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Integrating exploration as a learning context impacts feelings of empowerment and engagement

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ABSTRACT

By connecting discoveries in neuroplasticity, neuroevolutionary science, and the role of emotions in learning with a field study, this article investigates the impact of centering exploration as a learning context. Dependent variables in this study, engagement and empowerment, are critically important for learning growth in all types of educational settings. Surveys were conducted in multiple classrooms, across various age groups and content areas, and the impact of students' feelings of empowerment and engagement was measured after teachers integrated exploration as a theme into a unit of study. Humans have a primal emotion of seeking, which helps us stay motivated through challenges and activates our curiosity. This emotion can potentially be piqued by promoting an outlook of exploration, or an "explorer mindset," affecting feelings of self-efficacy and the desire to learn. By comparing pre-and post-survey results after an explorer mindset was integrated into a unit, measures of empowerment and engagement that were initially low had risen. Through qualitative data, the study found that students could articulate the concept of an explorer mindset with evident themes of empowerment and engagement. As empowerment and engagement affect academic achievement, the results of this study are important in educational research.

1. Introduction

1.1. Introduction

For over a decade, Gallup, Inc has been measuring student engagement and hope with results consistently showing that students in the United States become more disengaged throughout school (NCEE, 2022). Demonstrating the significance of this issue, polls have shown that higher student engagement leads to higher academic outcomes (Reckmeyer, 2021). Confirming on a broader scale, analysis of global trends in education confirm that student engagement is an essential measure of student performance, and disengagement is consistently associated with lower test performance (Buchholz et al., 2022a). Consequently, enhancing student engagement is a critical matter to the success of educational methodologies. One of the most widely applied methods is teaching how to use a growth mindset framework while learning. Dr. Carol Dweck was the first to show how people's understanding of neural wiring impacts learning (Dweck et al., 1988). Dr. Dweck found that people who understood their abilities to be malleable were more motivated to persist through challenges. Since then, our understanding of neuroplasticity has grown along with the technological capabilities to observe actual changes in the human brain. Examples include an article in which the MRIs of students with known learning disabilities in math showed new neural connections after tutoring (Luculano et al., 2015). However, does this understanding of neuroplasticity affect engagement and self-efficacy? As highlighted in *Academic Tenacity*, understanding neuroplasticity is a key trait of becoming self-motivated or empowered (Dweck et al., 2014). This was confirmed by a meta-analysis of ten studies, concluding that teaching growth mindset has a positive effect on motivation, achievement, and brain activity (Sarrasin et al., 2015). However, the process of teaching students how the human brain works as well as creating school and classroom circumstances based on neuroscience is a growing and complex process. Genetics, physical and social conditions, individual stressors and traumas, as well as varying individual coping mechanisms, all impact how constructive or destructive learning challenges can be (Goldberg, 2022). While teaching about neuroplasticity has been an important additional strategy over the past two decades, other research in cognitive science has uncovered more layers in how educators can help create conditions that foster feelings of engagement and

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empowerment.

1.2. Background studies

It is further known that learning is not a purely academic but also an emotional process; in fact, emotions and higher-order thinking are integrally linked and interdependent processes (Immordino-Yang, 2016). If the role of students' emotions in the learning process is undervalued, it is difficult to encourage motivation and maximize the number of developed neural connections that lead to higher-order thinking skills, deep learning, and real-world transfer of content.

> *…The aspects of cognition that are recruited most heavily in education, including learning, attention, memory, decision-making, motivation and social functioning, are both profoundly affected by emotion and in fact subsumed within the processes of emotion…Yes, rational thought and local reasoning do exist, although hardly ever truly devoid of emotion, but they cannot be recruited appropriately and usefully into the real world without emotion. (Immordino-Yang, 2016, page 37)*

Learning, creativity, memory and decision-making are all processes of "emotional thought" that overlap between cognition and emotion (Immordino-Yang et al., 2016). Educators can connect to emotions in a variety of ways including through students' interests, background knowledge, and experiences, and by nurturing interpersonal relationships. However, a novel approach tested in this study is igniting a primal human emotion through curriculum and instruction.

In *Archaeology of Mind*, Panskepp and Biven (2012) identify seven emotional systems that originate in the mammalian tier of the brain, having similarities across all mammalian species: seeking (expectancy), care (nurturance), play (social joy), lust (sexual excitement), fear (anxiety), grief (sadness), and rage (anger). These primary emotions, woven into the brain by evolution, are not the only sources of feelings; while others develop in conjunction with higher-order thinking, these primary emotions are our oldest, most foundational. Our older, more primal part of the brain, our affective consciousness, controls global states of the brain. If something is wrong or right with our emotions, it has a profound effect on how or what we are able to process with higher-order thinking.

> *The SEEKING, or expectancy system is characterized by a persistent exploratory inquisitiveness…This system holds a special place among emotional systems, because to some extent it plays a dynamic supporting role for all other emotions. When in the service of positive emotions, the SEEKING system engenders a sense of purpose, accompanied by feelings of interest ranging to euphoria…We seek many things and in many ways, as this system guides diverse kinds of anticipatory learning… When the SEEKING system is aroused, animals exhibit an intense, enthused curiosity about the world. (*Panksepp & Biven, 2012*, page 34)*

1.3. Theory

What would happen if we designed systems in learning to harness this primal emotion? In 2016, the concept of an "explorer" mindset was initially shared in the K-12 teaching and learning community by National Geographic Education as a framework for learning like a National Geographic explorer. The framework was created by a group of child development experts, educators, and explorers; and it was meant to translate the attitudes and skills explorers use in the field to a K-12 continuum. While the framework has been widely implemented by teachers, there have been no published connections tying the outlook of an explorer mindset to educational neuroscience prior to this article. There is, however, a study that links the act of exploration to growing neural connections and asserts that geoscientists and professionals involved in exploratory activity can leverage this empowering capability (Dell'Aversana, 2017). Therefore, this study presents the first analysis of how an outlook of seeking and exploration, when used in a unit with students, connects to neuroevolutionary science and the important role of emotions in learning while also presenting results from an introductory field test among students in grades 3–12.

To promote experience-dependent neuroplasticity, students need to be active participants in the learning process (Goldberg, 2022). Adopting the perspective of an explorer or pathfinder in their own learning can cultivate a sense of self-efficacy and agency. A related concept was examined, revealing that an inquiry-discovery framework enhanced higher-order thinking skills and scientific literacy, employing a mixed-methods approach (Wartono et al., 2018).

