Figure 1: Parts that make up the digital interactive board system

It is important to remember that in the early 1980s innovative technologies such as the interactive whiteboard were still under study, in the 1990s they began to be introduced as tools in education and it was until after 2000 that this type of technology has become a context of new learning teaching methodologies.

According to some authors, some advantages of working with Interactive Digital Whiteboard have been identified, for example, providing different tools to build more constructivist and autonomous teaching spaces for the student, the possibility of developing the metacognition of students, based on the motivation, interest and ease of understanding of the contents (by the use of different channels of communication) provided to them and from the point of view of the teacher , promotes flexibility and spontaneity, since it can be accommodated to any didactic strategy and is also an opportunity for professional development itself. In some cases the increase in the participation of interactive classes has been documented, where students refer to more fun courses where time efficient use is made which is reflected in better organized classes, (Akkoyunlua & Erkan, 2013)

The functions that the interactive board can have are very varied since it serves to create and save interactive images, develop playful activities, as well as be used for the evaluation of knowledge and skills. For the teacher it can be useful to organize activities and systems of distance education, in fact, by including the interactive board to the teaching and learning processes, it opens up new opportunities to:
1) Use information technologies for efficient chemistry learning.
2) Activate creative development among students to motivate them in learning (improving teaching outcomes).
3) Elaboration of presentations that include video or animations, which allow you to pause, highlight and interact with the images, transforming them to improve them.
4) Problem-based teaching (generating, recording and verifying ideas).
5) Improve skills and skills.
6) Reuse multimedia material for future presentations with the possibility to improve it, even in teleconferences and in distance education.

A negative possibility is for teachers to abuse the resource to be the protagonist rather than promoting interaction between students, instead it is necessary to capitalize on the qualities of the interactive board to bring to the classroom interactive experimental activities that would otherwise be unworkable to carry out experimentally, or molecularly explanations that would be impossible to see with the naked eye. (Gupta-Bhowon, 2009)

It is important to remember that digital interactive environments involve a number of needs and limitations that should be considered for the effectiveness of the purposes posed in the teaching and learning process.(Talanquer, 2009)

The first introduction of an interactive digital board was by SMART Technologies® in 1991 and since then it has become a valuable instructional tool valued by many institutions, because it has a wide variety of applications and integrated capabilities designed to improve the quality of teaching and learning in the classroom. For example, it is possible to project videos and animations to improve understanding of some abstract concepts; incorporate web resources, run specialized software, edit texts, incorporate interactive assessments, and save notes for future use. All of the above, promotes that the POI stimulates in students the imagination, creativity, active learning, feedback of individual and teamwork, in short, increases the interactivity of the class, attracts, motivates and increases the academic performance of the students.(Smart Technologies, Inc., 2016)(Bakadam & Sharbib Asiri, 2012)

Tools within the POI Software:
1) Instant camera.
2) Screen and items to reveal and share.
3) Record learning sessions.
4) Pens for writing, drawing and annotating.
5) Electronic files attached to the lesson.
6) Library of images classified by themes.

