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Enhancing Student Engagement Through Learning Science Principles: A Research-Based Approach Using a Classroom Management Tracking Tool and Video Analysis

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Abstract

Background: Due to disruptive student behavior, a K-5 urban school developed a problem of practice that focused on creating a classroom management plan and a social-emotional plan for students to regulate their emotions effectively, allowing teachers to execute engaging lessons that increase student engagement. Informal observations conducted by a fellow provided insight into variability in instructional practices, which resulted in developing tools based on learning sciences principles (Deans for Impact, 2015) that guide the instructional practices and also measure their impact on student engagement.

Potential consequences: Addressing this issue will help the leadership team understand the importance and coach teachers in effective implementation of teacher actions using teacher actions rubric and consciously embed the teacher actions in their lesson plans to increase engagement. Effective implementation of instructional practices will help reduce student disruptive behavior.

Method: A mixed-methods design was employed to conduct 31 observations using GoReact (Goreact, 2024) and classroom management tracking tools to investigate the impact of the frequency of effective teacher actions on students' engagement.

Findings: The quantitative data showed a positive correlation between teacher actions and student engagement, and the qualitative data highlighted the importance of effectively executing those actions.

Keywords: student engagement, learning by scientific design principles, GoReact, translational research, video-analysis

Introduction

Background of Problem

The problem addressed in this study arises from the difficulty teachers face in effectively managing classroom behaviors and engaging students in an urban K-5 charter school. Despite efforts to implement a school-wide classroom management plan, variability in instructional practices has resulted in inconsistent student engagement. This study investigates how teacher actions' frequency and quality impact student engagement. Different methods, such as utilizing classroom observations and video analysis, provide detailed feedback and actionable strategies for teachers to enhance their classroom management and instructional practices.

Case Study Description

To address this problem, the case study highlights the implementation of translational research in a school site by collaborating with a postdoctoral fellow. An urban K-5 charter school participated in this case study. One hundred sixty-five students were enrolled for 2022-2023. The school's leadership team consisted of 7 members. The school has 11 core-content teachers and three extra-curricular teachers. There are two teachers per grade level (K-4) and one teacher for 5th grade. Through the observations conducted by the leadership team, it was revealed that the teachers were unable to manage students' behavior effectively. Therefore, the school site generated a problem of practice that focuses on developing a school-wide classroom management plan and social-emotional curriculum to help students manage their behaviors and build a conducive learning environment. This problem of the practice template was adapted from the Kentucky Valley Educational Corporation and submitted by the school leadership team. To address this problem of practice, a postdoctoral fellow collaborated with the school site to design a study and conduct observations.

During the fellows' initial observations, the fellows observed that the lessons were variable from teacher to teacher, and this variability presented a problem to both research and the practices that engage students. It was unclear whether student behavior was caused by the lack of engaging lessons or students' inability to self-regulate their behavior. By partnering with the school leaders, professional learning communities (PLCs) (DuFour, R. et al., 2006) were set up, and an exit ticket tracker was developed to determine if the lesson was effective, separate from behavior. This helped teachers monitor their students' growth and understanding of the concept. But to further distinguish between teacher effectiveness and student self-regulation capacity, a video recording platform, GoReact(2024), was introduced. These initial observations led to the development of the research question that focused on investigating the impact of teachers' actions on student engagement. To address this need, the following research questions were developed:

How does the frequency of effective teacher actions based on learning science principles impact the students' engagement?

Does monitoring of frequency of schoolwide teacher actions, using classroom management tracking tool and GoReact increase student engagement actions?

Significant of the Study

This study is significant as it explores the impact of teacher actions framed by the learning science principles, enhancing student engagement, which is a critical factor in fostering a positive learning environment and promoting academic success. By employing a classroom management tracking tool alongside GoReact video analysis, this research integrates learning science principles into classroom practices, providing actionable data for teachers. The study not only highlights the importance of effective teacher actions in increasing student engagement but also emphasizes the need for proper execution of these actions to achieve desired educational outcomes. The findings from this research can inform teacher training and professional development, leading to improved instructional practices and more engaged classrooms.

Literature Review

Translational Research

McDonald et al. (2013) mentioned the importance of teacher education in shaping teacher practices that combine both knowledge and practice. Researchers also elaborated on the topic of developing a vision for pedagogy for teacher education. One of the ways by which teacher education pedagogy can be reimagined is to introduce research aiming at engaging teachers and teacher educators in generating systematic feedback based on teaching and teaching education pedagogy. This collaborative aspect of connecting research to practice and practice to research is termed "translational research" (McDonald et al., 2013). However, translational research is often interpreted within the context of engineering, health science, and medical fields but the translational research structured in education is yet unclear and unexplored (McDonald M. et al., 2013).

Lavelle (2015) defined educational translational research as the application of available research knowledge in practical educational settings. It may also be termed as the movement of knowledge to describe the processes that enable us to share the research and make it accessible to others (as cited in Jones et al., 2022). Jones et al. 2022 also elaborated on educational translational research. Due to the increasingly complex challenges faced by school communities and to address the gap in understanding translation research, it has been defined as the process by which teachers critically develop and use an evidence-based approach to improve their classroom

practice. Teachers play an important role in bringing those changes to the school site. (Jones et. al., 2022).

Influences on Student Engagement

Student engagement has always been a key aspect of achieving student success in the classroom. Various literature has defined student engagement in many ways. Pedler et al. (2020) mentioned student engagement as a malleable, multidimensional construct that combines the three dimensions of behavioral, emotional, and cognitive engagement. Fredericks et al. (2004) defined student engagement as the three interrelated dimensions: behavioral, emotional, and cognitive, based on a qualitative review. Student behavioral engagement includes their participation in the activities and following classroom norms or rules. Student emotional engagement involves their emotional reactions to activities, teachers, and peers, as well as the regulation of their own emotions. Student cognitive engagement involves understanding activities to the mastery level, as well as their use of learning in other contexts by developing metacognitive skills. Many factors impact student engagement. Devito, M (2016) conducted a qualitative study at the middle school level using a survey, focused-group interview, and observations which allowed to classify the student engagement into five main clusters - "1) communication, collaboration, active involvement in learning activities, and enriching educational experiences; 2) interactions between students and teachers; 3) levels of academic challenge; 4) supporting classroom environment; and 5) supporting family environment." Jang et al. (2010) investigated the two instructional styles of teachers that foster student engagement, autonomy support, and structure.

