Exploring creative learning in the classroom: A multi-method approach

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ABSTRACT

How might researchers better understand the variations in creative learning in and across classrooms? This article addresses this question. We introduce a multi-method approach that we used to explore the more dynamic features of creative learning in ten elementary classrooms. The ten classrooms were first classified into one of three groups (positive, negative, and null), based on the relationship between students’ measured creativity and academic achievement ($N = 204$; average positive $r = 0.52$; average negative $r = -0.23$; and average null $r = 0.02$). Next, we analyzed observed teacher and student behaviors in each classroom. We found different patterns of behavior based on classroom classifications. Teachers in classrooms with a positive association between creativity and academic achievement tended to demonstrate more caring behaviors toward students and to provide more emotional support to students. We also found that teacher behaviors associated with encouraging creativity in the classroom were associated with students’ positive engagement, self-expression, and ideation (regardless of classroom type). Finally, we used a micro-level interactional analysis to visually illustrate patterns of interactions between teachers and students in three different classroom classifications. We found more extended and exploratory interactions in the positive association classroom, whereas the negative association classroom was characterized by more directive and rapidly closing patterns of interaction and the null association classroom tended to have patterns of interaction that left students’ ideas suspended and lacked exploration, development or refinement of ideas. We close by discussing how the use of blended methodologies, like the one demonstrated in this article, can be further refined and developed in subsequent research to explore and understand the more dynamic features of creative thought and action in classroom settings.

“The problems of creativity in the educational setting are endless, and the scope of research in this area is rapidly spreading” Guilford (1967, p. 10)

How might creativity researchers better understand the relationship between creativity and learning in the classroom? Typically, researchers have attempted to examine this relationship by exploring patterns of association amongst measures of creativity and academic achievement (e.g., Gajda, 2016; Freund & Holling, 2008). The largest meta-analysis, to date, which has examined this association (Gajda, Karwowski, & Beghetto, 2017) indicates a positive, albeit moderate, association between creativity and academic achievement ($r = 0.22$). However, both the direction and strength of the relations between creativity and academic achievement is highly variable across schools and grades (Freund & Holling, 2008). Indeed, previous studies have demonstrated seemingly
contradictory results. Gralewski and Karwowski (2012) have, for instance, found that in some classrooms correlations between learning and achievement were positive and strong, whereas in other classrooms the correlation was non-existent and, in some cases, negative. Although previous work exploring the association between measures of creativity and academic learning highlights how the relationship between creativity and academic learning differs across classrooms contexts, such studies fall short in capturing the more dynamic, socio-psychological processes that may help explain these variations across classrooms.

What is needed are blended methodologies that can simultaneously examine the more dynamic, qualitative, and micro-level interactions amongst teachers and students in the light of the more static, quantitative, and larger grain differences in associations between creativity and academic learning across classrooms. Although there have been some initial efforts in this regard (see Beghetto, 2016a; Tanggaard & Beghetto, 2015; Schacter, Thun, & Zifkin, 2006), we would argue that more integrated and comprehensive approaches can yield new and needed insights into the relationship between creativity and academic learning. The purpose of the paper is to demonstrate a blended approach that we used to explore the more dynamic and micro-level features of student and teacher behaviors in classrooms characterized by larger grain differences in creativity and academic achievement. Specifically, we report on our initial efforts aimed at blending different analytic approaches in an effort to explore whether and how teacher and student interactions differ across elementary classrooms that have three different patterns of association between creativity and learning: positive, null, and negative.

1. Creativity and learning

Researchers have long recognized the link between creativity and learning (Dewey, 1899/2007; Dewey, 1934/2005; Guilford, 1950; MacClelland, 1975; Ripple, 1977). Although researchers agree that learning and creativity are related, they tend to highlight different aspects of this relationship. Some, for instance, have asserted that learning represents a special case of the creative process (Stariko, 1995), whereas others have asserted that creativity represents an instance of learning (Guilford, 1950). In fact, some have gone as far as to assert that creativity and learning essentially represent the same phenomenon (Barron, 1967). Most, however, recognize that creativity and learning have a mutually supportive relationship with each other (Beghetto, 2016b).

A key question, at this point, is what kinds of teacher and student behaviors are supportive of creative learning? In the section that follows, we briefly review previous theories and research that highlights features of the learning environment that are thought to be supportive of creative learning.

1.1. The role of teachers

Creative learning requires opportunities for students to engage with new and different perspectives and have opportunities to share and receive feedback on their own unique perspectives (Beghetto, 2016b; Glăveanu & Beghetto, 2016). The result of doing so can simultaneously support the development of new and personally meaningful learning for students’ and teachers’ learning opportunities for students to contribute to their peers’ and teachers’ learning (Beghetto, 2016b, 2016c). Not surprisingly, then, the kinds of interactions and behaviors demonstrated and expected by teachers play a key role in determining whether creative learning will be supported or suppressed (Beghetto, 2016b; Feldhusen & Treffinger, 1980; Soh, 2000).

Supportive teacher behaviors outlined by creativity researchers (Beghetto, 2013; Cropley, 2001; Davies et al., 2012; Hong, Hartzell, & Greene, 2009; Schacter et al., 2006; Torrance, 1962) include:

- establishing improvement-focused learning goals;
- providing opportunities for students to use their imagination while learning;
- encouraging students to take sensible risks and act independently;
- teaching with a more game-like or playful approach;
- providing opportunities for choice and discovery;
- encouraging flexible thinking and confidence in students ideas;
- treating student questions and ideas (especially unusual and unexpected ones) seriously;
- refraining from premature assessment of students ideas;
- demonstrating a belief that teaching should go beyond imparting simplistic and factual knowledge; and
- supporting students when they fail by showing them ways to learn from their mistakes.

Implementing these strategies, however, seems to be easier said than done. Indeed, teachers who espouse an appreciation and acceptance of student creativity may not demonstrate those beliefs in practice (Chan & Chan, 1999; Esquivel, 1995; Gralewski & Karwowski, 2013, 2016; Scott, 1999; Westby & Dawson, 1995). Consequently, instructional practices conducive to creativity are not always easy to find in observations of classroom teaching – particularly in classrooms with high proportions of minority and low-performing students (Schacter et al., 2006).

Conversely, the potentially stifling practice of asking known-answer questions and evaluating students for how well they can reproduce what is expected and how it is expected may be more readily observed (Goodlad, 2004; Mehan, 1979). We would assert that this likely has less to do with teachers harboring a secret dislike for creativity or creative students and more likely has to do with teachers not knowing how to simultaneously support creativity and learning and, instead, feel that they must choose supporting one over the other (Beghetto, 2007). One reason this occurs is because teachers (like most people) tend to narrowly define creativity (Andiliou & Murphy, 2010; Gralewski & Karwowski, 2016) – associating it with other personality (Scott, 1999) or cognitive traits.
(Karwowski, 2007), which may be at odds with the goals and objectives of classroom teaching and learning.

1.2. The role of students

Students also play a key role in establishing a learning environment supportive of creative learning. Not only do students need to have the confidence and willingness to take the risk necessary to share their unique perspectives and ideas, they also need to be willing to listen to and support their peers in doing the same (Beghetto, 2016b). This includes knowing how to build on each other’s ideas and productively contribute to the learning task or activity. Indeed, even teachers who genuinely appreciate creative learning may view students’ unique perspectives and ideas as disruptive when they start to drift off-topic and no longer connect to the task at hand (Beghetto & Plucker, 2015).

Given that students are still in the process of developing their creative capacity, it makes sense that it may be difficult for them to regulate how and when they express their creativity. This may be particularly challenging for students who are characterized as “rebellious creative” (Karwowski, 2017; Karwowski & Jankowska, 2016), who tend to demonstrate non-conformist and independent behaviors and thereby do not easily fit into the sometimes rigid framework imposed upon them by educational institutions (Günçer & Oral, 1993; Westby & Dawson, 1995).

The variability of student creative expression can pose challenges for both students and teachers. Johnson and Hatch (1990), for instance, reported on case studies of creative children – who were, at turns, able to be highly engaged and demonstrate on-task behavior and other times became disruptive. One child (Jack) became disruptive in class when he was not able to persuade his peers to his way of thinking or when he did not feel like engaging in an activity. The teacher explained to the researchers that Jack’s creativity could sometimes become disruptive when he wanted “to try his own ideas, to move on, to advance forth … not sit and listen to someone else’s opinion” (p. 216). These descriptive observations highlight how students’ creative behaviors can vary between and within children and, in some cases, are at odds with teachers’ behavioral expectations.

