

CONFIRMATORY ANALYSIS OF THE POSITIVE EFFECT OF DIALOGUE IN THE CONTEXT OF TEAM-BASED LEARNING

ANALISI CONFERMATIVA DELL'EFFETTO POSITIVO DEL DIALOGO NEL CONTESTO DEL TEAM BASED LEARNING



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Angela Basta¹

Università di Foggia

angelo.basta@unifg.it



Delio De Martino

Università di Foggia

delio.demartino@unifg.it



Andrea Tinterri

Università Telematica IUL

a.tinterri@iuline.it



ABSTRACT

Team-based learning (TBL) is a methodology focused on collaborative learning and self-assessment among students. Keys are collaborativeness and *dialogos* ("talk between"). This study presents the data analysis of an experimentation of a technologically enhanced implementation of TBL which took place in a Docimology course at the University of Foggia (2023-4). The aim is to assess the impact of I-RAT, T-RAT and of collaborative dynamics on student learning achievements. First results confirm better results in team compared to individual performance, highlighting the effectiveness of the methodology and encouraging further studies on TBL.

Il Team-based learning (TBL) è una metodologia basata sull'apprendimento collaborativo e sull'autovalutazione tra studenti. Le chiavi sono la collaborazione e il *dialogos* ("parlare tra"). Thesto studio presenta l'analisi dei dati di una sperimentazione di un TBL digitale, ottenuti con l'ausilio di learning analytics, in un corso di Docimologia dell'Università di Foggia (2023-4). L'obiettivo dello studio è valutare l'impatto di I-RAT e T-RAT e delle dinamiche collaborative sui risultati di apprendimento degli studenti. I primi risultati mettono in risalto il miglioramento della performance nelle attività di gruppo rispetto a quelle individuali, sottolineando l'efficacia didattica del TBL e la necessità di ulteriori indagini.

KEYWORDS

Team-Based Learning, I-RAT, T-RAT, formative assessment
Team-Based Learning, I-RAT, T-RAT, valutazione formativa

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¹ This work has been developed collectively. Angelo Basta wrote paragraphs 2, 3, and 4. Delio De Martino wrote paragraphs 1.1, 1.2, 1.3. Andrea Tinterri wrote Conclusion. The authors thank Prof. Anna Dipace for the support in conceptualizing and developing the project and for allowing data collection in her courses.

Introduction

When Larry Michaelsen in 1979 invented Team based learning (TBL), he created a new active learner centered methodology focused on the educational advantages of working in a team (Michaelsen et al., 1982 and 2023). In this innovative approach the key is the “dialogue” beyond the collaborativeness.

1.1 The origin of team-based learning

During the I-Rat (Individual Readiness Assurance Test) the student works in a traditional mode doing an individual test, very similar to the Multiple Choice Text (MCT) he or she has met in the classic summative assessment, where the dialogue is usually forbidden. But after the I-Rat the same test is proposed to the classroom with an opposite and innovative Socratic approach. In fact, in the T-Rat (Team Readiness Assurance Test) the crucial point is the dialogue between the students. In this phase the students reflect jointly about the question and the correct answers of the proposed test in a new co-constructive perspective. So, the answer is the result of a meaningful negotiation among all components of the team. The revolution of T-Rat is the dialogicization of the search for answers during the test, instead of a mute, individual test. The invention of TBL is strongly linked to Larry Michaelsen’s vision of the Socratic dialogue as a crucial tool to enhance learning and as a method to be used instead of classic teacher centered didactics. Michaelsen even before 1979 has always preferred to avoid the lesson understood as transmission of information passively received by the students. Indeed, when Michaelsen developed TBL he was 36 and he had a long didactic experience of use of innovative methodologies focused on the dialogue as an active interactive and learner centered element to teach in a more effective and modern way. So it is not surprising that TBL has already had a Socratic matrix since its prehistory as it was born following some experiments that Larry Michaelsen carried out using Socratic case-based teaching.

Even before the invention of TBL Michaelsen, when his classroom was about 40 students, had adopted in his lesson innovative methodologies focused on the Socratic dialogue to stimulate active cooperation. In fact, as Wallace (et al. 2017, p. 67) explains:

Michaelsen originally taught an undergraduate class of around 40 students using a case-based, Socratic teaching style. Students were able to demonstrate deep learning and problem-solving skills by applying concepts rather than just memorizing them.