The study found that both are positively correlated with each other and help to predict the students' behavior engagement. Kraft & Doughtery (2013) explored the causal effect of teacher communication with parents and students on student engagement. The study found that frequent teacher-family communication instantly increased student engagement, measured by students' homework completion rates, on-task behavior, and class participation. Conner (2011) inquired about the engagement ratings and instructional preferences of 93 students across three school levels: upper elementary, middle, and high school. The findings show significant differences between cognitive and emotional engagement among the three levels and no statistical difference in the behavioral dimension among the three school levels. The common theme among participants at all three school levels was the emotional theme, which focused on the importance of emotional connections between students and teachers. Another popular theme that arose from the qualitative data was the preference for kinesthetic activities. Participants prefer learning and teaching styles that involve hands-on activities and project-based learning. Teachers' instructional practices and building positive relationships with their students have a huge impact on the students' engagement. Building on previous research, this study utilizes a video recording platform to investigate the impact of effective teacher actions on student engagement.

Most recently, video-based classroom observation tools have gained more traction than observations and field notes as ways of data collection (Derry et al., 2010; Marsh et al., 2005). Video recordings allow multiple observers to provide time-stamped feedback on the same classroom session, enabling comprehensive, precise, and targeted feedback. GoReact is one such video recording platform that allows multiple users to record and provide feedback using rubrics, comments, and markers to tag specific behaviors or actions of teachers and students. This facilitates detailed and targeted feedback to all the participants (GoReact, 2024).

Gaps in Literature

The study identifies several significant gaps in the literature on student engagement and teacher actions. Firstly, while research has emphasized the importance of teacher behavior and student-centered teaching methods in promoting student engagement (Lee, 2012; Xerri et al., 2018), a notable lack of studies integrating structured, evidence-based feedback mechanisms, such as GoReact, into these practices. Most research has focused on either qualitative or quantitative measures of student engagement, but few studies have combined these approaches using video analysis tools to provide detailed feedback on teacher actions in real-time (Derry et al., 2010; Marsh et al., 2010).

Additionally, it bridges the gap between theory and practice by translating learning science principles into practical classroom strategies, offering a more nuanced understanding of the relationship between teacher actions and student engagement in a real-world educational setting. This approach not only enhances the existing body of knowledge but also offers practical solutions for improving instructional practices, which are often overlooked in traditional educational research. This study addresses this gap by applying the principles of translational research to analyze and improve teacher actions and their impact on student engagement.

Lastly, although video-based classroom observation tools have started to gain traction (Derry et al., 2010; Marsh et al., 2010), their systematic application in improving instructional practices and student engagement through feedback mechanisms is still in its early stages. This study fills this gap by using GoReact, a video analysis platform, to provide actionable feedback based on structured rubrics, offering a more nuanced understanding of how teacher actions affect student engagement in real-world classroom settings.

Theoretical Framework

The Science of Learning was developed by member deans of Deans of Impact in collaboration with Dan Willingham, a cognitive scientist at the University of Virginia, and Paul Bruno, a former middle school teacher. Deans of Impact is a national nonprofit organization founded in

2015 to transform educator preparation and elevate the teaching profession (Deans of Impact, 2015). The organization is guided by four principles emanating from Learning Sciences :

1) Data-informed improvement
2) Common outcome measures
3) Empirical Validation of effectiveness
4) Transparency and accountability for results

The science of learning identified five cognitive principles for students, along with practical implications for teachers in the classroom. Learning by Scientific Design(LbSD) principles translate learning science research into instructional practice by providing teachers with practice-based, actionable learning experiences (Deans for Impact, 2020). The LbSD comprises three main components: Encoding, Retrieval, and Creating a Motivating Environment. Each component comprises various principles, each of which is associated with the actions of different teachers. Table 1 represents the three components with the principles and various teachers' actions connected with each principle.

TABLE 1. Learning by scientific design (LbSD) and teacher actions)

Components	Principles	Teacher Actions
Encoding	Managing the Learning Load	Teachers intentionally sequence tasks to include opportunities to build foundational concepts before moving on to more advanced tasks.
		Teachers Scaffold student understanding through carefully designed instruction that includes modeling, explanation, thinking aloud, and worked examples.
	Connecting the Dots	Teachers prompt students to make explicit connections between new ideas and prior knowledge.
	Deepening Meaning and Learning	Teachers select tasks that require students to focus their attention on the meaning of content.
		Teachers' questions and tasks require students to engage in effortful thinking.
		Teachers prompt students to connect (and distinguish) varied examples and contrasting non-examples.

Retrieval	Practicing with purpose	Teachers' space and interleave practice opportunities to assist students in building automaticity.
		Teachers frequently use low-or-no-stakes quizzes to promote retrieval of information.
	Building Feedback Loop	Teachers provide feedback that focuses on fostering improvement rather than verifying performance.
		Teachers provide feedback to students that is focused on specific qualities of student work.
Creating a motivating environment	Creating a motivating environment	Teachers surface the voices, ideas, and opinions of all their students, and show that these are valued.
		Teachers communicate to their students that wrong answers are productive learning opportunities.
		Teachers acknowledge hard work and success.
		Teachers help students set learning goals based on improvement rather than performance.

Note. Each color in the table represents one component. Green represents encoding, blue represents retrieval and purple represents creating a motivating environment.

The current case study employed the "Learning by Scientific Design Principles" as its theoretical framework. As these principles provide the research-based instructional structure for the beginning teachers, it can enhance the classroom management skills thereby improving the student engagement. This case study investigates the impact of these teachers' actions on student engagement.

Application

Research Design

A mixed-method research design was used to investigate the relationship between the frequency of teacher actions and number of students engaged in the classroom. According to Creswell (2008), there are various ways in which mixed-methods research can be conducted. In this study, the concurrent embedded design was used as it helps to collect both qualitative and quantitative data at the same time.