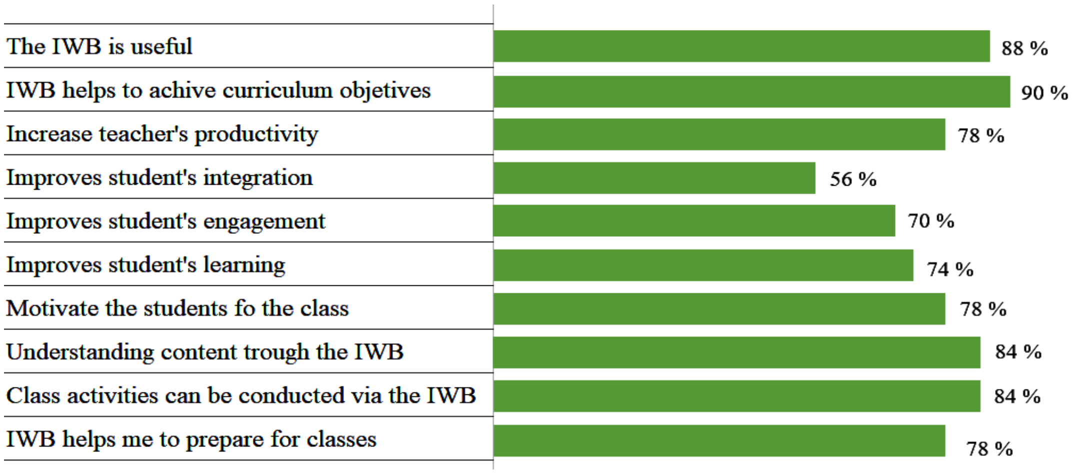


Figure 2: The teachers' perceptions toward the IWB's benefits (Smart Technologies, Inc., 2016)

4. General Objective

Design a didactic sequence using interactive blackboard on the concepts of constant pressure heat capacity, to facilitate the teaching and learning process in higher mid-level chemistry students.

5. Methodology

This study was carried out on the campus of the Tepeyac Institute Campus Cuautitlán, with 49 students from the UNAM-incorporated System of the National Preparatory School with an average age of 17 years, of which 51% women and 49% men, taking the second and last degree of baccalaureate in the subjects of Chemistry III and IV whose curriculums include the topics of calorific capacity and reaction heat. Diagnostic evaluation and final evaluation (relating to the teaching sequence on heat capacity), Pre-Post Test (ANNEXA)

A didactic sequence (Salazar R.E., Obaya A.,Giammatteo L., and Vargas-Rodríguez Y., 2019)(Jaramillo A., Obaya A., Giammatteo L., and Vargas-Rodríguez Y., 2019) was designed on the concept of calorific capacity constant pressure for high school students establishing general objective, specific objectives, learnings to be achieved, prior knowledge, with three steps, open, development and closure (Perez Rivero et al, 2019)

6. Didactic Strategy: Interactive Digital Board in Teaching Learning Heat Capacity for High School

Subject: What is specific heat?	CLASS:1
SESSION OBJECTIVE: Identify the use of heat capacity for troubleshooting and identify possible uses of antifreeze and water related to heat dissipation.	
SPECIFIC OBJECTIVES: 1. Solve exercises related to the heat capacity of the water used to cool the engines of the cars. 2. Calculate the heat capacity of a commercial antifreeze. a) Compare the amount of heat they dissipate based on their heat capacity to decide which substance is best for cooling a radiator.	
LEARNINGS TO ACHIEVE: 1. Identification of the difference between heat and temperature. 2. Relate the different materials with their heat capacities applied to the uses they may have in everyday events. ❖ Perform exercises, simulations and relationships between water and antifreeze and its different calorific capabilities.	**PREVIOUS KNOWLEDGE:** 1. What is mass? 2. What is temperature? 3. What's heat? 4. What is the difference between heat and temperature? 5. What is specific heat? 6. What is heat capacity?
ACTIVITIES	

Opening Phase	
SOCIALIZATION OF OBJECTIVES AND FRAME TIME: 5 min. / 5 min. Escuela Nacional Preparatoria UNAM, Plan de estudios 1996	*Technical:* *1.Exhibition*

Subject: Chemistry IV Grade: 6th year of high school Session: 2 h First Unit: Energy and Chemical Reactions Sub-item: First Law on Thermodynamics. $\Delta E = q + w$. Heat measurement $q = mc_p\Delta T$ Heat capacity (c)	*MATERIAL:* *2. Smart Presentation* *3. Interactive board* *Recommendations:* • *Do not extend or divert the conversation from the class topic.*
1. Identification of previous knowledge: The teacher will carry out a series of questions from a video showing the thawing of water and oil. TIME: 10 min. / 15min. ***Purpose of the activity: Identify students' prior knowledge and alternative conceptions near the topic, to adapt pedagogical intervention to the level of learning of*** students; in addition to contextualizing them in the topic to be addressed in the class.	*TECHNICAL:* *1. Discovery research* *MATERIAL:* *2. Smart Presentation* *3. Interactive board* *4. Video* *RECOMMENDATIONS:* *5. Do not extend or divert the conversation from the class topic.*