Taken together, the behaviors and interactions demonstrated amongst teachers and students help establish learning environments that are more or less supportive of creative learning. If students feel that unexpected questions and answers are not encouraged and respected, then they likely will not be willing to take the risks necessary to share or explore new ideas (Kawenski, 1991) and, instead, take the safer path of trying to provide the answer that teachers and peers expect rather than experience being dismissed, downgraded, or even ridiculed (Beghetto, 2013, 2016c).

In order to better understand how creative learning varies in and across classroom environments, creativity researchers need an analytic approach that allows for exploring the behaviors and interactions of teachers and students in classrooms that demonstrate varying patterns of creative learning. This is the goal of the present study.

2. The present study

The aim of this study is to illustrate an integrative analytic approach that combines quantitative classifications of classrooms based on correlational analyses of creativity and academic learning with a more micro-level, qualitative exploration of specific behaviors and interactions of teachers and students in and across classrooms. With respect to the quantitative classifications, we focus on identifying three types of classrooms: those that demonstrate a positive relationship between student creativity and academic learning (positive); those that demonstrate a negative relationship (negative); and those that demonstrate no relationship between creativity and academic learning (null).

We then examine patterns of observed teacher and student behaviors in those classrooms and, finally, zoom-in even closer and highlight more micro-level patterns of interactions amongst teachers and students engaged in classroom discussions. We focus our attention on analyzing classroom discussions because they represent one of the most frequently used instructional strategies by teachers (Cazden, 2001) and because discussions also provide students with opportunities to share and test out their unique ideas and perspectives on the subject matter being taught (Beghetto, 2016a, 2016b).

3. Method

3.1. Selection of classrooms and participants

We used purposive sampling to select 10 elementary classrooms, 204 elementary students (107 girls and 97 boys), and 10 teachers (all females) for this study. More specifically, we drew our sample of classrooms and participants from a large cross-sectional dataset (Gajda, 2016), which included more than 1000 students and 20 elementary classrooms. Using correlational analysis, we selected 10 elementary classes that demonstrated different patterns of relationship between students’ creative ability and school grades (see below for a discussion of these measures). The 10 classrooms selected for this study represented the following categories: positive relationship between student creativity and academic achievement (n = 3, average \( r = 0.52 \), range from \( r = 0.44 \) to \( r = 0.51 \) and \( r = 0.60 \)), negative relationship (n = 3, average \( r = -0.23 \), range from \( r = -0.34 \) to \( r = -0.25 \) and \( r = -0.10 \)) and null relationship (n = 4, average \( r = 0.02 \), range from \( r = -0.02 \) to \( r = 0.03 \) (two classes) and \( r = 0.04 \)).

The 10 classes selected for this study had an average class size of 20 students (min = 15, max = 28) and represented five schools that were similar in terms of localization, average socioeconomic status, and academic school performance. Consent for students’ participation in the study was obtained in writing from the students’ parents. In cases where parents or guardians had any questions pertaining to the purpose of the study, the first author provided explanatory information. Six parents had not consented to their participation in the study, but consented to participate in research activities, which included providing written descriptions of classroom interactions.
child’s participation in the creativity test, while all parents gave consent to observational study.

3.2. Measures and procedure

We used four types of data-sources for this study: measures of student creativity, measures of student academic achievement, observational measures of teacher and student behavior, and audio-recorded teacher and student interactions.

3.2.1. Student creativity

We used Urban and Jellen’s Test of Creative Thinking – Drawing Production (TCT-DP) (Jellen & Urban, 1986; Urban & Jellen, 1996) to measure creative ability. The test’s sheet included six incomplete shapes, which each participant used as the basis for completing a drawing in his or her own way. Each participant was allotted 20 min to complete the task.

The final drawing of each student was then quantitatively and qualitatively assessed using 14 criteria, which were used to calculate a composite creativity score (Urban & Jellen, 1996): Continuation (Cn), Completions (Cm), New elements (Ne), Connections made with a line (Cl), Connections made to produce a theme (Cth), Boundary breaking (fragment-dependent) (Bfd), Boundary breaking (fragment-independent) (Bfi), Perspective (Pe), Humor and affectivity (Hu), Unconventionality: manipulation of the test material (Cma), Unconventionality: surreal or abstract drawings (Ccb), Unconventionality: use of symbols or signs (Ccc), Unconventionality: Non-stereotypical use of a certain element (Ccd) and Speed (Sp). The overall reliability was $\alpha = 0.71$, which is in accordance with levels obtained in previous studies (e.g., Karwowski & Gralewski, 2013).

3.2.2. Academic achievement

We used students’ average school grades (GPA)$^1$ from the previous semester as a proxy of academic achievement ($M = 4.40$, $SD = 0.91$, range: $1 = \text{low to 6 = excellent}$). There were no statistically significant, $F(2212) = 0.68$; $p = 0.51^2$ differences in GPA across classes (positive correlation classes: $M = 4.35$, $SD = 1.14$, $N = 65$, min = 1, max = 6; negative correlation classes $M = 4.33$, $SD = 0.77$, $N = 64$, min = 2, max = 6, null correlation classes $M = 4.51$, $SD = 1.14$, $N = 84$, min = 1, max = 6, $SD = 1.14$).

3.2.3. Teacher and student behavior

The first author conducted observations in each of 10 classes. Observed classes included five Polish (native) language class and five math classes. During the observations, the researcher documented teacher and student behaviors and interactions using an observation protocol developed for this study (see Appendices A and B for examples of behaviors coded). The observation protocol consisted of a number of students’ and teachers’ exemplary behaviors, listed with regard to three components of creativity as defined in the Typological Model of Creativity (Karwowski, 2017; Karwowski and Jankowska, 2017): creative ability, openness and independence. The behaviors were dichotomously coded ($0 = \text{behavior absent}$, $1 = \text{behavior present}$) in five-minute intervals, which resulted in a total of 90 observational units, clustered within 10 classes for teachers’ and students’ behaviors.

3.2.4. Interactions between teachers and students

The first author audio-recorded classroom interactions between teachers and students in 10 classrooms. These data were collected for the purpose of conducting a micro-level interactional analysis (Beghetto, 2016a; Tanggaard & Beghetto, 2015), which uses transcribed excerpts of those interactions to develop visual diagrams of the patterns of interaction amongst teachers and students that can then be used for further analysis and interpretation. Doing so provides researchers with an analytic artifact (beyond the transcript) that can be helpful in identifying patterns of interactions, which may be more or less supportive of creative learning (see Beghetto, 2016a, 2016b; Tanggaard & Beghetto, 2015).

In the present study, we used this approach to visually illustrate and explore patterns of interaction amongst teachers and students engaged in academic discussions in three different classrooms: one classified as having a null relationship, one with a negative relationship, and one with a positive relationship between creativity and academic achievement. We used the following criteria to select a sample excerpt to apply this approach. First, a teacher and at least two students had to be engaged in an academic discussion (i.e., talking about academic subject matter, rather than some other procedural or non-instructional exchange). Second, the discussion had to include an exchange in which questions were posed and opportunities for students to respond were made available. Finally, the discussion had to be self-contained (i.e., an interaction focused on a particular academic goal) and the audio had to be clear enough throughout the discussion to transcribe. Using these selection criteria, we were able to select three relatively brief excerpts of teacher-student interactions (i.e., ranging from 13 to 29 total utterances) representing each classroom type (negative, null, and positive).

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$^1$ A recent meta-analysis (Gajda et al., 2017) demonstrates that the relationship between school grades and creativity is weaker than a relationship between creativity and achievement test results. Given that we did not have complete standardized achievement data to use in this study, we relied on average school grades (which is common in such studies, see Gralewski & Karwowski, 2012). Although our achievement data does not seem to be limited by restricted variance (i.e., very high or very low grades), it is possible that the potentially lower reliability of teacher grades (as compared to standardized assessments) could result in artificially underestimated relationships between academic achievement and creativity. In the case of this study, under-estimates of the relationship between creativity and academic achievement likely would not make a substantive difference in how the 10 classes were classified. Still, we want to highlight this potential limitation.

$^2$ The number of degrees of freedom for denominator is higher than the number of participants in observational study, as we used data about GPA of all students (also those who did not solve creativity test), to obtain unbiased estimate of classroom average school achievement.
The first author prepared a transcript of each brief interaction and then we used the transcript as the basis for depicting the interaction using a visual diagram\(^3\) (adapted from Tanggaard & Beghetto, 2015; see also Beghetto, 2016a). More specifically, we plotted teacher and student utterances along a horizontal timeline. We then traced out patterns of interactions as they moved in and between more or less open (i.e., indeterminate and exploratory) or closed (i.e., determinate or fixed) horizons of the diagram. We also added notation to differentiate between different speakers (e.g., teacher, students), different utterances from the same speakers; and moments in the interactions when ideas were accepted, contested, dismissed, suspended, and returned to in a subsequent interaction.