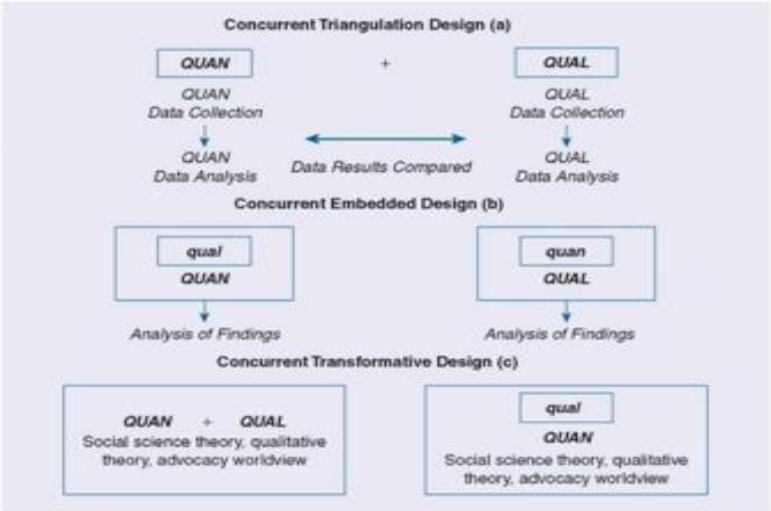


FIGURE 1. Concurrent embedded design.

This design helped in saving time for the fellow researcher and also provided extended information about students' engagement.

GoReact video feedback, utilizing the markers and student engagement section from the classroom management tool, provided quantitative data. Meanwhile, the embedded rubric in GoReact provided qualitative data. The rubric assisted in deepening the understanding of the level of student engagement.

Instrument

Two instruments, GoReact videos, and a classroom management tracking tool, were used to collect both qualitative and quantitative data. Both the tools are explained below:

GoReact Platform

GoReact is a platform used to video-record classroom observations, providing time-stamped and precise feedback to participants from multiple users. (GoReact, 2024). This video recording platform was used to collect data systematically to track relevant patterns. The various data sources developed in the GoReact video are:

1) The rubric embedded in Learning by Scientific Design (LbSD) principles was imported into the GoReact video recording platform (Figure 2). The rubric describes four teachers' actions connected to the students' engagement actions and was used to score the participants in the study. The four teachers' actions used in the Learning by Scientific Design rubric are the following:
    - Teachers prompt students to connect (and distinguish) varied examples and contrasting non-examples.
    - Teachers' questions and tasks require students to engage in effortful thinking.
    - Teachers prompt students to call up important prior knowledge and explicitly connect it to new ideas.
    - Teachers' questions and tasks require students to focus their attention on the meaning of the content.

All these teachers' actions were associated with the frequency of student engagement, which was coded as high, mild, and low. (See Appendix)

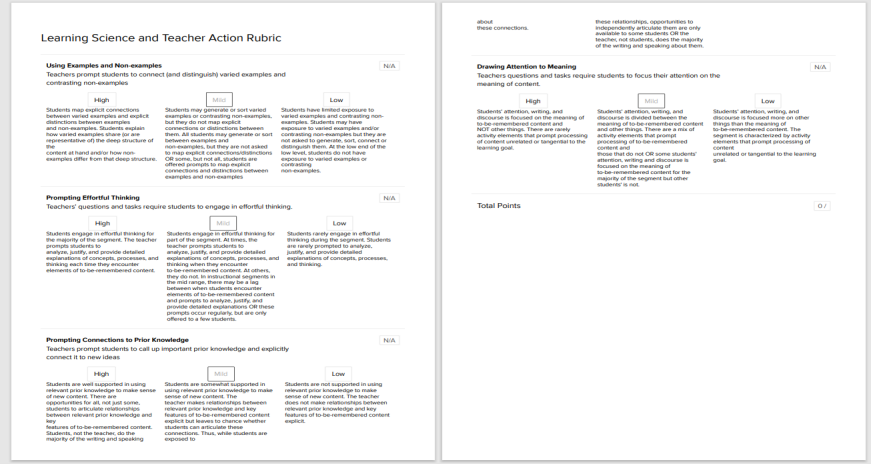


FIGURE 2. The sample of the rubric embedded in the GoReact video.

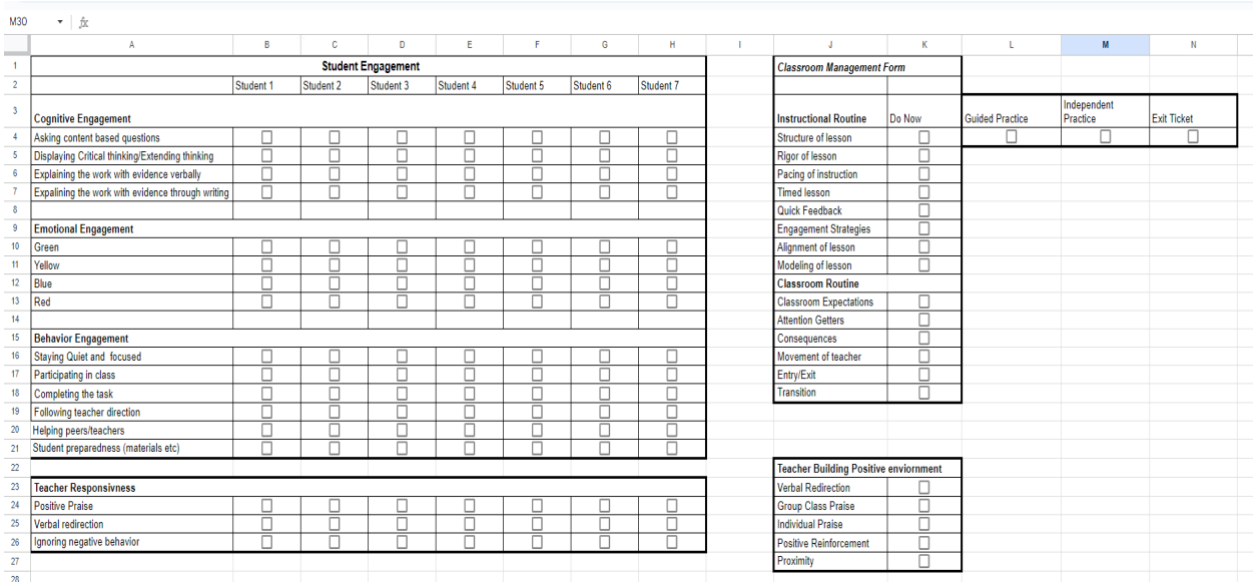
2) Markers were developed using Learning by Scientific Design (LbSD) principles and Teachers' Actions. Each teacher's action is labeled/marked by category and color code that corresponds to a specific action in the Goreact.
3) The feedback provided by the leadership team using the markers and/or the comments was used as one of the data sources.