2. Conceptual framework and research question

In a convergent mixed-methods design, this field study investigates the impact of an explorer mindset on participants' feelings of empowerment and engagement through pre- and post-surveys when an outlook of exploration is integrated into a unit through supportive discussion (Fig. 1). Further, open-ended responses are examined for themes to determine if students were able to internalize and apply an outlook of exploration in their studies, corroborating or contradicting the quantitative data. A mixed-methods approach is used in educational research when the complexity of the research question can't be best understood with exclusively quantitative or qualitative measures (Ponce et al., 2015), such as exists with the challenge of this study, capturing students' subjective attitudes and perceptions. Following mixed methods guidelines (Leech et al., 2010), the strategy of a mixture of Likert scale closed-ended (quantitative) and open-ended (qualitative) questions was selected, followed by steps of data reduction, display, transformation, comparison and integration.

Engagement can involve cognitive, emotional and behavioral variables and has been defined in several ways (Ali et al., 2018). Because this study acknowledges the foundational human emotion of seeking as a contextual factor, the definition of engagement best aligned is "A condition of emotional, social, and intellectual readiness to learn characterized by curiosity, participation, and the drive to learn more" (Abla et al., 2019). Student empowerment is a process in which students gain intrapersonal, interactional, and behavioral outcomes including: impact (voice), competence, meaningfulness, and choice or self-determination (Kirk et al., 2016).

3. Material and methods

3.1. Overview

This study analyzes the impact of using an explorer mindset (the independent variable) on students' feelings of empowerment and engagement (dependent variables) in learning. In the protocol, teachers were asked to integrate a theme of exploration via an explorer mindset into an existing unit that they were teaching, either in a formal or informal setting. Formal settings included traditional public or private classrooms and informal settings included after-school clubs. The effectiveness of this approach was measured using quantitative and qualitative analyses of engagement and empowerment. A pre- and post-survey was administered to provide a quantitative comparison, and an open-ended response form, delivered through an app, was used to gather more detail on how students interpreted and internalized a mindset of exploration into the various educational contexts that teachers chose. To ensure equitable access to information and create as uniform a

Fig. 1. A visual of the research question and conceptual framework.

procedure as possible, given the wide reach of the age levels, content areas, and geographies of the participants, all teachers were given the same resources. Care was taken to provide sufficient background information so that even teachers who had never heard of using exploration or an explorer mindset as a learning context could appropriately integrate it into the content area they were teaching, according to grade level and instructional context.

3.2. Participants

Teachers participating in the study were recruited between June and August 2021, through posts on social media, specifically Twitter and Facebook. On Facebook, the posts were made on two National Geographic Education community pages: the "National Geographic Education - Explorer Mindset" group and the "Nat Geo Ed/GT Fellows… Further" group. On Twitter, posts were made from the author's Twitter account, which was used for education-related networking. During the promotion on social media, 37 teachers expressed an interest in participating in the academic study and received follow-up information. Previous knowledge of using a mindset of exploration in learning was not a requirement; however, most teachers had some familiarity with what an explorer mindset is through general resources available on National Geographic Education's website because of the social media networks used for recruitment. The inclusion criteria consisted of any teacher of students in grades 3–12 in a formal or informal setting, completion of informed consent and cooperating institution forms, completion of baseline and post-surveys, and a professional agreement of discretion to integrate the provided resources into instruction, as appropriate. A total of 20 teachers began to participate, with 14 completing all the required steps of the study, and one serving as a control group. The teacher serving as the control taught the same content area as one of the participant teachers, teaching the same curriculum. The exclusion criteria included failure to complete the required teacher or student informed consent or cooperating institution forms, no post-survey results, or an evident lack of following study procedures. In alignment with considerations of developmental appropriateness, third-grade participants were exempted from the requirement to provide open-ended responses, however, the pre- and post- survey was required. Additionally, students participating from Tanzania were exempted from open-ended responses and the pre- and post-survey was translated into Kiswahili. Student participation was anonymous, and no identifying information was collected, including name, age, race, ethnicity, sex or gender identity. However, given that participating teachers instructed grade levels 3–12, the approximate age of students ranged from 8 to 18 years (Table 1).

Table 1
Demographic information of participating teachers and students.

Experimental Group				
Country	Number of teachers	Number of students	Subject area/s	Formal or informal education
India	1	6	Conservation	Informal
Tanzania	1	24	General studies	Formal
Canada	1	24	General studies	Formal
United States	11	444	Science, Spanish, World Religions, Geography, General studies, Gifted and Talented	Formal
Total	**14**	**498**		
Control Group				
United States	1	87	Science	Formal

3.3. Ethical clearance

A full ethics board review of *Evaluation of the Impact of an Explorer Mindset on Student Feelings of Empowerment in the Learning Process, Protocol #21-SPG-12* was conducted through the University of Wisconsin Green Bay. IRB approval was granted in April of 2021.

3.4. Procedure

After the recruitment of interested teachers, an introductory webinar that detailed the study procedure was provided (and recorded). The webinar and all the materials and resources were provided online and linked on a password-protected portal. Upon completion of informed consent and cooperating institution forms, teachers agreeing to participate in the study followed the protocol described by Table 2:

Table 2
Protocol Followed by Teachers.

Step	Task
1	Submit a declaration to integrate an explorer mindset into an existing three to nine-week unit
2	Use a provided anonymous and numerical pre-survey to gather baseline data on student feelings of empowerment and engagement
3	Using resources provided (further described in Table 3), teach what an explorer mindset is and provide an opportunity for students to reflect on what it means to themselves
4	Support a culture of seeking and exploration during the unit through periodic class discussions, following the template provided as described in Table 3
5	Complete the provided anonymous and numerical student post-survey. Pre- and post-student survey results comparison was the source for the quantitative data. The same survey questions were used for the pre- and post-surveys to detect changes in overall student perception for each question.

Table 3
Resources provided for the field study.

Name of Resource	Description
Why an Explorer Mindset? (reading)	Provided for teachers to offer background knowledge on the role of emotions in learning, as well as the connection between an explorer mindset and the seeking emotion.
Pre and Post Survey	Provided in an online format or a paper format.
Explorer Mindset Study App	Used to teach students what an explorer mindset is, and was the source of the qualitative data.
Learning Wildly Booklet and Videos	This narratively written booklet provided an alternative to introducing an explorer mindset if technology was not preferred or available. or as a supplemental resource by teachers.
Discussion Prompts	Provided to support class discussions as students applied a mindset of exploration in class.

To provide a universal resource for students to be introduced to using a mindset of exploration in learning, the Explorer Mindset Study App was created between October 2020 and June 2021 (Table 3). The app contained videos teaching students "What is an Explorer Mindset?" and videos on "Curiosity," "Responsibility," and "Empowerment" as well as a way for students to put "learning like an explorer" into their own words, as they completed the statements, "To me an explorer mindset means…" and "When I think of myself as an explorer, I am empowered because…" The app was structured as an interactive digital form, enabling students to enter their responses and subsequently save the document in PDF format upon completion, as well as send it to their teachers. To prevent limitations of participation based on access, the app was provided free for participants to use during the study. After the completion of the study in each participating classroom, these open-ended responses were collected from the study participants anonymously as qualitative data, and analyzed for themes (Table 3).