4. Results

4.1. Analysis of teacher and student behaviors

We used exploratory factor analysis to examine the factor structure of the observed teacher and student behaviors. More specifically, we used exploratory factor analysis in the structural equation modeling (ESEM) scheme, which treated individual behaviors as measured on the count scale and used the robust weighted least squares estimator (WLSMV, Nussbeck, Eid, & Lischetzke, 2006). We conducted the analyses using Mplus software (Muthén & Muthén, 1998–2014) and controlled for students’ class grouping.

4.1.1. Teacher behaviors

With respect to teacher behaviors, our results indicate that a four-factor solution fit the data well (Hu & Bentler, 1999; Kline, 2011): \( \text{CFI} = 0.97, \text{TLI} = 0.96, \text{RMSEA} = 0.023 \) (90% CI: 0.000, 0.055), \( \text{WRMR} = 0.62 \) (see Table 1).

As displayed in Table 1, the first factor represents behaviors associated with caring for students (e.g., careful listening, authenticity of the teacher’s behaviors, delayed assessment of ideas). The second factor represented behaviors associated with encouraging creativity, (e.g., encouraging students to be inventive and asking open questions). The third factor represents behaviors associated with emotional support (e.g., friendly humor, motivating to manage failure). The fourth factor represented risk acceptance behaviors (e.g., testing new ideas, taking risks, accepting unconventional ideas).

In an effort to explore the most commonly observed behaviors amongst teachers, we calculated factor scores.\(^4\) Given that teachers’ behaviors were coded as either present (code = 1) or absent (code = 0), we first estimated internal consistency of four factors obtained in factor analysis. To this end we used Cronbach’s alpha estimated on a matrix of tetrachoric correlations, which indicated acceptable internal consistency of our factors: caring (\( \alpha = 0.79 \)), encouraging creativity (\( \alpha = 0.91 \)), emotional support (\( \alpha = 0.81 \)), and risk acceptance (\( \alpha = 0.75 \)). In the next step, we proceeded with repeated-measures ANOVA to explore potential differences amongst behaviors. Our result indicate significant differences amongst these behaviors, with caring behaviors being the most typically observed set of teacher behaviors (\( M = 0.32, SD = 0.35 \)), followed by encouraging creativity (\( M = 0.16, SD = 0.26 \)), providing emotional support (\( M = 0.11, SD = 0.19 \)) and, finally risk acceptance (\( M = 0.06, SD = 0.10 \)), \( F(3, 89) = 20.33, p < 0.001, \eta^2 = 0.19 \).

4.1.2. Student behaviors

With respect to student behaviors, a four-factor solution fit the data well: \( \text{CFI} = 0.94, \text{TLI} = 0.89, \text{RMSEA} = 0.039 \) (90% CI: 0.00, 0.08), \( \text{WRMR} = 0.70 \) (see Table 2).

The first factor represented student misbehavior (i.e., behaviors that challenged the established order and classroom rules, such as questioning classroom rules and providing unexpected or inappropriate responses). The next factor represented positive engagement (i.e., not being discouraged by setbacks and demonstrating curiosity and interest in the topic). The third factor included behaviors that represented self-expression (i.e., expression of one’s own views, making jokes and using humor). Finally, the fourth factor represented behaviors associated with ideation (i.e., generating many ideas from various categories, providing surprising answers).

As with teacher behaviors, we estimated the internal consistency of our factors. Similar to what we found with the factors of teacher behaviors, the reliability of student factors was acceptable: misbehavior (\( \alpha = 0.68 \)), positive engagement (\( \alpha = 0.61 \)), self-expression (\( \alpha = 0.79 \)), and ideation (\( \alpha = 0.77 \)). Next, we used repeated-measures ANOVA to examine potential differences amongst behaviors. Our results indicate that positive engagement was the most typically observed set of student behaviors (\( M = 0.26, SD = 0.23 \)), followed by ideation (\( M = 0.14, SD = 0.20 \)), misbehavior (\( M = 0.12, SD = 0.18 \)) and self-expression (\( M = 0.11, SD = 0.18 \)), \( F(3, 89) = 11.93, p < 0.001, \eta^2 = 0.12 \).

Our next step was to examine whether and how these behaviors differed across classrooms that were classified as having a positive, negative, and null relationships between creativity and academic achievement.

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\(^3\) The development of micro-level interactions diagrams allows us to retrospectively depict a sample of utterances between students and teachers. Given that this type of analysis is not based on a representative sample of all behaviors in or across selected classrooms, it should be regarded as idiographic illustration of lesson discussion. Still, the value of such an approach is that allows researchers to depict – in a very concrete way – the more dynamic and somewhat tacit patterns of interaction that otherwise might go unnoticed using traditional transcript or discourse analysis. This approach provides researchers with an additional artifact (beyond the transcript) that can be used for analysis and interpretation.

\(^4\) The factor scores represent averages of the dichotomous items that make up the factor. Therefore, the means can be interpreted as a percentage of behaviors typical for each factor.
Table 1
Factor analysis of observed teacher behaviors.

<table>
<thead>
<tr>
<th>Behavior unit – Teachers</th>
<th>%</th>
<th>Caring</th>
<th>Encouraging Creativity</th>
<th>Emotional Support</th>
<th>Risk Acceptance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Careful listening to questions</td>
<td>13%</td>
<td>0.95</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Delayed assessment of ideas</td>
<td>8%</td>
<td>0.85</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group work organization</td>
<td>20%</td>
<td>0.69</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Authenticity, genuineness</td>
<td>16%</td>
<td>0.60</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Encouraging to search for diverse ideas</td>
<td>19%</td>
<td>0.96</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Encouraging to create many ideas</td>
<td>24%</td>
<td>0.90</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Open questions</td>
<td>20%</td>
<td>0.90</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Encouraging divergent thinking</td>
<td>18%</td>
<td>0.88</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Atmosphere of creative play</td>
<td>23%</td>
<td>0.61</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Friendly humor</td>
<td>27%</td>
<td>0.90</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Using constructive criticism</td>
<td>8%</td>
<td>0.67</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Motivating to manage failures</td>
<td>9%</td>
<td>0.48</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sensitivity to feelings</td>
<td>3%</td>
<td>0.47</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Making it possible to choose and make decisions</td>
<td>6%</td>
<td></td>
<td></td>
<td>0.59</td>
<td></td>
</tr>
<tr>
<td>Acceptance of unconventional and strange ideas</td>
<td>6%</td>
<td></td>
<td></td>
<td>0.59</td>
<td></td>
</tr>
<tr>
<td>Encouraging to test new ideas</td>
<td>4%</td>
<td></td>
<td></td>
<td>0.49</td>
<td></td>
</tr>
<tr>
<td>Tolerance of otherness and new ideas</td>
<td>6%</td>
<td></td>
<td></td>
<td>0.45</td>
<td></td>
</tr>
<tr>
<td>Encouraging to imagine different things</td>
<td>4%</td>
<td></td>
<td></td>
<td>0.37</td>
<td></td>
</tr>
</tbody>
</table>

Note. N = 90 observations; % = percent amongst all behaviors observed. Loadings are estimated using the WLMSV estimator and geomin rotation. Only statistically significant loadings are presented.

Table 2
Factor analysis of observed student behaviors.

<table>
<thead>
<tr>
<th>Behavior unit – Students</th>
<th>%</th>
<th>Misbehavior</th>
<th>Positive Engagement</th>
<th>Self-Expression</th>
<th>Ideation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Questioning classroom rules</td>
<td>6%</td>
<td>0.93</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Behavioral risk</td>
<td>16%</td>
<td>0.46</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Distraction of attention</td>
<td>22%</td>
<td>0.46</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inappropriate answers</td>
<td>3%</td>
<td>0.45</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transforming the student’s own and other students’ ideas</td>
<td>4%</td>
<td>0.70</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Expressing emotion</td>
<td>3%</td>
<td>0.66</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Curiosity and interest in the topic</td>
<td>44%</td>
<td>0.29</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Opposing the teacher’s views</td>
<td>4%</td>
<td>0.44</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engagement in new tasks</td>
<td>43%</td>
<td>–0.71</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ease in recalling words and expressions</td>
<td>11%</td>
<td>0.87</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Expressing one’s own views</td>
<td>13%</td>
<td>0.84</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jokes and sense of humor</td>
<td>12%</td>
<td>0.32</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Many ideas from various categories</td>
<td>10%</td>
<td>0.98</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Many answers to the same question</td>
<td>26%</td>
<td>0.53</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surprising answers</td>
<td>10%</td>
<td>0.67</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. N = 90 observational units; % = percent amongst all behaviors observed (percentages do not add up to 100%, as different behaviors might occur simultaneously). Loadings are estimated using the WLMSV estimator and geomin rotation. Only statistically significant loadings are presented.