The development of TBL originated from a problem Michaelsen faced when the number of students of his lessons increased dramatically. At first glance the Socratic dialogue in a large classroom posed a technical and efficiency problem. So Michaelsen looked for a new way to preserve the element of dialogue and not have to return to dispensing with teaching even when the number of students hindered it. Indeed, the idea of Tbl matured to try to maintain the same level of engagement in a larger classroom when the number of students switched from 40 to 120 and to ensure, at the same time, that each student comes to the classroom prepared to work on learning activities (Wallace et al., 2017, p. 68). As Sibley and Spiridonoff (2010, p. 1) clarify, Michaelsen “was unwilling to give up the effective outcomes that were possible in the smaller class using Socratic discussion”. In fact, the classic form of Socratic dialogue and the maieutic method is usually effective in a small group of students. Also in antiquity, in Platonic dialogues it is evident that the number of participants is limited to two or three characters. In the *Symposium* the number of participants is up to 10 (Alcibiades, Phaedrus, Socrates, Aristodemus, Apollodorus, Diotima, Pausanias, Aristophanes, Eryximachus, Agathon). But with larger groups it is difficult to maintain an effective dialogue and the “word” can’t be “between” many participants. Indeed, the etymology of the word dialogue comes from ancient Greek and it means “word between”, from “logos” (speech) and “dia” (between). In this switching from Socratic case-based methodology to TBL the crucial Socratic element of dialogue remains and indeed it doubles or triples his “places”. In TBL the dialogue is present in a triple form: internal dialogue during home pre-class study and I-rat and external dialogue (T-Rat) and constructivist dialogue (T-app). In summary, during the TBL the classroom turns into a sort of big and complex agora made of lots of mini-*agorae* where simultaneously all the teams put in practice the Socratic dialogue.

1.2. The role of dialogue in teaching and learning

The team of the T-Rat is, physically and metaphorically, a sort of didactic little agora open in a learning environment consisting of many simultaneous *agorae* where co-built the knowledge in order to individuate the correct answer of the multiple choice test. The same happens in T-app where the outcome is an application. In this context the classic 4s TBL elements (Simultaneous report, Specific choice, Same problem, Significant problem; Kibble, et al., 2016) can be considered a sort of framework aimed to set the boundaries of the Socratic dialogue and so to make converge all dialogic energies toward the learning outcomes. More in general, the emphasis on the dialogue is the substrate of every form of innovation of the classic didactics (Silaghi, 2014). If we consider the question more widely, we can observe that the dialogue is an essential and ubiquitous element of the entire learning

process, even when it is not evident. The dialogue in some situations is more evident than in others but without dialogue there is not real learning. Even from the historic point of view the first form of didactics, before the success of book-based learning methodology, in ancient times was the Socratic dialogue used as a heuristic tool (Flammia, 2023). Among the centuries the diffusion of the book as the unique educational medium, linked to the transmissive teaching, made less evident the role of the dialogue in the learning process. Above all in modern times the classic final summative assessment the dialogue seemed abolished. In last century the spread of new educational technologies since the beginning of the century has slowly brought attention back to dialogue as a key element for innovating teaching. The history of innovation technology can be seen as a slow return of the dialogue. The Pressey machine learning and the Skinner machine learning have in common the same fundamental elements of the TBL: the Socratic method or "vanishing" (Fry, 1960). Also, the most recent digital revolution and the development of e-learning has involved the recovery of the dialogue as an essential element of the co-constructivist framework. In fact, the virtual learning management system is a sort of new digital "agora" where students and teachers can co-build the knowledge through synchronous and asynchronous dialogue (De Martino, 2021). But if we look at the dialogue from a more general ontological point of view, we could consider it an essential phenomenon not only of learning process but more in general of the human being and of thinking process. The human mind works through an internal dialogue even when there is not an external and explicit dialogue. That's what occurs during the I-Rat when the student dialogues with himself looking for the correct answer. The switch from internal dialogue (I-Rat) to external dialogue (T-Rat), from an individual dimension to a team dimension dialogue follows but in reverse the same path explained by Vygotsky in child development. Vygotsky explains, from a psychological and child development point of view, that the social and interpsychological dimension of the dialogue comes before the intrapsychic phase of the internal dialogue:

every function in the child's cultural development appears twice: first, on the social level, and later, on the individual level; first between people (interpsychological), and then inside the child (intrapsychological). This applies equally to voluntary attention, to logical memory, and to the formation of concepts. All the higher functions originate as actual relations between human individuals. (Vygotsky, 1978: 57).