Participating teachers were also asked to submit their own post-study survey, which required them to reflect on the procedure. Oftentimes in the process of implementing units, the best-laid plans need to be adjusted. This information helped determine the extent to which teachers integrated the provided resources and followed the procedure step of supporting the theme of exploration through class discussions throughout the unit, and whether or not teachers adhered to the guidelines of the following protocol: (1) Conducting the pre-survey (2) Introducing an Explorer Mindset through the Explorer Mindset Study App or Learning Wildly booklet (3) Integrated discussion prompts periodically throughout the unit (4) Conducing the post-survey. The control group classroom teacher taught at the same school as one of the experimental groups using the same curriculum and administered the pre and post-survey at the same time as the corresponding experimental group without integrating an explorer mindset or supporting an outlook of exploration with class discussions.

3.5. Data collection

Two types of data were gathered in the study: quantitative data from the pre- and post-student surveys and qualitative data in the form of open-ended student responses from the app. The quantitative data were anonymous and gathered by classroom. This process ensured that if a teacher did not fulfill the entire procedure, their classroom's data could be removed. Throughout the duration of the study, from September 2021 to April 2022, responses were gathered both in online form (represented by the example, Fig. 2) and paper form (example, Fig. 3), depending on the needs of the classroom. Figs. 2 and 3 show how both the online and paper forms gathered a quantitative response from a student prompt.

After the quantitative survey responses were finalized, they were entered on a spreadsheet labeled by classroom, anonymously coded (T1, T2, …), and the average of each of the ten pre- and post-survey responses was recorded. Due to their anonymity, survey responses could not be compared to check for impact at the individual level, thus the comparison was made only between the average of each pre- and post-survey question before and after the intervention.

The responses to the two open-ended prompts from the Explorer Mindset Study App ("To me an Explorer Mindset"…and "When I think of myself as an explorer, I feel empowered because…") were gathered from a password-protected website database held on a dedicated server between October and December 2022. These responses were captured individually and anonymously entered on a spreadsheet, serving as a means to dig deeper into how students internalize and articulate using a mindset of exploration in learning and confirm or deny the presence of themes relating to engagement and empowerment. Student responses varied in length from just a few words to one, two or three sentences. Qualitative data from the school-based control group was not collected.

3.6. Data analysis

Quantitative results of all valid pre- and post-survey responses were aggregated in July 2022 to compare, from all the 498 participating students in the experimental group, how responses changed, if at all, on each prompt, from before and after their teacher's intervention. The following analyses were completed to understand the findings (Table 4).

Qualitative survey responses were compiled in December 2022 following mixed-methods content analysis guidelines. Responses were

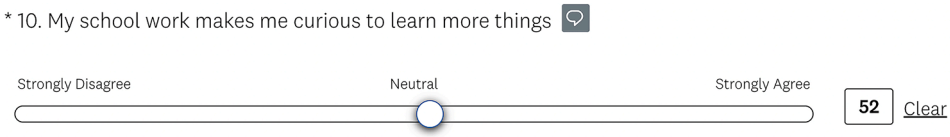

Fig. 2. An example of a question from the pre- and post-survey in electronic form.

Fig. 3. An example of a question from the pre- and post-survey in paper form.

Table 4
Quantitative Analysis Summary.

Analysis	Description
Instrument reliability and validity	Cronbach's alpha and exploratory factor analysis
Aggregated pre- and post-survey violin plots	Median, interquartile range, and distribution of responses allows for examining changes and presents a broad picture of the results
United States data	The majority of participants were from the US and this presents a look at how those students were impacted
Age group comparison	Provides further detail on the number of participants in each grade band, and how those students were impacted. To analyze the data equally across 3–5, 6–8 and 9–12 grade bands that had varying numbers of participants, weighted mean was used, comparing results from 84 students at the elementary level, 313 at middle school level and 101 at the high school level.
School-based experimental and control group comparison	Highlights a specific opportunity in the study where two teachers in the same school teaching the same content were able to provide an experimental and control group comparison. Mean, descriptive statistics and ANCOVA were used to analyze the differences in the two groups.

tagged for common themes, coded, and displayed using NVIVO software using the following steps:

1. Responses were exported on a csv file and identifying information user information was deleted
2. Responses were imported into NVIVO, coded and themed using the aforementioned definitions of empowerment and engagement.
   a. "Engagement" codes were created according to related concepts of discovery, desire to learn, curiosity and pursuing interests under the topic of engagement (as per the study definition).
   b. Codes for "empowerment" were categorized as problem-solving and "thinking outside the box", adventurousness, risk-taking and goal setting, perseverance and displaying a growth mindset, and leadership, responsibility and taking action on issues.
   c. Responses were also tagged (coded) for vagueness, being off-topic or displaying disengagement under "Undeterminable"
3. After coding, responses were sorted into themes of "engagement", "empowerment" and "undeterminable".
4. Displays of the coded and themed data were created for data transformation, comparison and integration.

4. Results

4.1. Instrument reliability and validity

To assess the internal consistency of the survey instrument used in this study, Cronbach's alpha was calculated using the pre-survey (baseline) data. The pre-survey consisted of ten items designed to measure students' feelings of empowerment and engagement in learning. Each item was rated on a scale, and the responses were analyzed to determine the reliability of the survey. The analysis yielded a Cronbach's alpha of approximately 0.839, indicating good internal consistency. This high value suggests that the survey items are highly correlated and measure the same underlying constructs of empowerment and engagement effectively.

To further validate the survey instrument, an exploratory factor analysis (EFA) was conducted to identify the underlying constructs measured by the survey items. The survey items were categorized into two constructs based on their intended measurements: empowerment and engagement. Specifically, questions A, C, D, E, G, and H were designed to measure empowerment, while questions B, F, I, and J were intended to measure engagement.

The factor analysis yielded the following findings:

- **Empowerment Factor Loadings:**
  - An Explorer Mindset helps me feel proud of my ability to learn: −0.634
  - An Explorer Mindset helps me continue to try, even when a class activity is difficult: −0.601
  - I think anyone can do well in school: −0.429
  - An Explorer Mindset helps me feel that I can make a positive difference in the world: −0.789
  - I am good at solving problems: −0.381
  - I can overcome challenges: −0.502
- **Engagement Factor Loadings:**
  - An Explorer Mindset helps me feel excited to learn new things in school: −0.556
  - I want to learn new things: −0.606
  - I am motivated by my desire to learn: −0.806
  - My schoolwork makes me curious to learn more things: −0.744

The factor loadings indicate that the survey items load strongly onto their respective factors, confirming the survey's validity. Items designed to measure empowerment showed strong loadings on the Empowerment factor, while items designed to measure engagement showed strong loadings on the Engagement factor.