4.2. Exploring variations in teacher and student behaviors

In an effort to examine whether teacher and student behaviors varied between classroom categories, we tested two separate multilevel models – one for teacher behaviors and one for student behaviors. Each time, we used class type to predict the four behavioral factors. We used the null-relationship class as the reference group for our models. We also included a “lesson duration” variable in our models, which represented nine 5-min time intervals across the entire 45-min lesson.

Table 3 presents a summary of coefficients and significance levels obtained in the teacher and student multi-level models.

4.2.1. Teacher behaviors

As displayed in Table 3, there was a significant difference in teachers’ caring behaviors between class types. Specifically, teacher’s caring behaviors were more frequently demonstrated in classes classified as having a positive correlation between students’ creativity and academic achievement as compared to classes with null correlation.

With respect to teacher behaviors associated with encouraging creativity, there were no significant differences between class types. A marginal significant difference (i.e., p < 0.10) in encouraging creativity, however, was found across lesson duration in all classroom types. Specifically, teachers’ behaviors associated with encouraging creativity decreased across the duration of the 45-min lesson.

With respect to teachers providing emotional support to students, our results indicate significant differences between class type and lesson duration. More specifically, teacher behaviors associated with emotional support were significantly less frequent in classes
Note. All coefficients are standardized, robust standard errors in parentheses. Class Type-Positive = classes with positive correlation creative ability-school achievement, Class Type-Negative = classes with negative correlation creative ability-achievement (classes with null correlations served as the reference category).

* p < 0.10.
* * p < 0.05.
* * * p < 0.01.

classified as having a negative correlation between creativity and achievement (as compared to classes with the null correlation). Similar to encouraging creativity, however, the frequency of teachers demonstrating emotional support decreased as the lesson progressed (regardless of class type). Finally, teachers demonstrating risk acceptance behavior did not differ between class types or across lessons duration.

4.2.2. Student behaviors

As reported in Table 3, our results indicate that student misbehavior, positive engagement, and self-expression tended to be lower in classrooms classified as having a negative relationship between creativity and achievement (as compared to the null classroom). Our results also indicate that across all class types, student behaviors associated with positive engagement tended to weaken in the final fifteen minutes of the lesson.

4.3. Relationship between teacher and student behaviors

Next, we explored the relationship between observed teacher and student behaviors. Given the ordinal nature of our observational behavior scales\(^5\), we used polychoric correlations to examine this relationship. As displayed in Table 4, there were significant relationships (i.e., \(p < 0.05\)) between observed teacher and student behaviors. Specifically, teachers’ caring behaviors were positively related to students’ positive engagement \((r = 0.25)\) and ideation \((r = 0.38)\). Moreover, teachers’ encouraging creativity behaviors were associated with students’ positive engagement \((r = 0.26)\), self-expression \((r = 0.47)\), and ideation \((r = 0.39)\). Finally, teachers’ risk acceptance behaviors were related to students’ self-expression \((r = 0.28)\) and ideation \((r = 0.37)\). We found no significant relationship between teachers’ emotional support behaviors and any observed student behaviors.

4.4. Analysis of micro-level interactions

Finally, we developed visual displays of interactions (Tanggaard & Beghetto, 2015) to help illustrate and explore patterns of interaction between teachers and students in three different classroom types (i.e., classified as having a null, negative, or positive relationship between creativity and academic achievement). In what follows, we provide a transcript of the class discussion, a visual display of that discussion, and a brief analysis of the patterns of interaction for each of the three classroom types: Null, negative, and positive.

4.4.1. Teacher-student interaction in a null classroom

The following transcript of a teacher-student interaction is from a classroom classified as having a null relationship between creativity and academic achievement \((r = 0.02; n = 20)\). The interaction occurs as part of a 4th grade Polish language lesson. Teacher (U1T) \((\ldots)\) let’s imagine a different use for a comb than just combing your hair \((\ldots)\)

\(^5\) Given observed behaviors were coded as either not present (0) or present (1), we treat our factors (comprised of these scores) as measured on ordinal or even count scale. We therefore used polychoric correlations, controlling for nesting observation duration within lessons. Readers interested in raw Pearson’s correlations are encouraged to contact the corresponding author.
Table 4
Polychoric correlations between teacher and student behaviors.

<table>
<thead>
<tr>
<th></th>
<th>T1</th>
<th>T2</th>
<th>T3</th>
<th>T4</th>
<th>S1</th>
<th>S2</th>
<th>S3</th>
<th>S4</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1: Caring</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T2: Encouraging creativity</td>
<td>-0.08</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T3: Emotional support</td>
<td>0.16</td>
<td>0.15</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T4: Risk acceptance</td>
<td>0.21</td>
<td>0.10</td>
<td>0.39</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S1: Misbehavior</td>
<td>-0.06</td>
<td>0.09</td>
<td>-0.04</td>
<td>0.12</td>
<td>0.33</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S2: Positive engagement</td>
<td>0.25</td>
<td>0.26</td>
<td>0.15</td>
<td>0.05</td>
<td>-0.33</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S3: Self-expression</td>
<td>0.11</td>
<td>0.47</td>
<td>0.07</td>
<td>0.28</td>
<td>0.58</td>
<td>0.08</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>S4: Ideation</td>
<td>0.38</td>
<td>0.39</td>
<td>0.12</td>
<td>0.37</td>
<td>-0.05</td>
<td>0.63</td>
<td>0.45</td>
<td>1</td>
</tr>
</tbody>
</table>

Note. Bolded coefficients are statistically significant (p < 0.05), N = 90.

Student (U₁S₁) Yy you can scratch your back ...
Student (U₁S₂) I wanted to say that!
Teacher (U₅T) Wait, stop. A tool for scratching, tadek [boy’s name, transl.]
Student (U₄S₃) It may also serve as something to digging out something else
Student (U₄S₄) Indeed, I personally do that sometimes.
[Noise]
Teacher (U₅T) Kamila? [girl’s name, transl.]
Student (U₆S₃) You can play on it
[Noise]
Student (U₁₀S₆) Play on it?
Teacher (U₁₁T): Karolina? [girl’s name, transl.]
Student (U₁₂S₆) Yy you can attach it to your hair
Teacher (U₁₃T) Other than combing, attaching to your hair?
Student (U₁₄S₄) a decoration
Teacher (U₁₅T) Well, OK
Student (U₁₆S₄) a decoration?
Student (U₁₇S₆) And how can you turn it into an instrument?
Teacher (U₁₈T) Kacper [boy’s name, transl.]
Student (U₁₉S₆) A rake!
Teacher (U₂₀T) Weronika? [girl’s name, transl.]
Student (U₂₁S₁₀) You can use it as a shish-kebab stick
Student (U₂₂S₁₁) but how?
[shouting]
Teacher (U₂₃T) Oh, this is not very nice! Unfortunately I am very disappointed with your attitude. Michał [boy’s name, transl.], what happened?!
Student (U₂₄S₁₁) this is impossible
Teacher (U₂₅T) It is possible! Everything is possible!
Student (U₂₆S₁₁) No
Teacher (U₂₇T) well, let me prove it to you that it is indeed possible
[Noise]
Student (U₂₈S₁₁) Than why can’t I fly?
Student (U₂₉S₁₂) or I?

Fig. 1 depicts the pattern of interactions between students and teachers for this segment of classroom discussion.

4.4.2. Micro-analysis of interactions in null classroom

In this classroom, the teacher presented the students with an open question and informed them that they would be conducting a brainstorming session. The students were asked to come-up with as many unusual uses for a comb as they could (i.e., other than its primary function). The first student shared an idea (U₁S₁) that was reinforced by two other students (U₄S₃; U₄S₄) and, ultimately, accepted (A) by the teacher (U₅T). As depicted in Fig. 1, this interaction starts by following an open (indeterminate) trajectory, wherein two other students endorse the first student’s idea, and then moves into a more closed (determinate) trajectory as the teacher accepts (A) it by re-voicing it and thereby closes the interaction.