Classroom Management Tracking Tool

A classroom management tracking tool was developed by collaborating with the school leadership team. The tool comprises four sections, measuring Student engagement, Classroom management form, Teacher responsiveness, and Teacher Building a Positive Environment (see Fig. 3). Each section is further divided into various elements. Out of four sections, only the student engagement section was used to understand the impact of teacher actions. The various elements of student engagement are described below:

Student Engagement. It is divided into three subcategories: Cognitive engagement, Emotional engagement, and Behavior engagement (See Fig. 4). Cognitive engagement is measured using four elements: Asking content-based questions, Displaying Critical thinking/Extending thinking, Explaining the work with evidence verbally, and Explaining the work with evidence through writing. Emotional Engagement is measured using the "Zone of Regulation" strategy (Kuypers, 2023). The students' emotional alertness is color-coded using their body gestures. Students were coded green if they were happy, calm, and had regulated emotional alertness. Students who were squirmy, stressed, frustrated, and silly were coded as yellow. Blue represents a low alert state which means that the student was sick, tired, bored, or sad. Students in the red zone represent extremely heightened emotions, which means having intense feelings like rage, anger, and explosive behavior. Behavior Engagement is measured using six elements: Staying quiet and focused, Participating in class, Completing the task, Following teacher direction, Helping peers/teachers, and student preparedness (materials, etc). The elements measured in cognitive engagement and behavior engagement are formed with the collaboration of the school site addressing their needs. Using these parameters, the inter-rater reliability was assessed for all observers of the student engagement section.

The inter-rater reliability of the student engagement section was conducted using 10 observations by the post-doctoral fellow and the instructional coach. Each observation was for 1 hour. Out of 10 observations, 9 (90%) observations were consistent with each other, i.e., both the observers witnessed each element in the class at least one time, showing high inter-rater reliability.



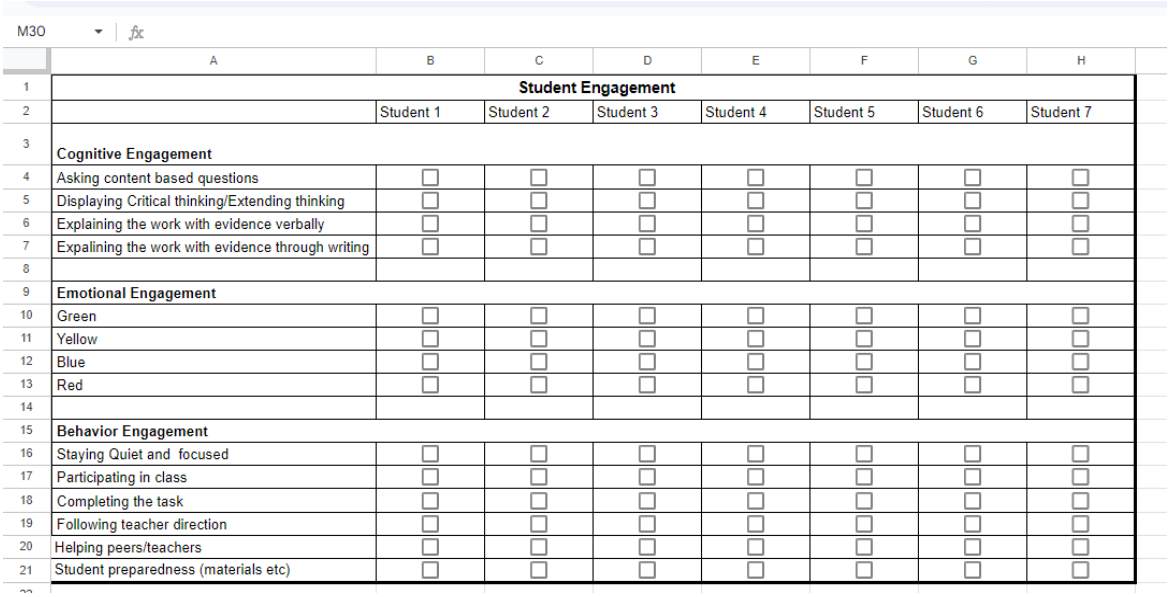
Student Engagement							
	Student 1	Student 2	Student 3	Student 4	Student 5	Student 6	Student 7
Cognitive Engagement							
Asking content based questions	☐	☐	☐	☐	☐	☐	☐
Displaying Critical thinking/Extending thinking	☐	☐	☐	☐	☐	☐	☐
Explaining the work with evidence verbally	☐	☐	☐	☐	☐	☐	☐
Expalining the work with evidence through writing	☐	☐	☐	☐	☐	☐	☐
Emotional Engagement							
Green	☐	☐	☐	☐	☐	☐	☐
Yellow	☐	☐	☐	☐	☐	☐	☐
Blue	☐	☐	☐	☐	☐	☐	☐
Red	☐	☐	☐	☐	☐	☐	☐
Behavior Engagement							
Staying Quiet and focused	☐	☐	☐	☐	☐	☐	☐
Participating in class	☐	☐	☐	☐	☐	☐	☐
Completing the task	☐	☐	☐	☐	☐	☐	☐
Following teacher direction	☐	☐	☐	☐	☐	☐	☐
Helping peers/teachers	☐	☐	☐	☐	☐	☐	☐
Student preparedness (materials etc)	☐	☐	☐	☐	☐	☐	☐
Teacher Responsivness							
Positive Praise	☐	☐	☐	☐	☐	☐	☐
Verbal redirection	☐	☐	☐	☐	☐	☐	☐
Ignoring negative behavior	☐	☐	☐	☐	☐	☐	☐

Classroom Management Form	
Instructional Routine	Do Now
Structure of lesson	☐
Rigor of lesson	☐
Pacing of instruction	☐
Timed lesson	☐
Quick Feedback	☐
Engagement Strategies	☐
Alignment of lesson	☐
Modeling of lesson	☐
Classroom Routine	
Classroom Expectations	☐
Attention Getters	☐
Consequences	☐
Movement of teacher	☐
Entry/Exit	☐
Transition	☐

Guided Practice	Independent Practice	Exit Ticket
☐	☐	☐

Teacher Building Positive enviornment	
Verbal Redirection	☐
Group Class Praise	☐
Individual Praise	☐
Positive Reinforcement	☐
Proximity	☐

FIGURE 3. Sample of classroom management tool.