These results, along with the high Cronbach's alpha, support the reliability and validity of the survey instrument, confirming that it effectively measures the constructs of empowerment and engagement in the context of integrating an explorer mindset into the learning process.

4.2. Aggregated Pre- and post-survey analysis

Quantitative results from the aggregated student pre- and post-survey responses show how the 498 students felt about 10 prompts measuring empowerment and engagement before and after their teacher introduced and integrated an explorer mindset into a unit. The results include responses from 3 to 12th grade students in varying content areas and time durations for the chosen units. The shortest unit where exploration was integrated was taught during three weeks, while the longest, 12 weeks. Fig. 4 and its corresponding legend show the overall change in the 498 student responses from pre- to post-intervention. The data visualization in the figure was created by Dr. Daniel Dick, using *R* version 4.2.1 with *ggplot2, viridis*, and *hrbrthemes* packages.

Observations we can draw from overall patterns in the quantitative data include:

- Students were already very confident in a couple of their answers before the intervention. Most of them already believed anyone could do well in school (D), that they wanted to learn new things (F), and they can overcome challenges (H). These areas showed little change.
- On prompts where students felt less confident, as evidenced by lower median response values, their confidence increased after the intervention.
- Questions measuring empowerment or self-efficacy (A, C, D, E, G, H) had a slightly more pronounced change than questions measuring engagement (B, F, I, J)

4.3. United states data

The majority of the study participants were from the United States, totaling 444 out of 498 participants. Therefore, it is essential to examine the impact of the intervention on US students. The data indicates a positive effect of the intervention with the empowerment average increasing by 3.64 points and the engagement average increasing by 3.33 points. Given that a significant portion of the study participants

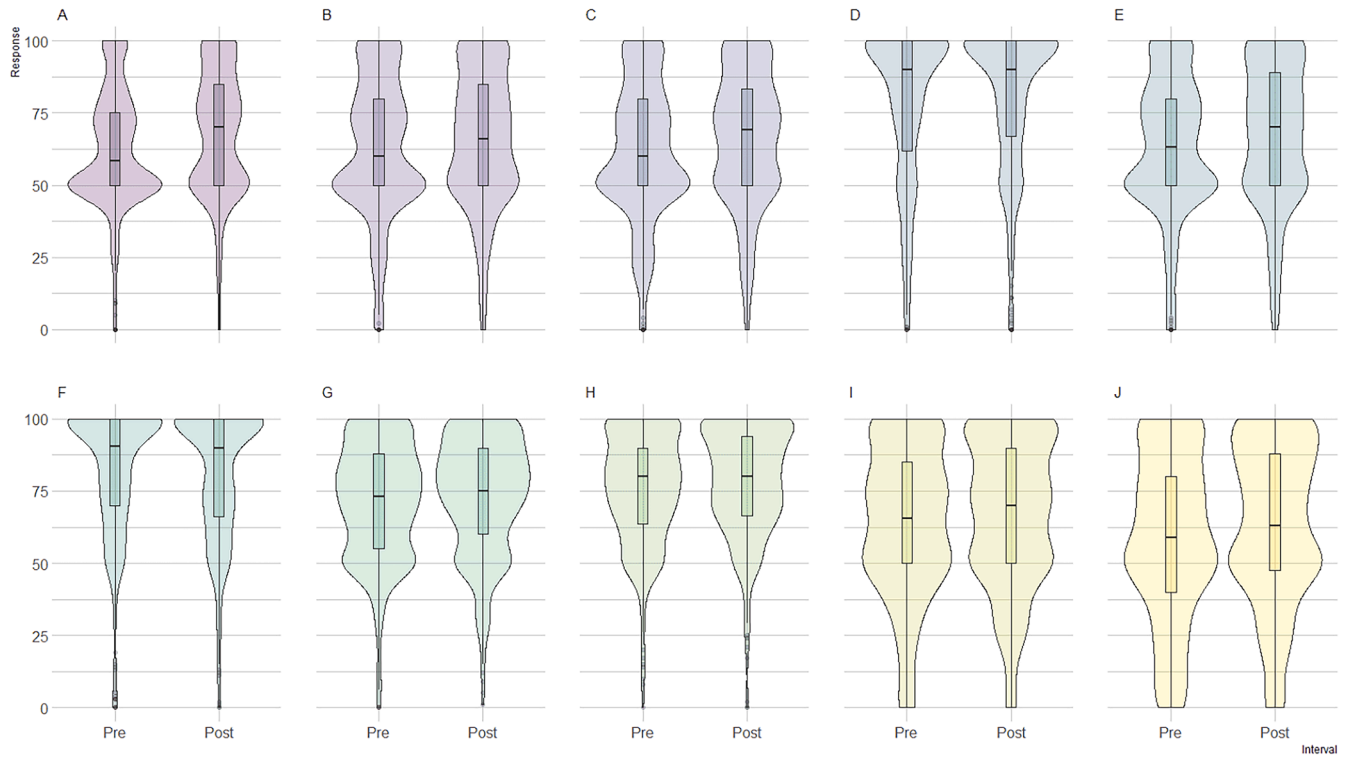

Fig. 4. Violin-and-box plots comparing pre-and post-survey results before and after an explorer mindset was integrated.
A: An Explorer Mindset helps me feel proud of my ability to learn. B: An Explorer Mindset helps me feel excited to learn new things. C: An Explorer Mindset helps me continue to try, even when a class activity is difficult. D: I think anyone can do well in school. E: An Explorer Mindset helps me feel that I can make a positive difference in the world. F: I want to learn new things. G: I am good at solving problems. H: I can overcome challenges. I: I am motivated by my desire to learn. J: My schoolwork makes me curious to learn more things.

Table 5
Changes in empowerment and engagement averages of US participants.

Empowerment			Engagement		
Pre	Post	Δ	Pre	Post	Δ
66.26	69.90	3.64	64.47	67.80	3.33

were from the United States, the overall trends observed in the entire dataset are likely influenced by the US data. However, isolating and analyzing the US data provides a clearer picture of the intervention's impact on this specific group (Table 5).

4.4. Age group distribution

The categorization of students into grade levels, specifically as "elementary, middle, and high school," may exhibit regional or local variations. For the purposes of this paper, however, grades are identified as the following: 3–5 elementary, 6–8 middle and 9–12 high school. Under this classification schema, it is noteworthy that a greater number of participants were drawn from the middle school segment in comparison to other age groups. The distribution of participants among these grade bands was as follows: 84 participants in grades 3–5 (elementary), 313 participants in grades 6–8 (middle), and 101 participants in grades 9–12 (high school). The data shows that the intervention had a positive impact on students' feelings of empowerment and engagement across different age groups, with a comparable influence observed in middle and high school levels and the most pronounced effect in elementary students (Table 6 and Fig. 5).