In that same utterance (U₅T), the teacher initiated another interaction by calling on one of the two students (Tadek) who agreed with the first student. This student shared his idea (U₄S₄), which was endorsed by another student (U₄S₃), but the teacher did not acknowledge it and, instead, called on another student (U₅T). Consequently, the Tadek’s idea (U₄S₃) remained suspended in the indeterminate space of the interaction (see Fig. 3).
The next student (Kamila) who was called on by the teacher, provided another idea (U9S5), which was immediately contested by a peer’s question (U10S6). The teacher calls on the student (Karolina) (U11T) who contested her peer. Karolina responded to this invitation by sharing a different idea (U12S6), instead of explaining her point of contestation that she raised (U10S6) about Kamila’s idea (U9S5). Consequently, Kamila’s idea and Karolina’s contesting of that idea were both suspended and not explored by the teacher or other students (see Fig. 1).

Karolina’s new idea (U12S6) was immediately questioned and, ultimately, dismissed by the teacher (U13T). Another student (U14S7) shared an idea, which was initially accepted by the teacher (U15T), but then contested by two students (U16S8, U17S6). Instead of exploring this interaction further, the teacher moved on by calling on yet another student (Kacper) and thereby suspended the interaction that was underway (U18T).

Kacper shared his idea (U19S9), which was left suspended as the teacher (U20T) immediately called on yet another student (Weronika). Weronika shared her idea (U21S10), which was immediately questioned by a peer (U22S11), and a quarrel between the children ensued. The teacher attempted to re-direct the nature of the discussion (U23T) and asked one of the students (Michał) what happened. The student (S11) who questioned Weronika reanimated his contestation of Weronika (denoted by a dotted line in Fig. 3) and re-voiced his protest about using a comb as a shish-kebab skewer (U24S11). The teacher then suggested that anything is possible (U25T) and the student contested the teacher’s argument (U26S11). The teacher attempted to defend the feasibility of the idea (U27T),
but the student challenged the teacher’s claim that anything is possible (U_{28}S_{11}) and received support from another student (U_{29}S_{12}) and ultimately drove the interaction in a closed direction (see Fig. 1).

In considering this pattern of interaction, we see the teacher inviting student ideation, but the discussion seemed to lack the structure necessary for clarifying the expectations or goals for the brainstorming session. Without such structure, a discussion can drift into a more chaotic and disruptive pattern of interaction (Beghetto & Plucker, 2015). Indeed, the teacher did not provide students with clear expectations for how to share their ideas or guidelines for how they should respond to the ideas of others. Moreover, the teacher often did not explore or expand on the ideas or questions that students shared.

Two key components of creative learning – exploring and providing feedback on ideas (Beghetto, 2016b) – were largely absent from the interaction. Students did contest ideas (including their teacher’s at the end of the session), but there was not adequate interactional support or time for further exploration of ideas, particularly discrepant ideas (such as using the comb as a shish-kebab skewer). Moreover, this pattern of interaction illustrates that it is not only teachers who sometimes take interactions into a closed trajectory, but that one or two persistent students can also contest and stifle the teacher’s invitations to explore a peer’s unconventional idea (Beghetto, 2016a). In sum, although the teacher provided opportunities for students to express and explore unconventional ideas, the guidance and expectations necessary for exploring, developing, and refining ideas seemed to be lacking (Beghetto, 2016b; Beghetto & Plucker, 2015).

A potential insight that can be gleaned from this brief micro-level analysis of a classroom classified as having a null relationship between creativity and academic achievement is that even though teachers may provide opportunities for open ideation, additional guidance seems necessary to develop those ideas into creative learning contributions that, in turn, may be reflected in connections between creativity and academic learning. Whether similar interactional patterns occur in other classrooms with null relationships is an empirical question that warrants subsequent analysis. Still, this kind of micro-level analysis offers researchers with an example of how they might use similar diagrammatic approaches in conjunction with more macro-level, quantitative classifications to concretely illustrate the kinds of dynamic patterns of interactions that can be depicted, interpreted, and explored in subsequent theoretical and empirical work.

4.4.3. Teacher–student interaction in a negative classroom

The following transcript of a teacher-student interaction is from a classroom classified as having a negative relationship between creativity and academic achievement ($r = -0.34, n = 28$). The interaction occurs as part of a 2nd grade mathematics lesson.

Teacher (U_{1T}) How else do we call 24:00? 00 or…?
Student (U_{1S_{1}}) Twelve?
Teacher (U_{2T}) Twelve at night, 24, or…?
Student (U_{1S_{2}}) Midnight.
Teacher (U_{3T}) Midnight, well done Bartek [boy’s name, transl.]. We write down hours like this, look at me, 5:00—just like it is screened on an electronic clock or with two dots, like we did in first grade, or with a dot. But when we mean an afternoon hour, then we will write seventeen, 17:00, right? We said today, just a while ago, that a day is 24 h and it is made up of a light part, how do we say this, when it is …
Student (U_{1S_{3}}) … bright outside.
Teacher (U_{4T}) Day and night. Take a look, when we speak about hours during the day. Then we say 5 in the morning, 9 in the morning, 12 noon, 15 in the afternoon or 20 in the evening. Meanwhile, night hours, 22 at night, 24 or midnight, one a
night or even three at night. The second exercise, compare what the clocks show. The ordinary clock shows what time, Agata [girl’s name, transl.]?

Student (U₁S₄) One.
Teacher (U₃T) One. Do we know if it is one or thirteen hour? Or can we write it down as 13:00 when we mean day and then one when it is...? One?
Student (U₁₀S₂) ...00
Student (U₁₁S₄) ...in the morning.
Student (U₁₁S₇) ...at night.
Teacher (U₁₂T) At night, what are you talking about, one in the morning, really? I am still asleep then. An electronic clock screens thirteen hundred hours during the day and at night it shows one. And we know right away whether it is day or night. Let’s assume that we are in some strange room and we don’t know if it is day or night, but that clock screens it for us and we already know. Underneath the frames, please write “day” or “night.” Please read the first of the series of hours, Antek [boy’s name, transl.].

Fig. 2 depicts the pattern of interactions between students and teachers for this segment of classroom discussion.

4.4.4. Micro-analysis of interactions in negative classroom

In this classroom, the teacher initiated the interaction by reviewing information about how to read hours in a 12-h and 24-h clock system. The teacher initiates the interaction by asking a question (U₁T), a student responds (U₂S₁), the teacher accepts the response and initiates a new question, “Twelve at night, 24, or...?” (U₁T). This pattern of interaction is depicted in Fig. 2 as an inverted U, which involves the teacher initiating an opening for students to respond, a student responds to the invitation, the teacher provides a closed (determinate) evaluation of that response, and immediately initiates a new question.

A different student (Bartek) responded to the teacher’s new question by providing the expected answer, “Midnight” (U₄S₂). As depicted in Fig. 2, the interaction follows the similar inverted U shape, with the teacher accepting Bartek’s response (U₃T) and then initiating a new opening for student response by tacitly invited students to respond by completing her sentence, “The day is 24 h and it is made up of a light part, how do we say this, when it is...”.

A different student attempted to complete the teacher’s sentence by saying, ‘...bright outside’ (U₅S₃). Once again, the similar inverted U-shape pattern of interaction ensues (see Fig. 2), with the teacher moving the interaction into closed (determinate) trajectory by dismissing (D) the students’ response, providing the answer she was expecting herself, and then initiating a new question directed at a different student (U₄T).

In this instance, the teacher initiated a new opening by directly calling on Agata to respond. The inverted U pattern is repeated once again (see Fig. 2), with the student (Agata) providing a response (U₆S₄) that her teacher quickly accepted, re-voiced, and then initiates a new opening in the form of an incomplete sentence, “One. Do we know if it is one or thirteen hour? Or can we write it down as 13:00 when we mean day and then one when it is...? One?” (U₅T).

Although several students provided responses to this invitation (U₁₀S₅; U₁₁S₆; U₁₂S₇), the same basic inverted U pattern of interaction was repeated (see Fig. 2), resulting from the teacher dismissing all but the last student’s response (U₁₂S₇), which she accepted and re-voiced (U₁₃T). In this segment the teacher also took a moment to further discount one student’s idea (U₁₁S₆), by saying in a somewhat mocking way “...what are you talking about, one in the morning, really? I am still asleep then” (U₁₃T). The segment closed with the teacher providing additional commentary about electronic clocks, directing students to label examples, and asking a student to read aloud the a series of hours.