Development Phase	
1. The teacher will introduce the concept of heat and temperature, using everyday classroom objects, while students participate in the proposed oral questions. TIME 5 min. / 20 min. **Purpose of the activity**: Contrast the difference between heat and temperature, as well as apply it to everyday events.	*Technical:* *1. Oral presentation* *Material:* *2. Computer (Smart Presentation)* *3. Everyday objects.* *Recommendations:* • *Accompany the presentation with projected molecular models.*
1. The teacher will hold an exhibition on: 1) The atomic structure of the three aggregation states. 2) Intramolecular movement and variation with temperature. 3) The concept of heat. 4) The concept of calorific capacity: theoretical and mathematical. 5) Heat capacity at pressure and constant volume. 6) Heat capacity as extensive property of matter. 7) Difference between heat capacity and specific heat. TIME 20 min. / 40 min. ❖ ***Purpose of the activity:*** Identify the main characteristics of the heat capacity at constant pressure and volume and relate them to the different materials.	*Technical:* *1. Oral presentation* *MATERIAL:* *2. Smart Presentation* *3. Interactive board* *Recommendations:* • *Constant feedback on student experiences.*
1. Theoretical activities: Students will solve problems on interactive blackboard, where heat capacity is involved while the teacher reviews their results. 2. Practical activities: Students will carry out the design of a practical activity where they can measure the calorific capacity of two liquid substances and carry it out in the laboratory, the teacher will supervise the work of the teams, the course of experimentation and the safety of the students. TIME 50 min. / 1h 30 min. ***Purpose of the* activity**: That students identify the mathematical expression and meaning of heat capacity in the resolution of exercises. Let students contrast the heat capacity of two substances experimentally.	*Technical:* *1. Structured experience* *MATERIAL:Inmersion resistance, thermometer, beakers, two problem substances, distilled water, stopwatch, balance, paper towels.* *Recommendations:* 2. *Continuous monitoring of the teacher towards students in the development of the activity.*
Closing Phase	
1. Final team activity: Students will answer some questions and exercises in oral and written form, relating different materials with their possible uses in interactive board organized into 6 teams, while the teacher acts as moderator. TIME 20 min. / 1h 50 min. ***Purpose of the* activity**: The knowledge acquired by the student will be evaluated through a questionnaire.	*Technical:* *1. Guided discussion.* *MATERIAL:* *1. Smart Presentation* *2. Series of exercises and images* *Recommendations:* • *Emphasize respect for the rules of the game.*
1. Closing activity: The tester will perform an oral dynamic to reinforce the concept of heat capacity as well as its application in the use of different materials and substances according to their purpose related to the amount of heat they must dissipate. TIME 10 min. / 2 h. ***Purpose of the* activity:** To feed the student in their performance and to assess the modification of some alternative conceptions.	*Technical:* *1. Guided discussion.* *MATERIAL:* *Recommendations:* • *Problems and questionnaire as a task.*

7. Results and Discussion

One diagnostic questionnaire was applied as an initial step in the teaching sequence to 49 students, of whom 25 belong to the group 5010 and 24 to the group 5020 of the Tepeyac Campus Cuautitlán Institute. It is worth mentioning that this didactic sequence was part of the contents of the Chemistry III program for the National Preparatory School of the System Incorporated into UNAM and was developed as a strategy to improve learning of the subject.

The following alternative conceptions could be inferred from the data obtained in the diagnostic evaluation and observation of students' verbal expressions for the teaching sequence concerning calorific capacity:

1) Confusion between the concepts of heat and temperature.
2) False belief that a substance with high heat capacity, heats up a lot in a short time.
3) Temperature is not related to a nanoscopic representation of the rapidity of molecules.

Based on the results by group (Table 1), the averages obtained in the diagnostic evaluation and the final evaluation (referring to the didactic sequence on calorific capacity) are compared, showing an improvement in the final results of both groups, as in Figure 3.

However, according to the variance analysis (ANOVA) applied to the samples, if there is a significant difference in the application of the sequence that includes the interactive blackboard on student learning (Table 2).