1.3. Dialogue in Team-based learning.

During the I-Rat, a sort of simultaneous dialogue occurs with himself but with the simultaneous presence of other students, a sort of silent "collective monologue",

to use pedagogical terms (Stanley, 2011, p. 16). In the T-Rat there is an explicit dialogue instead. So, switching from I-Rat to T-Rat, the students recover and make explicit the social dimension of their internal dialogue, enhancing the learning process and their outcomes. In this externalization the student switches from an internal to an external dialogue, from a sort of silent self-centered dialogue to a more social dialogue that aims to co-construct the knowledge and that is useful to individuate the correct answers for the multiple-choice test. The social and dialogical vision of TBL and the effectiveness of his dialogue is linked to Bakhtin's dialogical concepts of dialogic plot, polyphony, and otherness. These concepts, born in literature studies, have then become essential also in the modern pedagogical field (Manno, 2016). Indeed, the dialogue is the place where the polyphony spreads and we let room to the otherness, the words. From this Bakhtinian point of view, during TBL, the word becomes polyphonic, and, in this polyphony, space opens not only for the search for the most correct answer but also for creativity, for a reconfiguration of what we think and what we know. The concept of text as a "dialogical plot" can be applied as a fabric of voices and as a model of communication between all learning subjects and can shed light on TBL's cognitive processes (D'Acunto, 2016). Furthermore, the Bakhtinian conception of "comprehension" (different from "explanation") as dialogic event where two or more subjects (Ponzio, 2011) are implied, is a crucial interpretative key to the didactic effectiveness of the TBL's dialogicity. Modern neuroscience can help to understand why the Socratic TBL dialogue is so effective in learning. In fact, in the T-Rat the dialogue and the intersubjectivity also stimulate the mirror Neurons, a class of neurons that provides lots of benefits. During the dialogue the activation of neuron mirrors improves the emotions (Gallese, 2009) and the empathy also from a cognitive level involving the cognitive understanding of the other's perspective (Shamay-Tsoory, 2011). The "emotional brain" improves the learning outcomes in an enjoyable way. In more general terms the outcome of the Socratic dialogic didactics is a sort of distributed knowledge based on the neurons of a planetary hyper-cortex. So, the T-Rat dialogue can be seen as a metaphor of the entire world-wide collective intelligence (Bonaiuti, 2017, p. 67). The collective intelligence, understood as the human ability to exchange, build knowledge together also thanks to networks and technologies is a key competence. Therefore, the TBL also becomes a training ground for transversal dialogic and collaborative soft skills, more and more required in university and in Europe (Asquini et al., 2019). Keeping in mind the intrinsic value of the didactic dialogue, in this article through the qualitative analysis of a course of Docimology at University of Foggia (2023-4) we intend to analyze the role of I-Rat and especially of T-Rat to focus on the capabilities

of the dialogue to enhance the learning. The aim of the present study is to understand whether the different forms of dialogue happening during I-rat and T-rat lead to measurable improvement in student performance.

2. Methods

This study, carried out during the Docimology course aimed at first-year Primary Education students at the University of Foggia, investigates the impact of Team-Based Learning (TBL) on student performance through a comparative analysis of scores obtained in individual (I-RAT) and group (T-RAT) tests. The sample consisted of 21 groups, each formed by 5 to 7 students for a total of 145 participants. The groups were formed to maximize the heterogeneity within each group and homogeneity between groups (Dipace et al., *in preparation*). Each group participated in four formative assessment sessions that included individual and group tests; performance was measured using learning analytics collected through Moodle, the University Learning Management System. Data were analysed using descriptive statistical techniques to establish means and standard deviations, and Student's t-test for paired comparisons was used to test the statistical significance of differences between I-RAT and T-RAT scores. For I-RAT scores, the scores of participants to each group were averaged to calculate the aggregate score. Descriptive Analysis: Calculation of averages and standard deviations for I-RAT and T-RAT scores for each session and group. This provides a general overview of the central tendencies and variability of the scores. Student's t-test for paired samples: This test was used to compare the mean I-RAT and T-RAT scores for each group and session. The paired t-test is appropriate as the I-RAT and T-RAT scores come from the same subjects, allowing a direct comparison of their performance before and after the group intervention. Linear mixed model: enriched with interactions between the variables, which will allow us to assess in a more detailed and scientific way the effects over time and between test types (I-RAT and T-RAT). This model will allow us to examine the interactions between session, test type, and time, offering a more precise view of how group and individual work influence each other.