Our visual diagram (Fig. 2) illustrates a repeating pattern of briefly open and then rapidly closing interactions directed by the teacher. This pattern of talk represents a very common three-part pattern of discourse described elsewhere (Beghetto, 2016c; Cazden, 2001; Goodlad, 2004; Mehan, 1979), which involves: the teacher asking known-answer questions, student’s attempting to guess the expected response, and the teacher immediately evaluating whether the students’ responses match what is expected. Indeed, in the case of the interactions analyzed above, the teacher quickly accepted expected responses, re-voiced them, occasionally provided additional explanation, and used them to quickly move on to the next question. Any unexpected responses were dismissed either by being simply ignored or, in one case, seemingly mocked by the teacher. Moreover, students did not have an opportunity to elaborate on their ideas or provide feedback on each other’s ideas. Although such patterns of talk are not always problematic and can sometimes be justified (e.g., quickly reviewing information), they can become problematic for supporting creative learning when they represent the modal form of interaction in a classroom. Indeed, the lack of extended exploration of ideas and the lack of instructional feedback provided to students – coupled with a mocking evaluation of students’ ideas – can have a chilling effect on students’ willingness to share, test-out, and develop their ideas and thereby stifle creative learning (Beghetto, 2016b).

Given that our depiction and interpretation of this pattern of interaction is based on a very brief segment from one particular discussion, from one particular classroom, on one particular day; it would be inappropriate to make strong claims about this pattern representing a typical pattern of discourse for this classroom let alone generalizing to other classrooms. Indeed, other factors may be at play. It is possible that closed patterns of interaction tend to be more likely in particular subject areas (mathematics) versus other subject areas (e.g., language instruction) – regardless of the relationship between creativity and academic achievement. It may also be the case that the teacher felt pressured to quickly move through the material. As such, further exploration of the frequency and conditions under which such patterns emerged is needed prior to making claims about this pattern being characteristic of particular types of classrooms. This includes exploring the perspectives, rationale, and experiences of the teachers and students involved in such interactions.

Still, even with such caveats in mind, we would assert that the results of our initial, exploratory efforts provide creativity...
researchers with a concrete, visual depiction of a closed, inverted U-shape pattern that can be used as a basis for subsequent empirical testing and validation. Such efforts can help clarify whether this recurring inverted U-shape pattern of interaction is more likely to occur in classrooms characterized as having a negative relationship between creativity and academic achievement. Subsequent work may also clarify whether and how other factors (e.g., subject area, lesson goals, time constraints, teacher’s confidence with the subject matter) mediate and moderate the occurrence and frequency of this particular pattern of classroom talk. We therefore encourage researchers to explore the frequency and consistency of this finding in subsequent work.

4.4.5. Teacher–student interaction in a positive classroom

The following transcript of a teacher-student interaction is from a classroom classified as having a positive relationship between creativity and academic achievement ($r = 0.60$, $n = 22$). The interaction occurs as part of a 6th grade Polish language lesson.

Teacher (U) (...) We have to find out what the word ‘universalism’ means. Maybe you know the adjective ‘universal?’

Student (S) One of a kind

Teacher (U) Well, I don’t think so (high noise) … but let’s take it one-by-one: Robert comes first

Student (S) Well, you know, meaning everything

Teacher (U) Everything, you are on the right track, right?

Student (S) You know, that they aren’t …

Teacher (U) For example with what…? but one-by-one, please, for example with what other words can ‘universal’ go together with?

Student (U) Person

Teacher (U) What associations?

Student (U) Car

Teacher (U) A universal car, meaning what kind?

Student (U) It has many uses

Teacher (U) It has many uses, right?

Student (U) A universal computer

Teacher (U) Computers can be universal

Student (U) A remote control

Teacher (U) A universal remote control; what is it for?

Student (U) To put the volume up or down

Teacher (U) For your garage door, TV, right, so it is for…? Please. And when we have a t-shirt, then it has a universal size, right?

Meaning what kind of size?

Student (U) One that fits...

Teacher (U) One that fits everybody. So, see? We have an idea about what ‘universal’ means. Let’s now try a noun, right, it is ‘universalism’ that is the subject of this lesson; what may it mean?

Fig. 3 depicts the pattern of interaction between students and the teacher.

4.4.6. Micro-analysis of interactions in positive classroom

In this classroom, the teacher initiates the interaction by asking students whether they know the meaning of the adjective “universal” (U). A student provided a response, “one of a kind” (U), which the teacher explored further by inviting the student to explain what “one of a kind” means (U). The student then slightly modified the initial response and changed it from a statement to a question (U). The teacher contested this idea, “Well, I don’t think so…” and ultimately dismisses it – moving on to another student, “…but let’s take it one-by-one: Robert comes first” (U). As depicted in Fig. 3, this pattern of interaction represents an extended, inverted U-shape, which includes additional exploration and engagement with the student’s idea prior to dismissing it and initiating a new pattern of interaction with a different student (Robert).

The next student, Robert, shares his idea, “Well, you know, meaning everything” (U), which the teacher re-voiced and invited additional elaboration, “Everything, you are on the right track, right?” (U). As Robert attempted to clarify, “Well, you know, that they aren’t…” (U). The teacher interrupted Robert and took the discussion in a different direction by initiating a new question, “…what other words can universal go together with?” (U). As depicted in Fig. 3, this exchange left Robert’s initial idea suspended.

Robert was the first to respond to the teacher’s new question, offering: “Person” (U). The teacher did not acknowledge Robert’s new idea – again leaving it suspended. Instead, the teacher posed a leading question, “What association?” (U).

A different student provided a response “Car” (U) that the teacher used as the basis for a question, “A universal car, meaning what kind?” (U). Yet another student offered a response, “it has many uses” (U), which the teacher accepted by re-voicing, “it has many uses” and then added the question “right?” to invite further exploration (U).

This extended exchange amongst the teacher and two students is depicted in Fig. 3, including how this exchange invited yet another student (S) to offer a new idea “A universal computer” (U), which the teacher accepted by re-voicing it, “Computers can be universal” (U). A moment later a different student provided an idea, “a remote control” (U), which the teacher re-voiced, “A universal remote control” and invited further exploration by asking “what is it for?” (U). The same student who offered “remote control” responded by explaining that it can be used to “put the volume up or down” (U). The teacher, however, the teacher initiated two additional questions, “And when we have a t-shirt, then it has a universal size, right? Meaning
what kind of size?” (U23T). A different student started responding by saying “One that fits….”(U22S7), which the teacher picked up and finished, “One that fits everybody” (U23T). The teacher concluded the interaction by explaining that the group now has an idea of what universal means, and then directs the students to explore the meaning of the noun, “universalism.”

This more extended and linked exchange amongst the teacher and several students is depicted in Fig. 3 and we use dotted lines to illustrate how ideas shared at earlier points in the exchange were re-animated and built upon to develop a growing, more emergent and collective understanding. Such an exchange seems to be consistent with what would be expected in a more improvisational or participatory form of creative collaboration (see Clapp, 2017; Hanson, 2015; Sawyer, 2010). Indeed, as Sawyer (2010) has argued, creativity in groups is characterized by “collaborative emergence.” This form of creative expression is emergent because the “outcome cannot be predicted in advance” and it is collaborative because “no single participant can control what emerges – the outcome is collectively determined by all participants” (Sawyer, 2010; p. 181).

Although the patterns of interactions in this excerpt from a positive classroom have some distinct features, there are also some similarities with the patterns of interaction analyzed in the null classroom (e.g., inviting multiple student responses) and negative classroom (i.e., re-voicing expected responses, ignoring responses and re-directing to expected responses). What seems to be different in this classroom, however, is that the teacher explored and encouraged elaboration of student ideas and used those ideas in a more open and emergent fashion (Beghetto, 2016b; Sawyer, 2010). Moreover, the teacher provided more guidance and structure and there was less closure and no mocking of ideas as compared to the null and negative classroom.

Moreover, the teacher in this excerpt seemed to demonstrate a willingness to explore and try to understand the way students were thinking. This is not to say that there were no instances of dismissing or ignoring student ideas. Indeed, there were instances when the teacher cut-off students and attempted to direct students with leading questions and explanations. A potentially important difference, however, was that teacher in this excerpt from a positive classroom often explored first, then evaluated or re-directed. This “explore first, then evaluate” approach is one recommended way of how to promote creative learning (Beghetto, 2013, 2016b). It may be the case, that classrooms with a positive association between creativity and learning tend to be characterized by a more exploratory interactional pattern as illustrated in Fig. 3. Again, such claims require additional empirical exploration and verification.

5. General discussion

Prior to discussing our findings, we first want to highlight a few limitations of the study. Given that this article reports on an exploratory and somewhat ambitious endeavor, we recognize that our approach has limitations that require additional refinement and replication.