Student Engagement							
	Student 1	Student 2	Student 3	Student 4	Student 5	Student 6	Student 7
Cognitive Engagement							
Asking content based questions	☐	☐	☐	☐	☐	☐	☐
Displaying Critical thinking/Extending thinking	☐	☐	☐	☐	☐	☐	☐
Explaining the work with evidence verbally	☐	☐	☐	☐	☐	☐	☐
Expalining the work with evidence through writing	☐	☐	☐	☐	☐	☐	☐
Emotional Engagement							
Green	☐	☐	☐	☐	☐	☐	☐
Yellow	☐	☐	☐	☐	☐	☐	☐
Blue	☐	☐	☐	☐	☐	☐	☐
Red	☐	☐	☐	☐	☐	☐	☐
Behavior Engagement							
Staying Quiet and focused	☐	☐	☐	☐	☐	☐	☐
Participating in class	☐	☐	☐	☐	☐	☐	☐
Completing the task	☐	☐	☐	☐	☐	☐	☐
Following teacher direction	☐	☐	☐	☐	☐	☐	☐
Helping peers/teachers	☐	☐	☐	☐	☐	☐	☐
Student preparedness (materials etc)	☐	☐	☐	☐	☐	☐	☐

FIGURE 4. Sample of student engagement tool.

Data and Results

Fellows collected data using the GoReact platform and classroom management tool. Forty-four classroom observations were conducted using both tools for each observation. All classroom observations were recorded in the GoReact platform for approximately 1 hour (60 minutes) and student engagement was observed using the student engagement section. Out of 44 classroom

observations, 31 classroom observations were analyzed and reported in this case study. The researcher determined that the rest of the observations were not included in the study due to variability in the classroom instruction style. The leadership team and the fellow provided feedback on videos using GoReact markers, rubric, and comments. Figure 5 shows the sample of feedback provided using the markers.

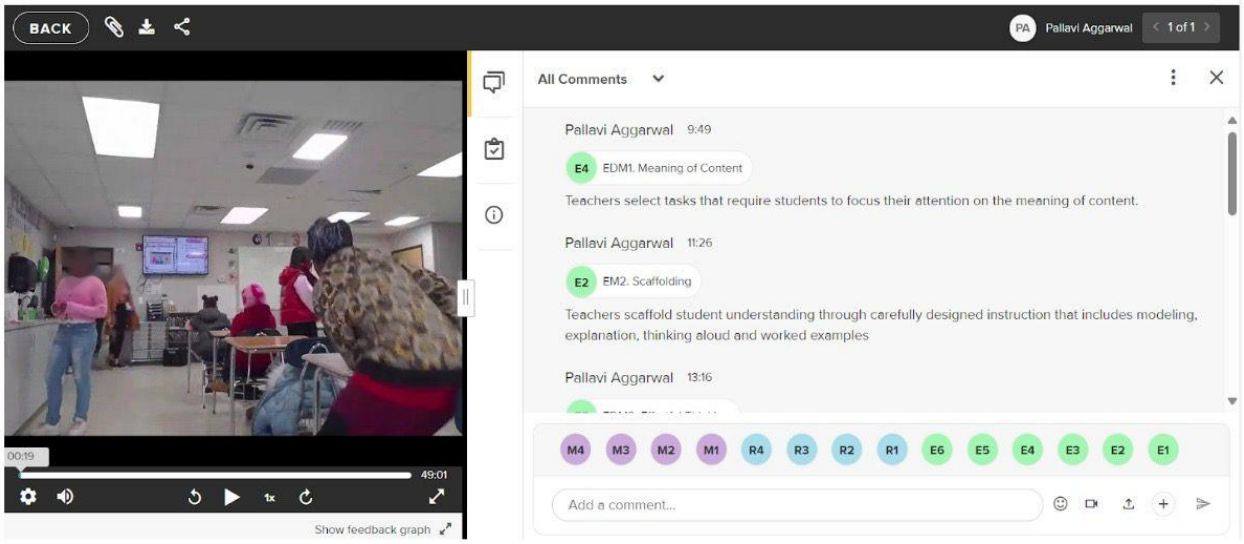


FIGURE 5. Sample of GoReact tool.

While GoReact was set to record the video, the fellow was recording data for each student in the classroom management tool. The student engagement section recorded the number of students cognitively, emotionally, and behaviorally engaged for each classroom observation. It also provided data for each element of each engagement category. For example: If student 1 asked a content-based question, then the fellow marked a check in that category or If student 4 had all materials ready/ was in the green zone then student 4 was checked. (See Figure 4). In the Goreact Video recording, the leadership team and fellows provided feedback using markers, personal comments, and rubric.

Quantitative Analysis

Quantitative data was analyzed for 14 elements of teacher actions performed by 31 teachers in the Goreact videos and student engagement using the classroom management tool. To investigate the impact of the frequency of teacher actions on the frequency of student engagement, correlational analysis was used. Pearson Correlational analysis was run in SAS (SAS on demand for academics) . The linear equation showing the relationship between two variables is :
Frequency of student engagement (Y) = m x (frequency of teacher actions) + c
Where y represents the frequency of student engagement; m represents slope; x represents the frequency of teacher actions and c represents intercept.

Table 2 shows the descriptive statistics of the two variables. The means of frequency of student engagement and frequency of action used by teachers were 95.57 and 69.64 respectively. The minimum and maximum values of frequency of student engagement were 1 and 216. The minimum and maximum values of the frequency of actions used by the teacher were 45 and 120.