3. Results

Table 1 (Tab.1) indicates the averages and standard deviations for each session and test type (I-RAT and T-RAT).

Test	Average I-RAT1	Std. Dev. I-RAT1	Average T-RAT1	Std. Dev. T-RAT1
Session 1	19.47	4.08	26.22	1.84
Session 2	24.91	3.28	29.30	0.64
Session 3	25.06	2.94	29.31	0.69
Session 4	26.87	3.20	29.65	0.48

Tab.1. Averages and standard deviations for the I-RAT and T-RAT.

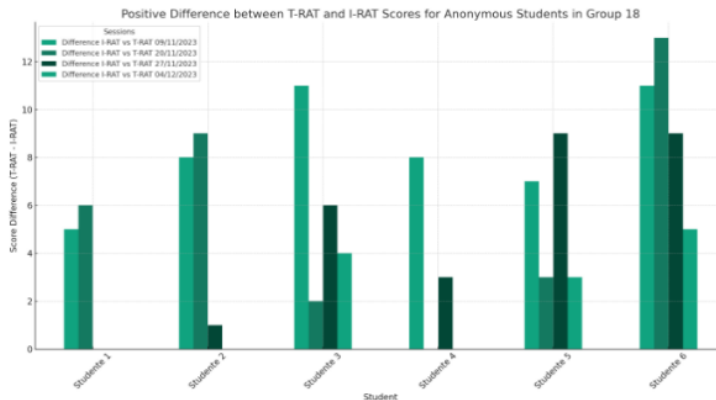
The averages and standard deviations show a consistent difference between I-RAT and T-RAT scores, with group (T-RAT) scores generally higher. When comparing the mean scores of the I-RAT and T-RAT tests for each session, Student's t-test for paired samples was used to test whether the observed differences were statistically significant. The very low p-values (<0.001) indicate that the differences in mean scores between I-RAT and T-RAT are statistically significant for all sessions (Tab.2). This suggests that group work (T-RAT) leads to significantly higher scores than individual tests (I-RAT).

Session	t-Statistic	p-value
1	-20.06	<0.001
2	-15.73	<0.001
3	-16.38	<0.001
4	-10.65	<0.001

Tab.2. Student's t-test for paired samples between I-RAT and T-RAT scores for each session.

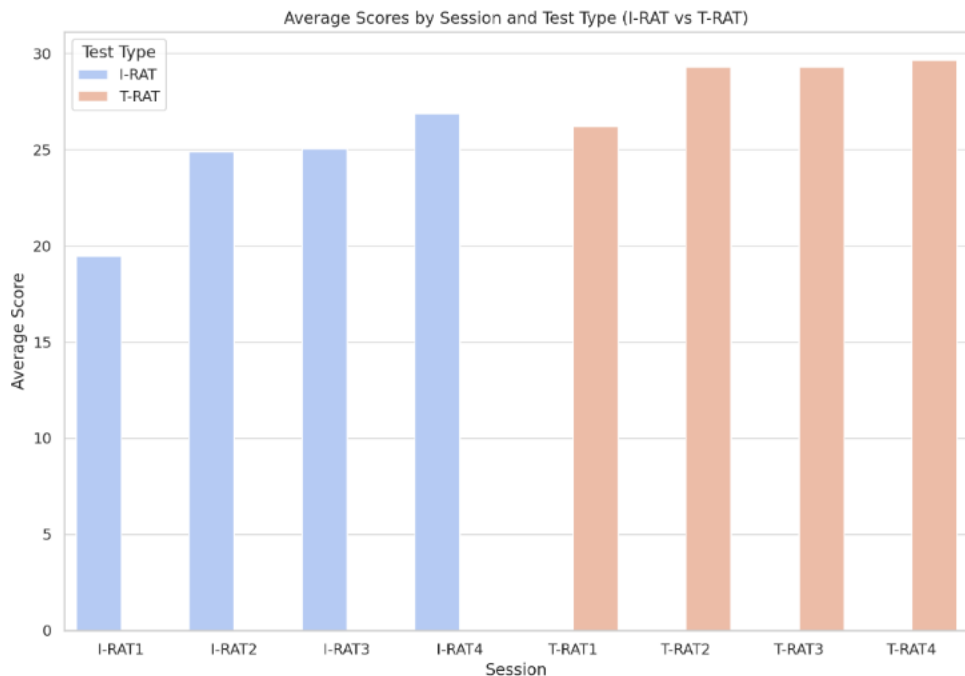
Furthermore, the table shows that I-RAT Scores tend to increase from one session to the next, indicating that individual performance improves over time. Below is a sample graph (Graph. 1) showing the individual student data for one of the 21 groups, showing the difference between the T-RAT and I-RAT scores for each student over the four sessions. Each bar represents one session: a positive value indicates higher score in T-RAT compared to I-RAT, while negative values indicate higher individual than team performance. Only in 15 cases out of 580 comparisons individual students exceeded group scores. Although rare, these cases could be due