More specifically, our analysis was limited by the use of teacher grades to select classrooms, brief observations of single lessons in the ten classrooms selected, and our inability to control for other potentially important moderating and mediating factors. Consequently, subsequent efforts would benefit from using larger, more diverse samples and observations across time and across grade levels and subject areas. Also, given that the expression of creative thought and action can be variable across different subject areas (Baer, 2016), different ages of students (Gajda et al., 2017), different teachers (Beilock, Gunderson, Ramirez, & Levine, 2010), and different measures of creativity and academic achievement (Gajda et al., 2017); it will be important that researchers examine these potential mediating and moderating factors in subsequent efforts.

Moreover, although we used systematic observation protocols and the resulting behavioral factors demonstrated good internal consistency, our use of a single observer may have also limited the reliability of these observations. We therefore recommend that subsequent efforts include video recordings of lessons, which can be coded and cross-checked by multiple observers. Similarly, our micro-level analyses and visual depiction of excerpts from lessons were based on our retrospective analyses. A more robust approach would include sharing our analyses with teachers (and even students) in an effort to further explore and understand what additional factors and constraints (e.g., temporal, socio-emotional, physical, situational) may have been at play and thereby influenced the interactional responses and patterns depicted herein (Beghetto, 2016a). We therefore recommend that researchers consider ways of assessing the perspectives and experiences of teachers and students using methods such as experience sampling (Hektner, Schmidt, & Csikszentmihalyi, 2007).

Still, even with these limitations, we feel that this initial effort represents a promising and much needed multi-method approach for exploring the dynamic nature of creative learning in the classroom. In what follows we will briefly discuss some key findings from this initial effort and offer some concluding thoughts.

5.1. Teacher and student behaviors

Given that a classroom is a system (Parsons, 2008), teachers and students dynamically shape how that system operates and is experienced by virtue of the behaviors they exhibit. With respect to creative learning, the classroom environment plays a key role in determining whether creative learning will be supported or suppressed (Beghetto, 2016b). Our results indicate that there were several types of teacher and student behaviors that seemed to vary as a function of whether classrooms had a positive association with creativity and learning (versus a negative or null relationship).

5.1.1. Teacher behaviors

Teachers in classrooms with a positive association tended to demonstrate behaviors that we labeled as more “caring” (i.e., careful listening, authenticity of the teacher’s behaviors, delayed assessment of ideas) and “emotionally supportive” (e.g., friendly humor, motivating to manage failure). These findings align with prior work that has highlighted the importance of the affective support when
it comes to behaviors associated with supporting creative learning (Kader, 2008; McGreevy, 1990). Indeed, this type of emotional scaffolding (Rosiek & Beghetto, 2009) seems to not only support creativity and learning, but in the context of our findings, seems to play a larger role than behaviors associated more directly with supporting creativity (e.g., encouraging creativity and providing risk acceptance). Although these findings require further exploration in subsequent studies, they do suggest that establishing an emotionally supportive and caring environment may provide the psychological safety necessary for students to take the risks required for creative learning (Beghetto, 2016b).

Conversely, in classrooms with null and negative relationships between creativity and learning there seemed to be limited opportunities to share and build on ideas. Moreover, there seemed to be greater instances of quick acceptance, dismissals, and contesting of ideas. Although contesting ideas can be an important aspect of providing creativity supportive feedback, how that feedback is delivered and received can play an important role in whether it supports or suppresses creative expression (Beghetto, 2007, 2016b; Niu, 2007).

Another interesting set of findings with respect to teacher behaviors pertain to lesson duration. Specifically, our findings suggest that some behaviors such as encouraging creativity and emotional support may be more difficult for teachers to sustain across the duration of a lesson. To the extent that these behaviors are important for encouraging students’ creative thought and behavior in the classroom, it will be important to examine the consistency and consequences of these findings in subsequent efforts.

5.1.2. Student behaviors

With respect to student behaviors, our results indicate that there were not many differences across types of classrooms. One pattern of findings that is interesting, however, is that positive engagement tended to decline across all classroom types and students in classrooms classified with a negative relationship between creativity and achievement, tended to demonstrate lower levels of misbehavior, self-expression, and positive engagement. These findings suggest that classrooms classified with a negative relationship between creativity and achievement may reinforce conformity to teachers’ expectations – both cognitive (i.e., provide expected responses) and behavioral (i.e., behave in expected ways). Whereas classrooms with a null relationship may occasionally result in higher levels of misbehavior because, as we noted in our micro-analysis of interactions, there may be a lack of necessary structure and guidance provided by the teacher.

These findings offer new and more nuanced insights into previous work that has tended to associate student creativity with perceived misbehavior (Stone, 1980; Westby & Dawson, 1995). Specifically, creativity may be able to co-exist with academic learning and behavioral expectations as long as there is sufficient structure and guidance in place. However, students may lack the stamina to maintain high levels of positive engagement during the course of a 45-min lesson. Again, these findings point to directions for subsequent study by creativity researchers.

5.1.3. Relationship between teacher and student behaviors

Regardless of classroom type, we found that encouraging creativity was associated with students’ demonstrating positive engagement, self-expression, and ideation. These results contribute to and align with previous work, which has suggested that actively encouraging creativity can result in behaviors associated with creative expression (Davies et al., 2012; Feldhusen & Treffinger, 1980; Torrance, 1962). Teacher’s risk acceptance was also positively related to students’ self-expression and ideation. As we mentioned above, however, encouraging creative expression and risk acceptance were not more pronounced in classrooms that demonstrated a positive correlation between creativity and learning. Indeed, our findings suggest that demonstrating care and emotional support may be more important to establishing creative learning environments that more directly form encouraging creativity. These findings raise some interesting questions, particularly as they pertain to the idea that creative learning benefits from the productive conflict of ideas and encounters with difference (Beghetto, 2016b; Glâveanu & Beghetto, 2016), including: Are there certain ages, topics, or situations when the experience of care and emotional support are more important for promoting the productive conflict of ideas? Do younger students, for instance, benefit more from such conditions than older students? Or might there be a certain threshold of caring behaviors and emotional support necessary for creative learning to occur? These questions warrant further exploration by creativity researchers.

5.2. Discussion of teacher and student interactions

The results of our more micro-focused analyses of teacher and student interactions highlight how using concrete, visual displays of interactions – even brief interactions – can reveal potentially important insights into the norms and expectations of different types of classrooms (Beghetto, 2016a; Tanggaard & Beghetto, 2015). As we discussed, classrooms supportive of creative learning seem to be those characterized by patterns of interaction that provided openings for students to share their ideas and opportunities to further explore those ideas (even when expected answers are provided). This differs from classrooms where openings are provided, but not explored or receive more closed and directive evaluations (negative and null classrooms).

This is not to say that directive and even dismissive moments are completely absent from the classroom with a positive association between creativity and academic learning. Indeed, our analysis highlighted moments of dismissal, suspended (abandoned) ideas, and directives by the teacher. These findings suggest seemingly stifling behaviors may not always be problematic, but that the frequency or intensity of such behaviors may be more of an important factor to consider in classrooms that are more or less supportive of creative learning. Again, such speculations require further empirical exploration.

Moreover, as we have discussed, our findings indicate that regardless of classroom type (positive, negative, null) it may be difficult for teachers and students to sustain behaviors associated with creative learning over the duration of the entire lesson. One
reason may be that as the lesson progresses, teachers may feel the pressure to move students to predetermined learning goals and outcomes. Moreover, students may start to lose interest as the lesson progresses for more than 15 min. These findings highlight the dynamic and more nuanced nature of classroom interactions and suggest to us that no classroom is monolithic with respect to how teacher or student behaviors are displayed at different times across different patterns of interactions. Still, given that we did note differences in the behaviors and interactions across the three classroom types, there may be consistent and salient features of those behaviors (e.g., demonstrating care and providing emotional support) and interactions (e.g., inviting elaboration shared ideas) that established classroom conditions more conducive to creative learning.

Along these lines, there are several important questions to be explored in subsequent work, including: Is there an optimal balance that can be struck between exploratory versus directive teaching? How might that balance vary by academic subject area and sub-topics within subject areas? Are there more or less optimal durations of a classroom interactions when it comes to supporting creative learning? How might teachers who are more closed and directive in their approach incorporate more opportunities for open exploration? Conversely, how might teachers who take a more open approach find ways to provide necessary structure, feedback, and directives to keep the lesson moving along? Under what conditions might productive conflict of ideas be best promoted – does this vary by age, subject matter, and participants in the room? What other moderating and mediating factors might be play in establishing conditions more or less supportive of both creativity and learning?