Table 6
Change in feelings of empowerment and engagement across age groups.

	Empowerment			Engagement		
	Pre	Post	Δ	Pre	Post	Δ
Elementary	77.42	84.51	7.09	77.47	85.82	8.35
Middle	68.02	70.72	2.70	64.02	66.10	2.08
High school	67.97	70.03	2.06	64.34	67.71	3.37

4.5. School-based experimental and control group comparison

One ninth-grade teacher from the United States participating in the study partnered with another teacher at the same school to act as a control group. This provided a unique opportunity as a subset of the broader study. While the experimental group followed the full procedure described in Table 2, the control group only completed steps 2 and 5, the pre-survey and post-survey. The teachers taught the same age students, same content area (science) and the same unit, with the same curriculum as well as a similar number of students (81 in the experimental group and 87 in the control group). The only difference was the interventions of the teacher in the experimental group completing all the steps described in Table 2. Responses measuring engagement (B, F, I, J) rose from an average of 62 to 63.8, and questions measuring empowerment (A, C, D, E, G, H) rose from 66.3 to 67.5 from pre-to post-survey in the experimental group (Fig. 6). In the control group engagement responses lowered from 64.8 to 60.5, and empowerment from 71.3 to 67.5. While the change in the school-based experimental group was less than the overall US data, the results show that in a distinct school setting where teachers are teaching the same grade level of students and same curriculum, the intervention made a positive impact.

The descriptive statistics showed that the baseline scores for the intervention group (Mean = 64.60, SD = 10.47) were slightly lower than those for the control group (Mean = 68.59, SD = 7.38). Post-intervention scores for the intervention group improved (Mean = 66.00, SD = 7.32), while those for the control group decreased (Mean =

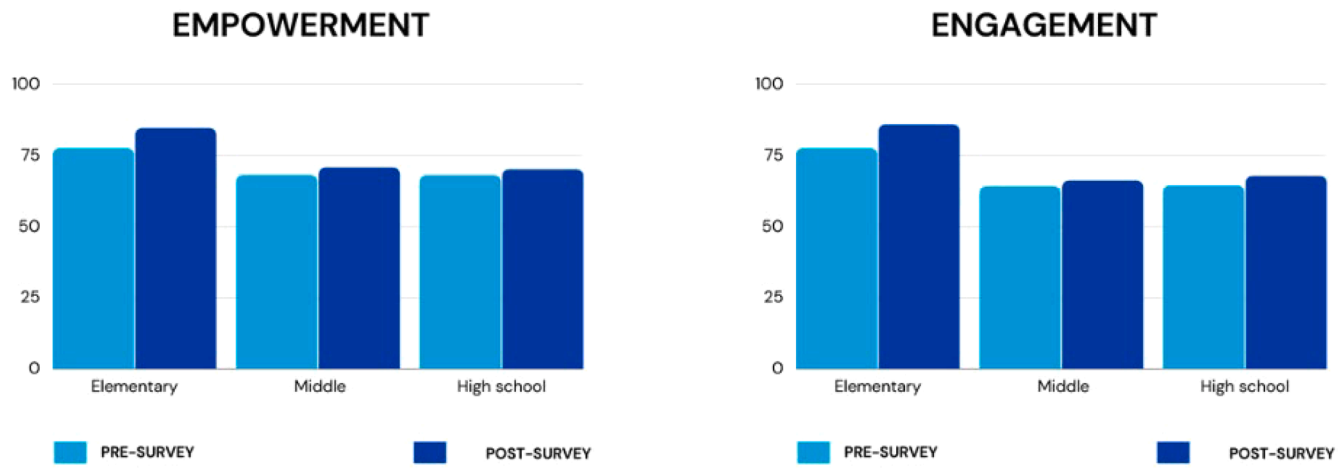

Fig. 5. A comparison of pre- and post-survey data across age groupings.

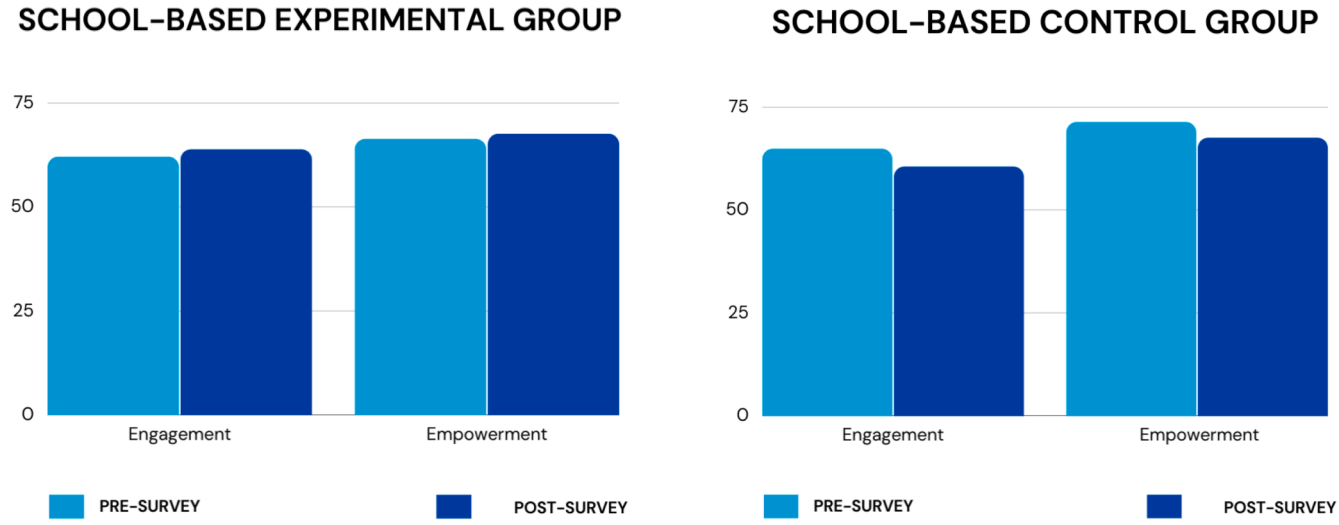

Fig. 6. A comparison of pre- and post-survey data between the experimental and control groups.

64.58, SD = 5.75) (Table 7).

An ANCOVA was conducted to compare the post-test scores between the intervention and control groups, with baseline scores as a covariate, however, aggregated data from the two classrooms were used while accounting for sample size. The analysis revealed a significant effect of the intervention on post-test scores ($F = 19.23, <0.001$), indicating that the explorer mindset intervention significantly improved student outcomes. Additionally, baseline scores were a significant covariate ($F = 161.47, <0.001$), emphasizing the importance of initial student performance in determining post-test results (Table 8).

Table 7
Comparison of Mean Baseline and Post-Intervention Scores for School-Based Experimental and Control Groups.