to various individual factors such as personal preferences for autonomous learning, differences in individual test-taking skills, or less effective group work in those specific sessions.



Graph. 1. Individual differences in performance between I-RAT and T-RAT scores for students of one sample team.

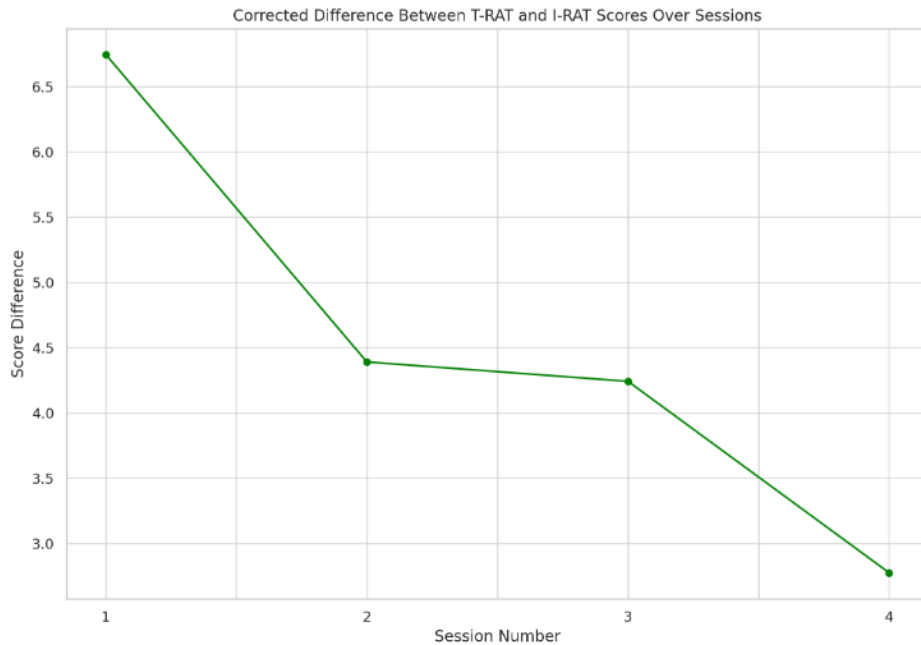
The analysis of the data by means of a linear mixed model enriched with interactions between the variables allowed us to evaluate the effects over time and between test types (I-RAT and T-RAT). This allowed us to examine the interactions between session, test type and time, offering a more precise view of how group and individual work affect each other (Graph. 2).



Graph. 2. Average Scores by Session and Test Type (I-RAT vs T-RAT): Shows the average scores for each test type across sessions, highlighting how T-RAT scores are generally higher than I-RAT scores.