6. Conclusion

Creative learning is a complex process that is not easy to examine in a single study, even one that uses multiple methods. However, we hope that the blended approach we have demonstrated in this study provides researchers with insights into how they might use a combination of quantitative and qualitative methods to more thoroughly examine creativity and learning in classroom settings. We therefore encourage researchers to test the consistency of our findings reported herein and build on these findings in their subsequent work. Although studies such as this one are time and resource intensive, we believe they have the potential to deepen our understanding of how something as complex as creative learning might be better understood and, ultimately, supported in the classroom.

Appendix A. Student behavior examples

<table>
<thead>
<tr>
<th>Item</th>
<th>Example of interaction or behavior</th>
</tr>
</thead>
</table>
| Questioning classroom rules       | S: Miss, can I change my seat? because I'm not comfortable here  
T: You know the rules; we do not change our seats during the lesson  
S: (...) but really I'm not comfortable here, but can I?  
T: No, you can't  
S: But I want another seat!  
T: Why are you turning away, do it yourself [task]  
T: But it itches, it itches … and what are you laughing at?? [to his classmates] |
| Behavioral risk                   | T: Olek [name] Your behavior is inappropriate. Please improve  
S: That's not true! I will not!  
T: But you know what is the risk? I'll have to give you a reprimand in your report card |
| Distraction of attention          | i.e. students are losing concentration during a brainstorming session. They start the sentence but many distractors prevent them from finishing the speech |
| Inappropriate answers             | T: It is possible! Everything is possible!  
S: no  
T: well, let me prove it to you (...)  
S: Then why can't I fly? |
| Not being discouraged by setbacks | T: Jaś [name], what did you learn during today's lesson? The last condition that you met? You need to remember?  
S: That the sum of two…er…, I don't know.  
T: Try again. What did you learn, what is the conclusion from this? That each interior angle of a triangle, the triangle has three interior angles. What is the conclusion?  
S: That the sum of these angles is always 180° |
| Transforming the student's own and other students' ideas | T: What is the problem we have in the book?  
S1: The Stranger (The main character of the book)  
T: But please name the problem. Say what is the problem?  
S2: No one is interested in him |
| Expressing emotion                | A student wants to tell an idea for a solution to the problem, after lesson is over:  
T: I want to finish a lesson  
S: and I want to tell my idea  
T: And I want to finish a lesson! |
Curiosity and interest in the topic
Students carefully listen to the teacher who presents a new topic of a lesson:
T: And you shall know soon what you have to do in a group class. Soon I'll show you
S1: Cool!
T: here it is the hidden password [shows the board with mathematical tasks], what else can you
do in a group, in a class? What are we going to do? you will be guessing some things. I would
like to .
S2: I know, I know! Thirty! [gives the answer to the first task]
T: Who will guess the second task?
S: [students chorus] Me, me! I can do it!

Opposing the teacher's views
T: unfortunately, unfortunately (….) We don't go to the court. After Maciek's [the name] last
fall it might still better … Isn't it?
S: It actually it isn't better (…)

Engagement in new tasks
i.e. students start to create mind maps (new task) with the willingness and curiosity
Ease in recalling words and expressions
T: So you say the characteristics of the comb well. Olive [name]?
S1: This is handy
T: is a small handheld, it can be e.g. hidden in a purse or even in your pocket, Ewa [name]
S2: useful, helpful
T: Great! Julia [name]
S3: smooth, comfortable

Expressing one's own views
T: Please listen to the questions, and what our colleagues have to say, first read the question:
S: How do you think, why did the girls fail to complete the project? [gives an answer]. They
have to cope alone because Natalka [character in text] went to the store well and asked for a
shoe box and well, they need to deal with themselves.
Jokes and sense of humor
[Discussion about how to encourage colleague to clean]
S1: it is better to clean up, because at the same time it can be fun to play. Throw it, play with it,
e.g. some missions up there, or collect blocks, disarm bombs and so on. It's fun.
S2: Unless you stumble finally, and such fun will come out of it [laughs]

Many ideas from various categories
i.e. Students give the use of term “universal” for the remote control, clothes, computers, etc.
Many answers to the same question
i.e. Students give a wide variety of ideas on the question of the use of the comb.
Surprising answers
T: What questions can we ask in connection with our text?
S: Did grandmother have hearts cut in the shutters? [there is no such information in the text read in class]

Cordiality toward other students
Pupils care for each other, in a situation where a student does not understand task, a colleague
offers him help

Appendix B. Teacher behavior examples

<table>
<thead>
<tr>
<th>Item</th>
<th>Example of interaction or behavior</th>
</tr>
</thead>
<tbody>
<tr>
<td>Careful listening to questions</td>
<td>During the discussion about the term “universal” a question not related to the subject of the lesson is asked: S: Miss, Can I borrow an eraser from you? T: And why do you need it? We have not used a pencil so far S: I know, but I am writing with a pencil now</td>
</tr>
<tr>
<td>Delayed assessment of ideas</td>
<td>i.e. While giving answer to the question on the use of a comb by students, teacher does not evaluate ideas for good and bad. She defers assessment and allows for discussion on the merits of each idea at a later stage of lesson.</td>
</tr>
<tr>
<td>Group work organization</td>
<td>T: Now, working in groups, solve problems as a group, as a team. That is: not one person solves the problem, but all together</td>
</tr>
<tr>
<td>Authenticity, genuineness</td>
<td>T: I'm sorry you could not appreciate the efforts of your colleagues (…)</td>
</tr>
<tr>
<td>Encouraging to search for diverse ideas</td>
<td>T: The task is to come up with as many uses for a comb but other than its basic application which is combing.</td>
</tr>
<tr>
<td>Encouraging to create many ideas</td>
<td>T: Please note, those of you who generate the most of these ideas, this group [while working in groups] will get rewarded. But remember, all the questions …. All the answers should address this question.</td>
</tr>
<tr>
<td>Open questions</td>
<td>T: How could the main character feel at that time? (During classes about one of the school books)</td>
</tr>
<tr>
<td>Encouraging divergent thinking</td>
<td>T: Look for a variety of ideas in your heads, such that no one else would come up with</td>
</tr>
</tbody>
</table>
Atmosphere of creative play  

i.e. During the classes, when possible, the teacher allows a playful atmosphere, playing with ideas and moving away from rigid class rules.

Friendly humor  

T: There are three [about numerical tokens] Magda [name], you have three? that's good. Come on, give one — all the same, after all they are not signed. Please. And what? Yours are missing? [to another student] Is Dinosaur camouflaged or what? [about an illustration on the pencil case one of the students]

Using constructive criticism  

T: What a great idea! It's not exactly the answer to our question. But how can this idea be developed, improved?

Motivating to manage failures  

while solving a mathematical problem:

T: Sara [name]. What is the answer?  
S1: The 3/10 x.  
T: Victor?  
S2. 3/10 x.  
T. And the last group?  
S2. 7/10 x. [Gives the wrong answer]  
T: See, here the answer is wrong, then try to resolve it once again, can you see where was the mistake?

Sensitivity to feelings  

T: Okay, folks. We read a book, you have heads now certainly full of emotion and I would like that we begin to try to define… et… what is the concern of the book. So, cruel notion that carries a lot …. a lot of really moving to the depths of emotion.

Encouraging to take risk  

To a student who doubt whether to approach to mathematical competition:  
T: What worries you? What can happen if you do?  
S: Well, I do not know. I'm afraid…emm… that I'll not be able to handle it  
T: And how would you feel if you tried, and if you did well?  
S: Cheerful  
T: And if it went bad?  
S: I would be nervous that I didn't succeed.

Making it possible to choose and make decisions  

T: Would you prefer to play the math bingo now [game combines bingo and ability to perform mathematical operations] or the intelligence? [coming up with answers that start with a particular letter]

Acceptance of unconventional and strange ideas  

T: I think the creativity in presentation [is noticeable], especially because not all the answers were consistent with the theme. But the boys here were tempted by a little bit of acting and it worked out fine, right?

Assertiveness, respecting students’ feelings  

T: We can’t change the date of the test. It is important to me that it’s held in a week, because then there is a long weekend and it will be harder to concentrate when you return. But I’m sure that you will do well, because I see how hard you have worked so far.

Encouraging to test new ideas  

S: Miss, can I put it this way? [creating triangles of sticks of different lengths]  
T: Well, check if that will suit

Tolerance of otherness and new ideas  

T: hmm it’s an interesting point of view. I’m very curious of your opinion about Zenek Wojcik [literature character]

Encouraging to imagine different things  

T: Close your eyes and try to see the girl, the character of a fairy tale: What is she wearing? How does she look? What is she doing? Where is she? What is she going through?

References