Group	Mean Baseline (SD)	Mean Post (SD)
School-based experimental	64.60 (10.47)	66.00 (7.32)
School-based control	68.59 (7.38)	64.58 (5.75)

Table 8
ANCOVA Results for Post-Test Scores with Baseline Scores as Covariate.

Source	Sum of Squares	df	F	p-value
Group	90.06	1	19.23	0.0003
Baseline	756.41	1	161.47	< 0.0001
Residual	89.01	19		

The findings suggest that integrating an explorer mindset into the curriculum positively impacts student engagement and empowerment, as evidenced by the improvement in post-test scores for the intervention group. These results support further research into the efficacy of the explorer mindset as a valuable educational intervention.

4.6. *Open-ended response, "To me an explorer mindset…"*

A total of 57 students who either belong to the exempted 3rd grade age group or participated in Tanzania do not have contributing data to this section. Open-ended responses to the prompt "To me an Explorer Mindset…" were examined for themes in self-efficacy, self-determination, and empowerment in one category (299 total references) and themes of motivation in learning and general engagement in learning in another category (252 total references), as evidenced by Fig. 7. This was done to determine how students applied the idea of using a mindset of exploration in learning. Some responses (99 in total) made references that fell into both categories. A total of 46 responses were too vague to be able to be categorized, presumably because the student was disengaged from or did not understand the activity. Phrases within responses that share similar meanings were categorized into sub-themes, which are subsequently organized into broader themes according to the study definitions of engagement and empowerment. This approach closely aligns with the process utilized in prior research studies (Curelaru et al.,

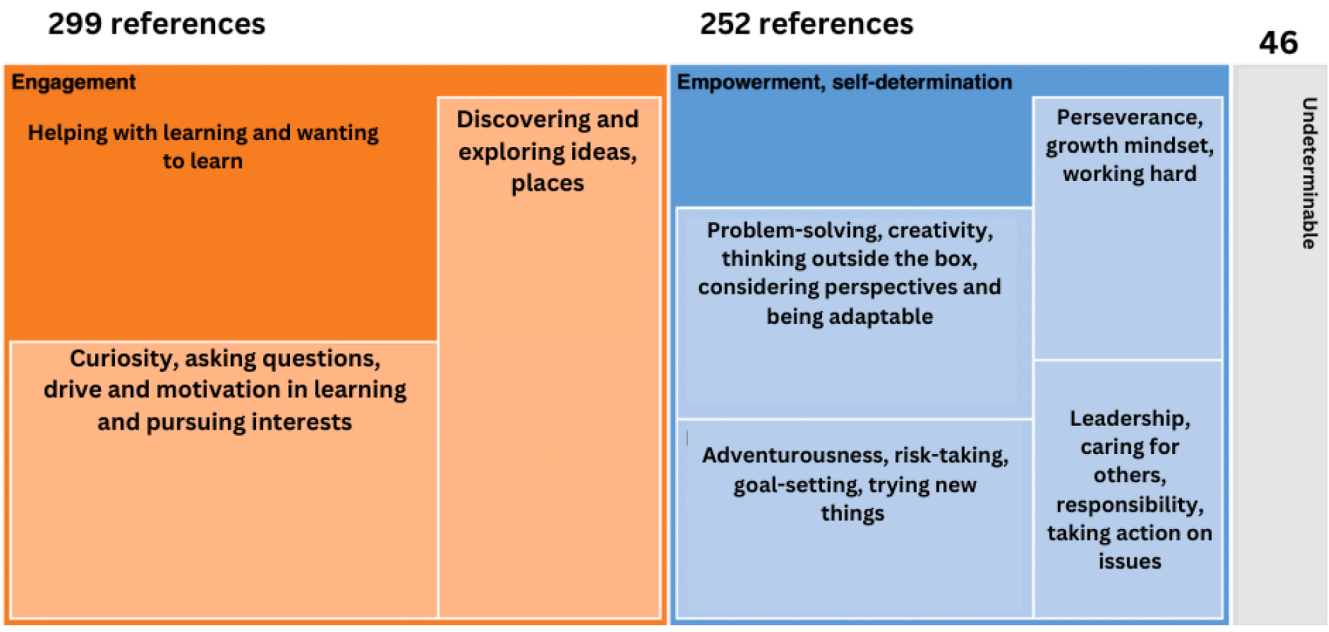

Fig. 7. Themes of empowerment and engagement that emerged from the open-ended prompt "To me an explorer mindset…".

2022). To further support and elucidate the study's results, it relies on the inclusion of illustrative quotations, in alignment with the approach detailed in other work analyzing open-ended responses (Fig. 7, Tort--Nasarre et al., 2023).

Examples of responses to the prompt generally categorized as engagement include:

- "Is a new way of thinking. Instead of 'going through the motions' with schoolwork and classes, you need to look deeper and find your interest in a topic that you haven't even discovered yet." (high school)
- "Is when you have an open mind to discovery. You are curious and willing to learn." (elementary)
- "Is a different way of learning where you explore what you want to learn, not just being told what to learn." (elementary)
- "is a different way of learning where you explore what you want to learn, not just being told what to learn." (middle)
- "Being able to make my own connections on the material that we're learning." (high school)

Examples of responses generally categorized as empowerment include:

- "Is thinking outside the box, being a great problem solver, doing your best, and chasing your dreams". (middle)
- "Is stepping out of your comfort zone" (high school)
- "To experiment and try new things, even if it might seem scary" (middle)
- "Being able to try your hardest, finding things that you need, and being able to work hard to achieve a goal" (middle)
- "Means to look at a problem and say I can do this" (elementary)

Examples of responses having elements of both categories include:

- "Is focusing on what you are exploring, not thinking 'I can't do this, this is impossible'; instead, thinking and wondering about whatever it is you are exploring." (middle)
- "Is being able to learn, being able to share your ideas and put yourself out there, and finding what interests you and exploring it." (middle)
- "Means that you think out of the box when discussing an issue or problem. When you have an explorer mindset, you look for curiosity, you look for ways to solve problems that are out of the ordinary." (high school)

Through the transformed qualitative data, it is observed that 92% of students articulated a positive association with "To me an explorer mindset means…". When comparing Fig. 5 with the pre- and post-survey quantitative data in Fig. 4, we can observe that as a whole group, there was a generally positive impact of the actions followed by teachers as displayed in Table 2. This is further supported by the comparison of the experimental and control group as described in Fig. 6.

4.7. Open-ended response, "When i think of myself as an explorer, i am empowered because…"

The purpose of analyzing this response was to determine if thinking like an explorer affected students' feelings of empowerment and engagement and if students could effectively internalize those feelings when in a classroom setting.