Table 1: Comparison between the average per group of the diagnostic and final assessment on calorific capacity

Group	Initial Evaluation	Final Evaluation
No Blackboard	55	73
With Blackboard	63	84

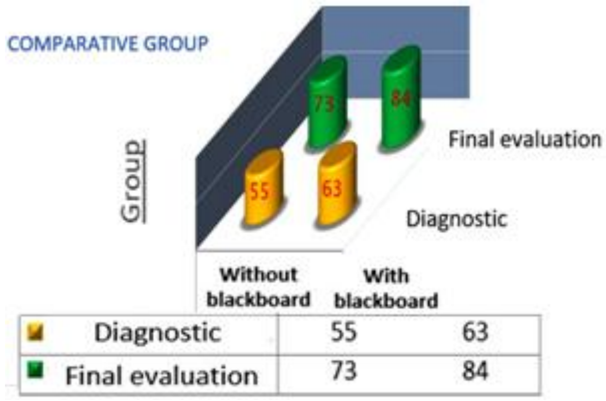


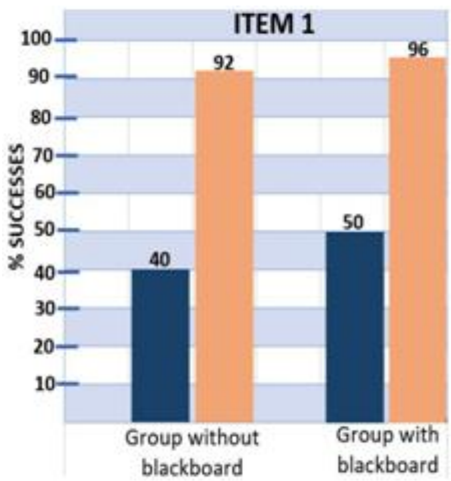
Figure 2: Comparative graph between diagnostic average and final per group on heat capacity

Table 2: Results of the One Factor Variance Analysis (ANOVA) for the two teaching sequences (with blackboard and no blackboard)

Variance Analysis						
Origin of variations	*Sum of squares*	*Degrees of freedom*	*Average squares*	*F*	*Probability*	*Valor crítico para F*
Between groups	0.20121216	1	0.20121216	11.6990999	0.001339971	4.056612461
Within the groups	0.773952463	45	0.017198944			
Total	0.975164624	46				

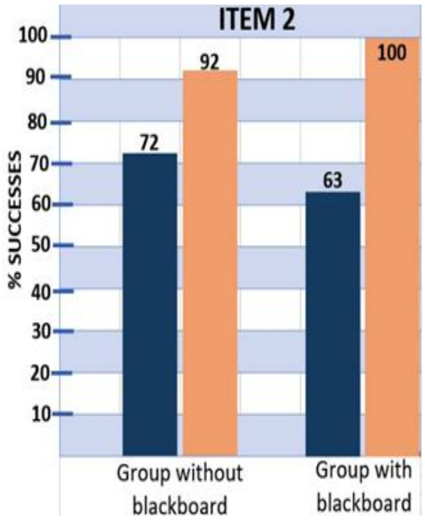
Comparative results are presented between the individual items of the diagnostic and final evaluations in both group:

1. You're in front of two tables at room temperature, if you simultaneously place a bucket of frozen water in one and a frozen oil cube on the other, which cube do you think will melt first?
In the first question the objective to be evaluated was to differentiate between the calorific capacity (heat capacity) of two substances.
a) The one with the water.
b) Oil.



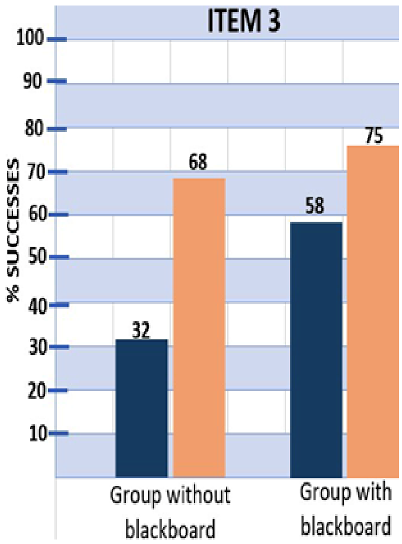
This item shows a significant improvement between the two groups, mainly the result of the demonstrative experience carried out in both sequences.