TABLE 2. Descriptive statistics of frequency of student engagement and frequency of actions used by teachers

Variable/Label	N	Mean	Std. Deviation	Median	Minimum	Maximum
Frequency of Student Engagement (Y)	*14*	95.57143	79.72811	75.00000	1.00000	216.00000
Frequency of actions used by teachers (X)	14	69.64286	20.67926	67.00000	45.00000	120.00000

The Pearson correlation coefficient value was 0.63013. This means the frequency of student engagement was moderately correlated with the frequency of teacher actions. The p-value is $0.0157 < 0.05$ which indicates a statistically significant relationship between the frequency of student engagement and to frequency of actions used by teachers (See Table 4). The scatter plot analysis shows the upward trendline establishing a positive correlation between the two variables (See Fig 6). In the scatter diagram, the coefficient of determination (R^2) is 0.397 which means approximately 40% of the frequency of student engagement can be determined by the frequency of teacher actions used.

TABLE 4. Pearson correlation coefficient value (n=31)

Pearson Correlation Coefficients, Prob> |r| under H0: Rho = 0	
	Frequency of action used by teachers
Frequency of Student Engagement	0.63013
Frequency of Student Engagement (Y)	0.0157

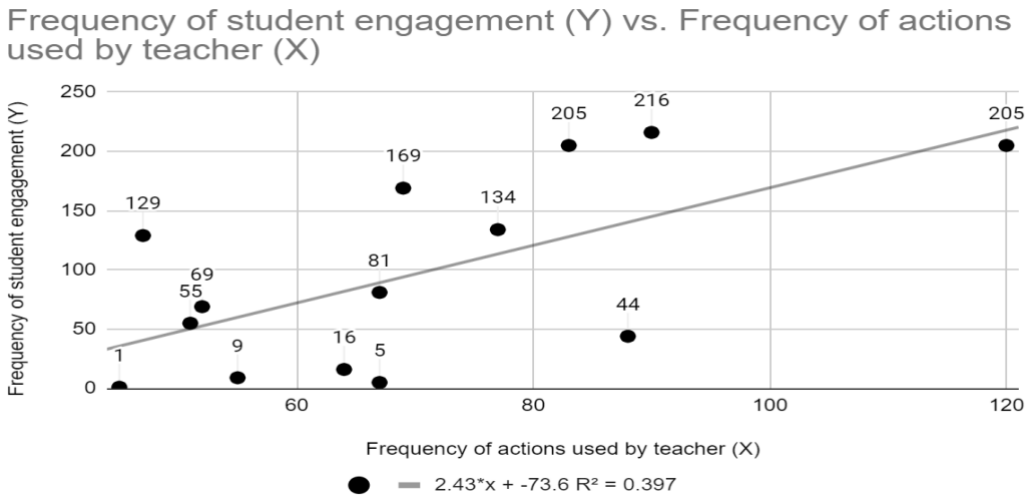


FIGURE 6. Scatter plot analysis of frequency of student engagement (y) vs. frequence of action used by teacher (x).

Result of Quantitative Data

The correlation between the frequency of teacher actions and the frequency of student engagement is positively moderate and statistically significant. This means the increase in the frequency of teacher actions will increase the frequency of student engagement. If the teacher uses more teachers' actions, the frequency of students showing engagement will increase.

Qualitative Analysis

The qualitative analysis of the rubric containing four teacher actions with student engagement was conducted by combining the data for 31 GoReact videos. Figure 4 shows the rubric embedded in the GoReact platform. The student engagement was coded as high, mild, or low as per the effectiveness of the teacher's actions in the class. Each student engagement code means:

High engagement- Either the number of students engaged was high or the level of engagement among the students was high.

Mild engagement- Either the number of students engaged was mild or the level of engagement among the students was mild.

Low engagement- Either the number of students engaged was low or the level of engagement among the students was low.

Table 3, summarizing the qualitative analysis, is shown below. The first column represents the teacher's initials and the grade level. The second column represents the frequency of effective teacher actions used by that teacher. The rest of the columns represent the four rubric questions with student engagement coded as High, Mild, or Low.

TABLE 3. Summary of qualitative analysis (n=31)

Summary of Qualitative Analysis					
		Ques 1	Ques 2	Ques 3	Ques 4
Teacher Grade	**Frequency of Effective Teacher Actions**	**Teachers prompt students to connect (and distinguish) varied examples and contrasting non-examples.**	**Teachers' questions and tasks require students to engage in effortful thinking.**	**Teachers prompt students to call up important prior knowledge and explicitly connect it to new ideas**	**Teachers' questions and tasks require students to focus their attention on the meaning of the content.**
	37	High	High	High	High
	30	High	High	High	High
BT 5	29	High	High	High	High
	8	Mild	Mild	Mild	Mild
	27	Mild	High	Mild	Mild
DT 4	16	Mild	Mild	Mild	Mild
	7	Low	Low	Low	Low
	20	Mild	Mild	Mild	Mild
HT 4	7	Mild	Mild	Mild	Mild
	24	Mild	Mild	Mild	Mild
ST 3	29	Mild	Mild	Low	Mild
	27*	High	High	High	High
	27	Mild	High	High	High
RT 3	92	Mild	High	High	High
UT 2	35	High	High	High	High

	35	Mild	High	High	High
	96	High	High	High	High
	38	High	High	High	High
	45	High	High	High	High
BaT 2	63	High	High	High	High
	21	Mild	High	High	High
	21	Low	Mild	High	High
PT 1	14	Low	Low	Low	Low
	37*	Mild	Mild	Mild	Mild
RT 1	32	Low	Mild	Mild	Mild
	28	Mild	High	High	High
	40	High	High	High	High
HT K	39*	Low	Mild	High	Mild
	22	Mild	Mild	Mild	Mild
	33	Mild	High	High	High
RT K	26	Low	Mild	High	High

Note. The rows highlighted in gray in the table represent the highest frequency of student engagement with the frequency of teacher actions used in that observation, while the row with * represents the exception.

Results: Patterns in Qualitative Data

1) 5th-grade teacher had the highest frequency of student engagement with 37, 30, and 29 frequency of teacher actions used.
2) One of the 3rd-grade teachers had the highest frequency of student engagement, with 27 and 92 frequency of teacher actions used.
3) Both 2nd-grade teachers had the highest frequency of student engagement, with the frequency of teacher action ranging from 96 to 35.
4) One of the kindergarten teachers had the highest frequency of student engagement, with 40 teacher actions used.
5) 4th-grade teachers had one of the lowest frequencies of student engagement with the teacher actions, ranging from 7 to 27.