This open-ended prompt was a leading question, guiding students to think of how they relate exploration to self-efficacy or self-determination. Fig. 9 shows that students made 156 references tying feelings of empowerment from exploration to *curiosity, gaining knowledge, or a desire to learn*. This implies that, for students who made those references, thinking of themselves as explorers, it was the desire to learn that made them feel empowered. There were 323 references (shown in Fig. 8) to *reaching goals, leadership, awareness of strengths, and other themes* of self-determination and self-efficacy. In these cases, it was the act of doing, striving for goals, leading, making a difference, that makes one feel empowered. Few responses to this prompt (only 6) made references that fell in both categories.

Examples of responses in the category of engagement include:

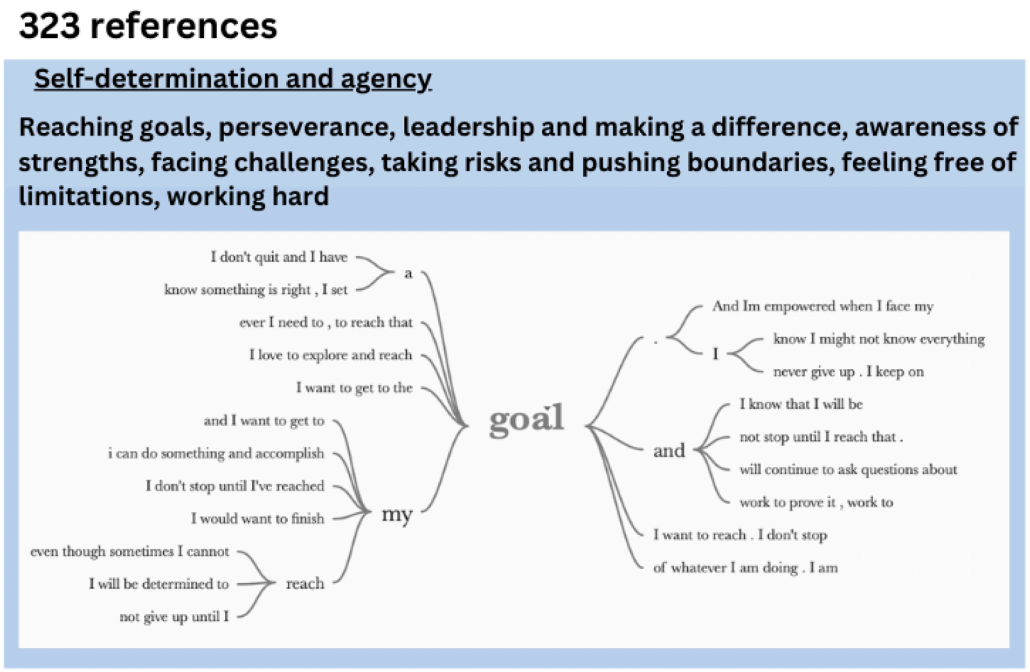

Fig. 8. Word tree showing associated feelings of empowerment from exploration with references to self-determination and agency.

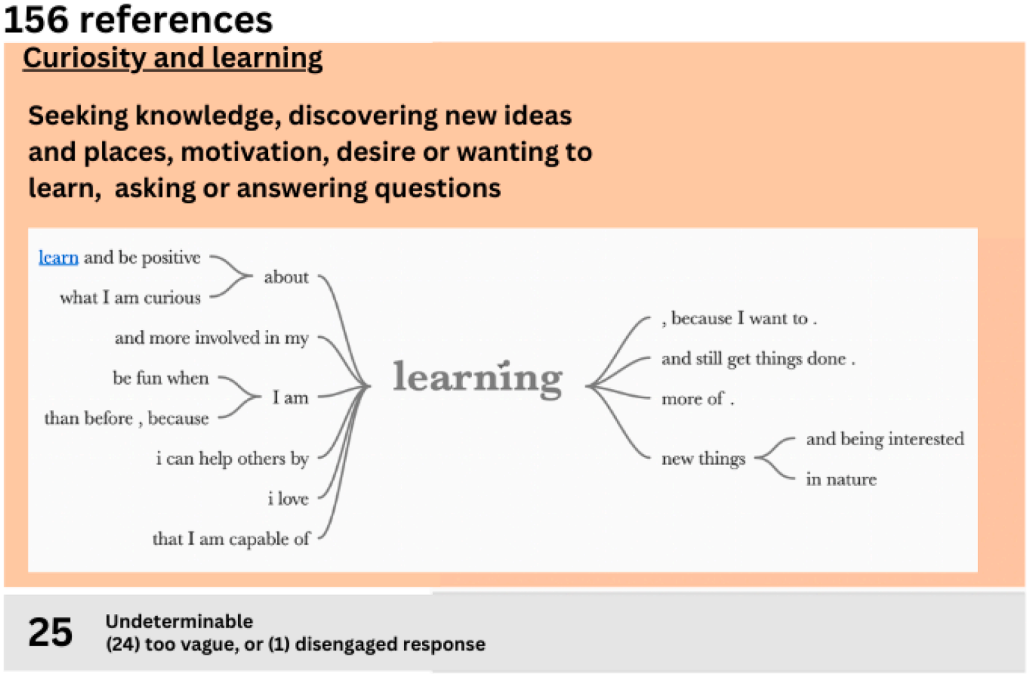

Fig. 9. Word tree showing feelings of empowerment from exploration that connect to the motivation to learn. Some students' responses were too vague or indicated a disengaged response.

- "I want to learn." (multiple times in elementary, middle, and high school)
- "I am curious and want to learn new things." (found in multiple statements in middle and high school)
- "Everything is interesting to me." (middle)
- "It makes me feel like I can learn at a higher level and I feel more motivated." (high school)
- "I want to answer a question." (elementary)

Examples of responses in the category of empowerment include:

- "I can take action and make a change. I also am empowered to use my talents to reach goals and solve problems." (elementary)
- "I can use my talents and attitudes in order to be successful in challenges." (high school)
- "I can do things I never thought I could do before." (middle)
- "I know I am in charge of my own journey." (high school)
- "I can overcome challenges and reach the goals I've wanted to reach." (middle)

Examples of responses making connections to both categories include:

- "I can ask the questions and look for the solutions no one else is willing to." (high school)
- "I know however small, I can use my curiosity to make a difference. I can take action and make a change. I also am empowered to use my talents to reach goals and solve problems." (elementary)
- "Trying new things, taking risks, and finding out my skills and abilities by being adventurous and curious." (middle)
- "I can learn whatever I want to and power through every obstacle." (high school)

As previously stated, the rationale behind organizing this question into themes of empowerment and engagement was to look for the presence of each in student self-perceptions. As responses show, the desire to learn is important to feelings of empowerment in this open-ended prompt. Likewise, one can argue that students need to feel a sense of self-efficacy in order to want to learn. When comparing this transformed qualitative data to the quantitative data, we can note that 95% of students were able to describe how an explorer mindset can help them feel empowered, which correlates with the growth in positive responses shown in measures of empowerment, comparisons A, C, D, E, G, H on Fig. 3.