2. You and your sister boil water using the same stove. In your sister's container there's 1 liter of water and only half of you in yours. Indicate which container you think requires the most heat to boil.
In the second question the objective to be evaluated was to identify heat as extensive property.
a) Your sister's.
b) Yours."



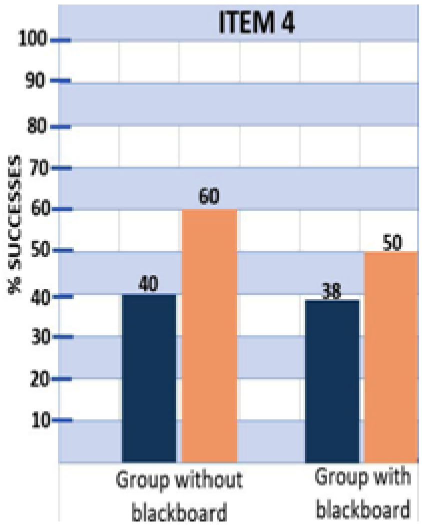
In this item there are 100% successes in the group with POI, which leads us to think that the introduction of this tool was significant and important for learning.

3. If you heat water from 20oC to 70oC (with a specific heat capacity of 1 kcal/kg C) and in the same hot conditions an antifreeze from 20oC to 70oC (with a specific heat capacity of 0.5 kcal/kg C)
In the third question the objective to be evaluated was to interpret the numerical value of the specific heat according to the heat absorbed.
Which one do you think will absorb more heat inside a radiator?
a) Water.
b) Antifreeze.



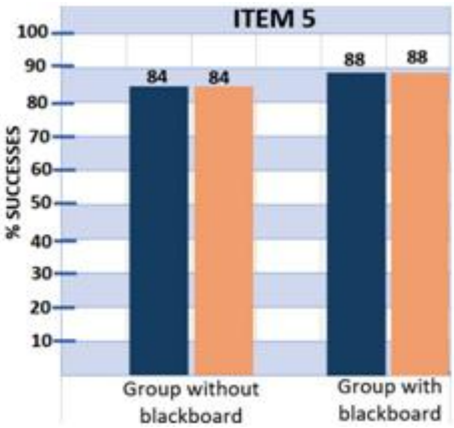
It should be noted that this was one of the concepts that was most difficult to observe in terms of understanding and application, because students confuse that the specific heat is inversely proportional to the heat absorbed by a material.

4. If you heat water from 20oC to 70oC (with a specific heat capacity of 1 kcal/kg C) and in the same hot conditions an antifreeze from 20oC to 70oC (with a specific heat capacity of 0.5 kcal/kg C)
In the fourth question the objective to be evaluated was to interpret the numerical value of the specific heat according to the time at which a temperature increase is recorded.
Which one do you think takes longer to warm up?
a) Water.
b) Antifreeze"



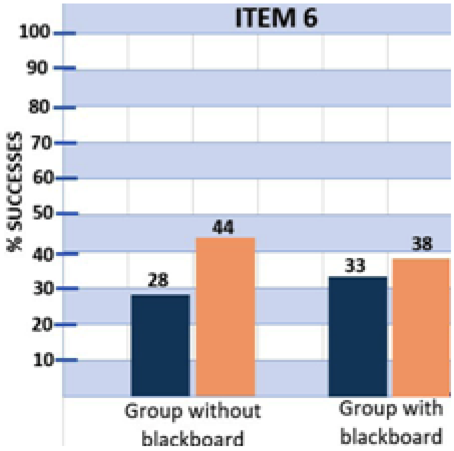
Like the previous item, this concept was difficult to learn and although there was improvement, it was not significantly important in both groups, as a good percentage of students failed to relate that the numerical value of calorific capacity is inversely proportional to the time at which a temperature increase will be recorded.