Exception of Qualitative Data

The frequency of teacher actions with * represents the exception to the trend between the two variables. One of the teachers in first grade and kindergarten had used 37 and 39 teacher actions, respectively, but still, the frequency of student engagement remained low and mild. One of the 3rd-grade teachers employed 27 teacher actions, which resulted in the highest frequency of student engagement.

Result for Qualitative Data

Qualitative data showed that as the frequency of teacher actions increased, student engagement was coded as high. It also highlighted that the crucial part of the effective execution of the teacher's actions is to develop student engagement. Qualitative data provided insight into a few teachers using more teachers' actions, but still not engaging enough students, and vice versa.

Discussion and Conclusion

Findings from the quantitative and qualitative data helped to answer the research questions: How does the frequency of effective teacher actions based on learning science principles impact the students' engagement?

Quantitative data showed that there is a positive correlation between the frequency of teacher actions and the frequency of student engagement. This means that the number of students engaged or the frequency of students displaying cognitive/ emotional and behavioral engagement increases as teachers' actions increase. Qualitative data showed the same trend but highlighted some exceptions that show that even more usage of teachers' actions may sometimes result in less engagement.

Does monitoring the frequency of schoolwide teacher actions, using a classroom management tracking tool and GoReact, increase student engagement actions?

Although quantitative data mentions the increase in student engagement, the qualitative data highlights some of the exceptions. This underscores the importance of proper understanding and effective execution of learning by scientific design principles and other aspects of the environment that were not observed in these instruments, such as the teacher's relationship with the students, consistency in the execution of norms, and time management in the classroom. To seamlessly incorporate those actions at the school site, the fellow, in collaboration with school leaders, developed a teacher action rubric associated with the student engagement rubric observation template (Aggarwal, 2025) that aligns with the school's teacher evaluation list. A

lesson plan template with the checklist of those teacher actions and student actions was also created in order for teachers to be intentional and mindful while developing lesson plans.

Future Research Implications

Several research studies have demonstrated that teachers' actions have a positive impact on student engagement (Stramber et al., 2013; Bundick et al., 2014; Cents-Boonstra et al., 2020). The current study might be extended to investigate the effectiveness of the frequency and quality of teachers' actions on the number of students being engaged. Furthermore, research can be extended to understand the relationship between each Learning Science principle with different types of student engagement. As mentioned earlier, the other key aspects that impact the student engagement are not studied or the data for those aspects were not collected using the instrument which means the future research can be extended on focusing on those specific aspects of time management, teacher-student relationship and teacher execution of classroom norms.

Practical Implications

The school can use these results and provide training to the teachers in professional development sessions to use the lesson plan template and also understand the teacher action and student engagement rubrics. Professional Learning Communities will use data (rubric scores, marker comments with time-stamped video) to discuss teacher actions and improve student engagement actions. Grade-level teachers will also collaborate by providing feedback on their instructional practices within GoReact. Professional development will be provided around the specific learning science principle that might help teachers to improve their instructional practices, resulting in a highly engaged classroom.

Implications for Metropolitan Universities

Teacher preparation programs could adopt tools and frameworks similar to those described in this study to strengthen the connection between theory and practice in teacher education.

First, **video-based reflective practice** using platforms such as *GoReact* allows preservice teachers to record lessons and receive time-stamped, rubric-based feedback aligned with the *Learning by Scientific Design (LbSD)* principles. This enables candidates to connect cognitive science principles—such as encoding, retrieval, and motivation—to authentic classroom practice, fostering deeper self-reflection and instructional growth (Deans for Impact, 2020; Derry et al., 2010).

Second, **data-driven feedback cycles,** supported by observation instruments such as the *Classroom Management Tracking Tool,* can provide structured data on candidates' instructional

actions and their impact on student engagement. Faculty and mentors can then analyze trends in these data to promote evidence-based refinement of practice (McDonald, Kazemi, & Kavanagh, 2013).

Third, embedding **translational research frameworks** in coursework allows teacher candidates to systematically apply learning science principles in classrooms and examine their effects on student engagement, thus bridging the research-to-practice gap (Jones et al., 2022; McDonald et al., 2013).

Additionally, organizing **Professional Learning Communities (PLCs)** enables candidates and mentors to collaboratively interpret instructional moves using shared video data and rubrics, replicating effective coaching cycles observed in K–12 settings (DuFour et al., 2006).

Finally, designing **lesson plan templates** that explicitly align *LbSD* principles with teacher actions and engagement indicators can help preservice teachers intentionally plan for encoding, retrieval, and motivation in their lessons (Deans for Impact, 2015, 2020).

By integrating these observation, reflection, and design tools into teacher preparation, programs can operationalize learning science principles—helping future teachers develop adaptive expertise and intentional, evidence-based instructional practices.

Limitations

One of the limitations of the study was that the research was conducted in a single school and could be more valid if conducted in another school using the same method. Another limitation was the positionality of the researcher. The researcher was close to the teachers so to address this bias, the researcher met with the leadership team weekly to discuss the next steps and share the findings subjected to every teacher.