5. Discussion

5.1. Critical reflection about the use of the term "explorer"

When considering the overall picture of both the quantitative and qualitative results, they reveal that students can feel positively impacted by using a context of exploration. Had this study been centered exclusively on quantitative data, however, an important question might have been missed: What about the 46 undeterminable responses to question one and the 25 to question 2? These results show that there were students the intervention did not reach. Determining the reasons for this goes beyond the scope of this basic introductory study. There is one potential issue, however, that is worth bringing forward into future discussions and research on the topic: the historical use of the word "explorer."

In educational resources, "explorer" has been used to gloss over the harmful actions of capitalists who were seeking to exploit resources rather than simply understand areas of the world that were new to that nation or community. In this study, a couple of students' responses to the prompt "To me an explorer mindset…" pointed to the root of this issue at play in exploration that has both a positive and a negative impact: the "seeking" emotion. One student stated "To me, an explorer mindset is someone who always wants more but in a good way. They are always looking for something new to learn"; and another, "Is a person ready to learn anything at any cost." Although made in the context of learning, the phrases "always wants more" and "at any cost" are reminders that the seeking emotion is powerful and isn't inherently good. When elaborating on the seeking emotion, Panksepp and Biven (2012) noted contexts, such as revenge and fighting, where the seeking emotion is driving instances that have a negative impact on others, and state that "there are many, many cognitive differences in such experiences but the anticipatory urgency in all of these activities shares a positive want-to-do and can-do feeling."

As part of the resources provided to teachers for the integration of an explorer mindset, one of them centers on the issue of how the word "explorer" has been used. Teachers were asked to invite discussions with students about connections and disconnections to the word "explorer" using the following prompts:

- Do you connect or disconnect from the word "explorer" or "explorer mindset"? What connections or disconnections do you feel?
- How has the word "explorer" been used in your life or learning path? Has this been positive or negative?
- How have we used the word "explorer" in history? What are the different perspectives surrounding that word?
- Thinking of a perspective that empowers you to be the catalyst of your own learning and seeking, is there a different word or words than "explorer mindset" that you connect with? What word speaks to you?

Among the responses to the prompt "To me an Explorer Mindset…", there were two that potentially showed some students connecting with seeking as a theme in learning but preferring a different word than "explorer", that is, "pathfinder."

Due to the nature of this anonymous and introductory study, there is no way to know if the students who responded as such were in a class where those discussions happened or if they felt disconnected from the word "explorer." However, this discussion brings to light the same thing noted by Panksepp and Biven (2012): there are positive and negative impacts of the seeking emotion. This should be acknowledged by educators as they integrate exploration into content areas.

5.2. Limitations

While this paper provides a pioneering inquiry of the use of exploration as a strategy employed by educators to enhance engagement and empowerment in the context of learning, it is important to acknowledge certain study limitations. The study involved multiple teachers, classrooms, age groups, and content areas, inherently introducing a degree of variability and, consequently, yielding limited control of variables. This complexity presents challenges in disentangling the distinct impact of the explorer mindset from other factors that might affect engagement and empowerment. Another limitation relates to the reliance on self-reported measures of empowerment and engagement from the participating students in only one unit. Such self-reported data are prone to biases, including social desirability and halo effects (Gonyea, 2005). To improve the validity and reliability of future research findings and more accurately capture the complexities of learning, it would be beneficial to incorporate a broader range of data modalities (Noroozi et al., 2020). Furthermore, the study includes only one comparison between a control group and an experimental group. Expanding the number of such comparisons would enhance the robustness of the results. Another limitation arises from the data collection method: student responses were anonymous and aggregated, preventing the tracking of individual changes in feelings of empowerment and engagement. Consequently, the analysis was limited to the classroom level and beyond. Finally, teachers were asked to integrate the explorer mindset into existing units, and their enthusiasm or commitment to the approach may have influenced the results. It is plausible that teachers who were more enthusiastic about the explorer mindset might have delivered the intervention differently or emphasized it more prominently.

5.3. Institutional implications

The widespread issue of student disengagement is a warning to educational researchers that there is a need to ignite our own outlook of seeking to explore solutions that best support students. The quantitative results, when categorized by grade band, showed that the intervention had a larger impact on elementary students, which aligns with the previously noted engagement decline as students progress through school (NCEE, 2022). We have a moral obligation in public education to critically examine our systems from a lens of equity. Measures of engagement in the Programme for International Student Assessment report that socio-economically disadvantaged students, students with an immigrant background, and boys are more likely to show disengagement (Buchholz et al., 2022b). In addition, we need to ask ourselves, from a systemic perspective, what structures in our institutions can create disengagement? What can promote engagement and agency? Have we created structures that support or optimize conditions for

neural growth; furthermore, do we have factors in our structures that discourage neural growth? Schools are institutions where both collective and individual well-being can have a profound impact, be it positive or negative. Creating an outlook of seeking, exploration, and agency is one potential strategy to be further investigated among a multitude of factors that impact student success.

6. Conclusion

Combined data from this broad and introductory field test using an explorer mindset in various content areas and at different grade levels confirm what concepts in neuroevolutionary science (we all have a seeking emotion) and cognitive science (emotions are pivotal in learning) also suggest: using exploration as a context for learning can help connect students with feelings of empowerment and engagement. Furthermore, because engagement and empowerment are vital to the degree to which academic goals and progress are reached, this strategy shows promise for further development and research in the education and cognitive science communities. However, the historical use of the word "explorer" to describe a person exploiting resources also indicates that inclusive discussions giving students space to connect or disconnect with the word are essential. By framing learning in the context of exploration and honoring the pivotal role that students have as pathfinders in their own quest for understanding of the world, we are harnessing seeking, an innate emotional system, to benefit students' feelings about learning. Possible future questions in this research could investigate the degree to which individuals can be impacted by an explorer mindset in their emotional wellness, the depths to which they achieve academic understanding, and the extent to which these variables could be impacted in different age groups.

Informed consent

Informed consent was obtained from all the subjects involved in the study.

Data availability statement

The data that support the findings of this study are available on request from the author.

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Math formulae

Median, Interquartile range, Weighted mean, Standard Deviation, Cronbach's alpha, Exploratory Factor Analysis, ANCOVA

CRediT authorship contribution statement

Kelly Koller: Writing – review & editing, Writing – original draft, Methodology, Funding acquisition, Formal analysis, Conceptualization.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: The author reports that financial support was provided by the National Geographic Society for the funding of the app that provided the qualitative data for the study. In 2017, the co-principal investigator of the study was first introduced to exploration as a context for learning as a National Geographic Certified Educator and further developed resources in 2018 as a Grosvenor Teacher Fellow, a professional development program co-funded by the National Geographic Society and Lindblad Expeditions.

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