5. Imagine you put a raw egg in 1 kg of water and another raw egg in 1 kg of oil, in equal containers. If you heat the two at the same time, which egg do you think will cook first?
In the fifth question the objective to be evaluated was to identify the temperature increase in relation to heat absorption.
a) Water.
b) Oil



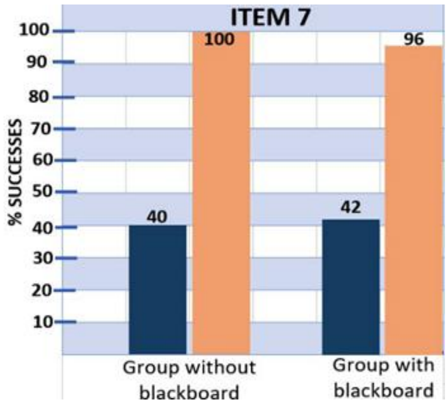
For most students, learning this concept was significant mainly due to their previous experiences in relation to the relationship of the examples used, with this it was relatively easy for most to identify that in the same span of time and with the same mass ratio, the oil increases its temperature faster than water.

6. Will a rapidly heated substance have a high or low specific heat capacity?
In the sixth question the objective to be evaluated was to identify that the higher the temperature increase the lower the heat capacity.
a) High.
b) Come down



It is observed that when the relationship between the numerical value of heat capacity related to heat absorption is implied, it is not significantly important for students, so they tend to forget it.

7. If a fast-moving marble hits a group of slow-moving marbles: Would the fast marble normally increase or decrease its speed?
In the seventh question the objective to be evaluated was to relate molecular movement in relation to heat flow.
a) It would increase.
b) It would decrease."



These results show the importance of previous knowledge when they manage to relate to new learning, in this case the vast majority of students were able to infer that rapid molecular movement is associated with the body with higher temperature than when contacting another cooler one yields heat to it represented as a decrease in molecular movement.

8. Conclusion

From the data obtained we can say that, if there is a significant difference between the results obtained with the didactic sequence using the POI compared to the sequence without the POI; the results of the post-teaching sequence evaluation, from the point of view of the student who learned using the POI, identified an improvement in understanding the main topics, a better willingness to work in the classroom, the molecular representation capacity of phenomena and an improvement in linguistic expression and mathematical interpretation of these.

From the teacher's point of view, the use of interactive board facilitated the processes of presentation, modification of alternative conceptions and evaluation through the interactive SENTEO system, as well as feedback to the student. According to the one-factor variance analysis (ANOVA) presented, when comparing the two teaching methods, the traditional one using whiteboard and practical experiences on a microscale with the method using POIs in conjunction with interactive evaluation, if there is a significant difference suggesting that the latter method favors students' learning and communication during class as well as the participation and motivation that was measured by an observation guide, in which both positive comments and increased class attendance were recorded.

The POI as a teaching and learning tool has a wide range of applications, from this experience work could arise where the method adoption rate and variables that affect a successful implementation of POIs such as the ability and willingness of students to learn are examined.

We recommend as additional work that students solve how would they design an experiment to compare the heat capacity of two different antifreeze?

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Annex A. Heat Capacity Questionnaire

1) You are in front of two tables at room temperature, if you simultaneously place a bucket of frozen water in one and a bucket of frozen oil in the other:
   - Which cube do you think will melt first, water or oil?
   - What do you think is the source that provides heat to the cubes to thaw?
2) You and your sister boil water using the same stove. In your sister's container there's 1 liter of water and only half of you in yours. Indicate which container you think requires the most heat to boil. Justify your answer.
3) If you heat water from 20oC to 70oC (with a specific heat capacity of 1 kcal/kg C) and in the same hot conditions an antifreeze from 20oC to 70oC (with a specific heat capacity of 0.5 kcal/kg C)
   - Which one do you think will absorb more heat inside a radiator?
   - Which one do you think takes longer to warm up?
4) Imagine you put a raw egg in 1 kg of water and another raw egg in 1 kg of oil, in equal containers. If you heat both at the same time, which egg do you think will cook first and why?
5) Does heat transfer depend only on temperature? If not, what else does it depend on?
6) When heat is transferred, what happens to particles in the heat-absorbing substance?
7) Will a rapidly heated substance have a high or low specific heat capacity? Explain your reasoning.