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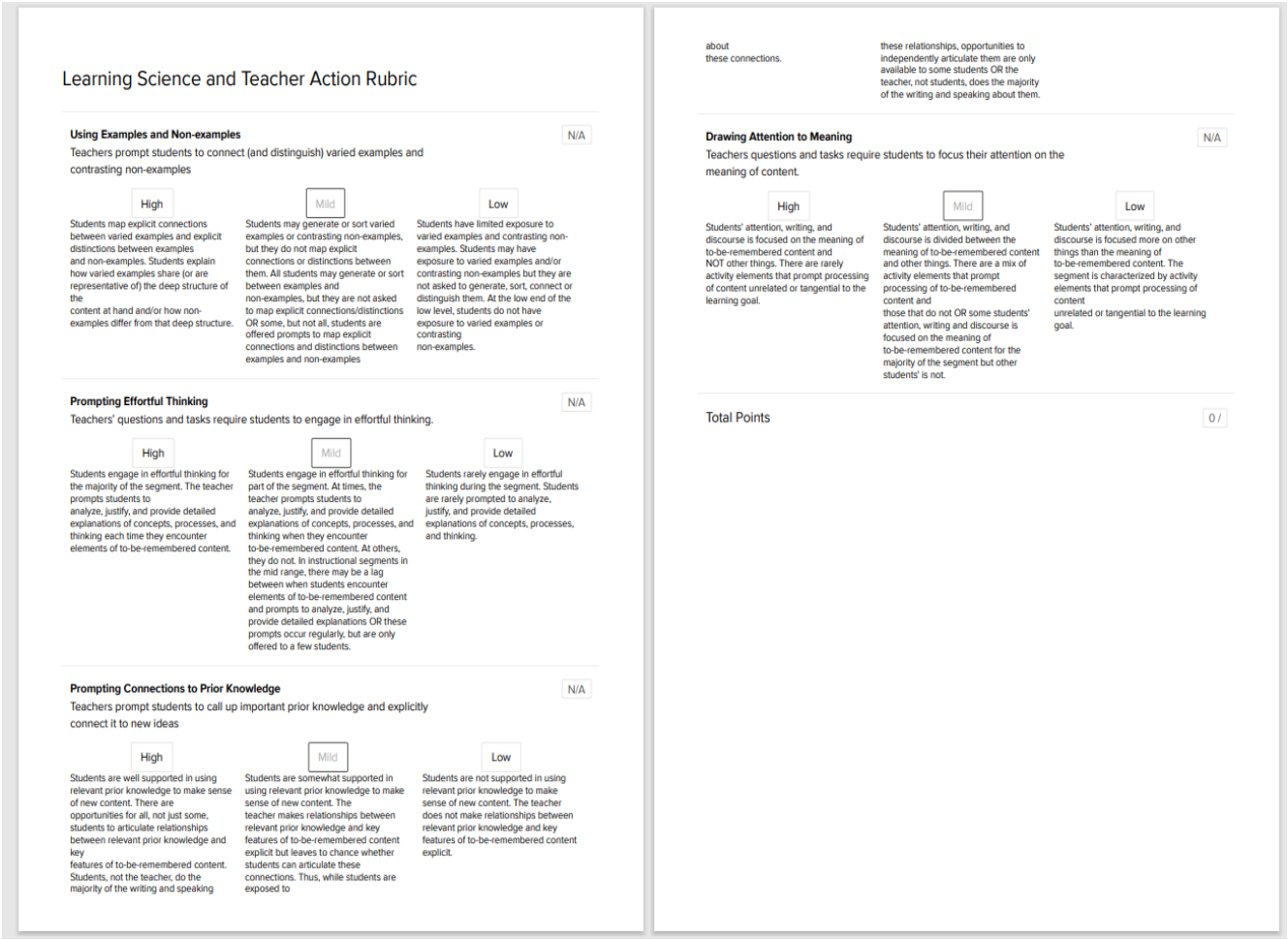
Appendix

The sample of the rubric embedded in the GoReact video



Learning Science and Teacher Action Rubric

Using Examples and Non-examples N/A

Teachers prompt students to connect (and distinguish) varied examples and contrasting non-examples

High	Mild	Low
Students map explicit connections between varied examples and explicit distinctions between examples and non-examples. Students explain how varied examples share (or are representative of) the deep structure of the content at hand and/or how non-examples differ from that deep structure.	Students may generate or sort varied examples or contrasting non-examples, but they do not map explicit connections or distinctions between them. All students may generate or sort between examples and non-examples, but they are not asked to map explicit connections/distinctions OR some, but not all, students are offered prompts to map explicit connections and distinctions between examples and non-examples	Students have limited exposure to varied examples and contrasting non-examples. Students may have exposure to varied examples and/or contrasting non-examples but they are not asked to generate, sort, connect or distinguish them. At the low end of the low level, students do not have exposure to varied examples or contrasting non-examples.

Prompting Effortful Thinking N/A

Teachers' questions and tasks require students to engage in effortful thinking.

High	Mild	Low
Students engage in effortful thinking for the majority of the segment. The teacher prompts students to analyze, justify, and provide detailed explanations of concepts, processes, and thinking each time they encounter elements of to-be-remembered content.	Students engage in effortful thinking for part of the segment. At times, the teacher prompts students to analyze, justify, and provide detailed explanations of concepts, processes, and thinking when they encounter to-be-remembered content. At others, they do not. In instructional segments in the mid range, there may be a lag between when students encounter elements of to-be-remembered content and prompts to analyze, justify, and provide detailed explanations OR these prompts occur regularly, but are only offered to a few students.	Students rarely engage in effortful thinking during the segment. Students are rarely prompted to analyze, justify, and provide detailed explanations of concepts, processes, and thinking.

Prompting Connections to Prior Knowledge N/A

Teachers prompt students to call up important prior knowledge and explicitly connect it to new ideas

High	Mild	Low
Students are well supported in using relevant prior knowledge to make sense of new content. There are opportunities for all, not just some, students to articulate relationships between relevant prior knowledge and key features of to-be-remembered content. Students, not the teacher, do the majority of the writing and speaking about these connections.	Students are somewhat supported in using relevant prior knowledge to make sense of new content. The teacher makes relationships between relevant prior knowledge and key features of to-be-remembered content explicit but leaves to chance whether students can articulate these connections. Thus, while students are exposed to these relationships, opportunities to independently articulate them are only available to some students OR the teacher, not students, does the majority of the writing and speaking about them.	Students are not supported in using relevant prior knowledge to make sense of new content. The teacher does not make relationships between relevant prior knowledge and key features of to-be-remembered content explicit.

Drawing Attention to Meaning N/A

Teachers questions and tasks require students to focus their attention on the meaning of content.

High	Mild	Low
Students' attention, writing, and discourse is focused on the meaning of to-be-remembered content and NOT other things. There are rarely activity elements that prompt processing of content unrelated or tangential to the learning goal.	Students' attention, writing, and discourse is divided between the meaning of to-be-remembered content and other things. There are a mix of activity elements that prompt processing of to-be-remembered content and those that do not OR some students' attention, writing and discourse is focused on the meaning of to-be-remembered content for the majority of the segment but other students' is not.	Students' attention, writing, and discourse is focused more on other things than the meaning of to-be-remembered content. The segment is characterized by activity elements that prompt processing of content unrelated or tangential to the learning goal.

Total Points 0 /