The average base score, or intercept, for the I-RAT in the first session was about 19.47, indicating the starting level of the students in their individual learning. When we compare this with the scores obtained on the T-RAT, we see a significant average increase of about 6.75 points, showing that group work significantly improves performance. Looking at the effects of subsequent sessions on I-RAT, we see a gradual increase in I-RAT scores, with an increase of 5.45 points in the second session, 5.60 points in the third, and a remarkable 7.41 points in the fourth, suggesting a steady improvement in individual learning as the course progresses. These data are further illuminated by the analysis of interactions between session and test type, which shows a decrease in the difference between I-RAT and T-RAT scores in subsequent sessions (Graph. 3): the difference decreases by 2.36 points in the second session, 2.50 points in the third, and 3.97 points in the fourth, confirming that individual learning receives significant impulses from interaction and collaboration in groups. This set of analyses unequivocally demonstrates that T-RAT scores are consistently higher than I-RAT scores, highlighting that group work not only improves immediate performance but also contributes significantly to the

improvement of individual skills over time, supporting the idea that we learn better in groups.



Graph. 3. Evolution of the Difference between I-RAT and T-RAT: Illustrates how the difference between I-RAT and T-RAT scores changes over the course of the sessions. The trend shows a decrease in the difference, suggesting an improvement in individual learning influenced by group learning.

4. Discussion

In this study, we examined individual and team scores in I-RAT and T-RAT over time as an indicator of performance. Individual Readiness Assurance Test (I-RAT) scores are a key measure of students' ability to assimilate study material independently. The steady increase in these scores from session to session not only reflects an improvement in individual readiness but also significantly highlights the positive influence of collaborative learning, a pillar of Team-Based Learning (TBL). Students accumulate knowledge across sessions, and this cumulative effect is amplified by group discussions and exposure to different perspectives during T-RAT sessions. These interactions not only help clarify doubts but also promote a deeper internalisation of the study material, evidenced by improved I-RAT scores.

Repeated testing experience and continuous feedback received during T-RAT sessions help students identify and fill gaps in their knowledge, honing their learning and testing skills. The significant increase in I-RAT scores over time shows the effectiveness of collaborative learning as a tool to improve individual learning. The fact that students also show substantial improvements on individual tests suggests that the skills developed in a collaborative environment transcend the group context, improving each student's ability to function independently. This confirms that collaborative learning in the context of TBL not only enriches the overall educational experience but also has a profound impact on individual learning, reinforcing the argument for integrating collaborative teaching methods into academic curricula by fostering a learning environment that values both interaction and student autonomy. The decrease in the difference between group (T-RAT) and individual (I-RAT) scores observed in the graph across sessions adds another layer of understanding to the effectiveness of collaborative learning in TBL. This trend indicates that not only are individual scores improving, but that the gap between individual and group performance is narrowing. This suggests that the skills and knowledge acquired during group sessions are transferring and improving individual performance over time. This evolution in the difference between scores could reflect how collaborative learning not only facilitates a better understanding of learning material during group sessions, but also continues to positively influence students when they face similar challenges on their own. The ability to reflect on what has been learned in a group, discuss it with peers and then apply it individually is an indicator of deep and lasting learning.

Furthermore, the progressive narrowing of the difference between I-RAT and T-RAT scores could indicate that students are becoming more autonomous in their learning, internalising the problem-solving strategies and techniques discussed and practised in groups. This not only improves their performance on individual tests, but also prepares them to be more effective and independent in their future studies and professional careers.

5. Conclusion

The results of this study not only confirm that, in team-based learning, dialogue between team members can significantly increase student performance; they also indicate that individual performances tend to increase over time, reducing (but not filling) the gap between team and individual results. This highlights the effectiveness of TBL as a methodology able to generate deep and meaningful learning even with many students attending classes, by creating in *mini-agorae*

where students externalize internal dialogue and develop it further with the help of their peers. The results also suggest that this collaborative and Socratic methodology could progressively equip students with strategies and resources to achieve better individual performance, a key indicator of the development of more effective study strategies and metacognitive competence. It would be interesting to further explore which students (for instance, high-performing or lesser-performing students) gain the most benefit from the pairing of individual and group dialogue, whether this gain is sustained over time, and whether it is accompanied by a change in individual preparation and study strategies. In any case, as both schools and higher education institutions are evolving to incorporate learner-centered methodologies in the transition from content-based to competence-based teaching and learning, this study highlights team-based learning as a valuable resource. By building upon the most ancient form of active learning, Socratic dialogue, TBL is poised to become one of the key methodologies to drive education into the future.

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