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Zhou, Chunfang

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A Study on Creative Climate in Project-Organized Groups (POGs) in China and Implications for Sustainable Pedagogy

Chunfang Zhou

Department of Planning, Aalborg University, 9000 Aalborg, Denmark; Chunfang@plan.aau.dk

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Abstract: This paper aims to explore a research question: what are the drivers and barriers to fostering a creative climate in POGs in China and how to improve POGs towards a better sustainable pedagogy? Theoretically, this paper bridges studies on creativity, collaborative learning, creative climate, and sustainable pedagogy in one framework. Empirically, mixed methods of quantitative questionnaire survey (n = 126) and qualitative interviews (n = 15) were used to collect data. The findings demonstrate that the drivers to a creative climate include the challenge of the task, openness, trust between peers, experts' help, and group diversity, etc. However, some group problems, such as poor management, lacking of supervision supports, and students' fear of authority, etc., are barriers to a creative climate. This implies the needs of restructuring the relationships between teachers and students in POGs in order to improve it as a better sustainable pedagogy.

Keywords: project-organized groups (POGs); creativity; sustainable pedagogy; creative climate; collaborative learning

1. Introduction

Recently, education for sustainability has been increasingly important at all levels of the educational system including higher education [1,2]. In diverse contexts around the world, universities are experiencing a growing trend to redefine their strategies and organizations along the lines of sustainability. Sustainability has been seen not only as a component of education, research and innovation, but also as a social learning process within and beyond academia [3].

As pedagogy is defined as the art of science of teaching [4], it determines how teachers think and act, and affects students' lives and expectations [5]. The choice of a pedagogical approach depends on the target (pedagogical and educational goals) and the specifics of the situation (reading students, teachers, or the learning environment) [4]. According to the literature, there has been a growing attention to develop sustainable pedagogies in diverse countries such as Australia [5,6], the United Kingdom [1,7], Spain [8], the Netherlands [9], and Sweden [10]. In this way, education for sustainability is underpinned by radically different ways of comprehending learning, teaching, and human interaction with the environment and each other that is understood by the 'business as usual' society in which we live. The sustainable pedagogies also require teachers who should prepare for transformative education with the accompanying personal transformation required [5,6,11].

Among diverse sustainable pedagogical approaches, learning by student projects and solving real-life problems has been discussed much as a good strategy [5]. For example, Lozano et al. [4] described that project-based and problem-based learning are broadly overlapping approaches to education, which emphasize the principles of encouraging students to work with complex and real-world problems. The students normally work in collaborative and interdisciplinary groups and meanwhile self-directed learning is also highlighted, which also may facilitate universities to collaborate with industries and address problems through inquiry under conditions similar to

professional consultation. Accordingly, the shift from teacher-led lectures to group facilitation becomes another principle in project-based and problem-based learning; and students are expected to develop knowledge, skills and competences that particularly help them to deal with challenges of problems/projects representing interdisciplinary sustainability challenges [12]. The project-based and problem-based learning approaches may also overlap with case studies as another form of inquiry-based learning [13,14].

Meanwhile, the literature has addressed the role and value of creativity in higher education for sustainability [6,15]. In general, creativity involves the ability to offer new perspectives, generate novel and meaningful ideas, raise new questions, and come up with solutions to ill-defined problems [16]. Creativity helps people envision and implement alternative practices to the status quo [6]. In other words, the transition towards sustainability demands a capacity to think more laterally, and requires the creation of new actionable knowledge [17]. In this sense, creativity is a pathway to sustainability. As in an earlier discussion, Clark [18] emphasized sustainability is essentially transformative, constructive, and participatory, and underpins the ecological worldview: a very different orientation, and one that stresses community, creativity, and capacity building rather than control, fit, and dependence. Furthermore, there also have discussions on how to foster creativity by student projects that further reflects how to improve sustainable pedagogies [5,12,15,19].

However, there are multiple manifestations of the conceptualization of creativity: personal cognitive and social or emotional processes, family aspects, education, characteristics of the domain and fields, social or cultural contextual aspects, as well as historical forces, event, and trends [12]. Therefore, there are many factors influencing creativity in the transformation into practice of sustainable pedagogies [15]. Thus, both drivers [6,17] and barriers [20,21] have been investigated and discussed in order to improve 'creativity-enhancing' learning environments in higher education [15,22]. Accordingly, the concept 'creative climate' has been much addressed as one way of measuring creativity, which refers to behaviors, attitudes, and feelings that are common in a group or an organization [23], and which underpins the shaping role of the situational environment on the generation of creative ideas in working groups.

Following the above lines, this paper takes project-organized groups (POGs) in Chinese universities as the research context and focuses on a research question: what are the drivers and barriers to fostering a creative climate in POGs in China and how to improve POGs towards a better sustainable pedagogy? This question drives to develop a theoretical framework by bridging studies on creativity, creative climate, collaborative learning, and sustainable pedagogy from a social-cultural perspective. Empirical work will be based on a mixed methods research design involving two parts of data collection: one is a questionnaire survey (n = 126) and one is made up of qualitative interviews (n = 15). As demonstrated by data analysis and results, this study shows important significances of unpacking a creative climate in collaborative learning contexts in a pedagogical strategy of using student projects that provides implications for future sustainable education development.

2. Theoretical Framework

The social-cultural theories indicate creativity and learning go hands in hands in collaborative contexts. Creativity can be regarded as a driver to collaborative learning, and group climate is an indicator of collaborative learning. This leads this paper to regard using student projects as an example of sustainable pedagogy in fostering a creative climate. Based on these points, the following sections will develop the theoretical framework step by step.

2.1. Creativity as a Socio-Cultural Concept

In recent years, a socio-cultural perspective to creativity has been increasingly focused in published work that highlights creativity is a situated activity by considering the contextual influences on creative ideas development [24,25]. For example, the systems model [26] shows creativity happens at the interplay of three subsystems: an individual who learns information from his culture and then changes

it in a way that will be selected by the relevant field of gatekeepers for inclusion into the domain; from such interplay, the novelty of creativity will be accessible to the next generation. This means that creativity cannot happen without taking into account environmental conditions. In the process of creativity development, a variation has to be adapted to its social environment, and it has to be capable of being passed on through time. This further means creativity can be regarded as the engine driving the evolution of culture, since creativity always involves a change in a symbolic system that in turn will influence other individuals' thoughts and feelings in other cultures. Thus, creativity is not only related to individual personality, knowledge, and cognition, but also influenced by interactions between individuals and their environment. Briefly, creativity presupposes a community of people who share new ways and methods of thinking and acting, who learn from each other and imitate each other's actions [26] The socio-cultural perspective to creativity provides a basis of shifting creativity research from individual level to collaborative and organizational levels [27].

2.2. Creativity as an Integrative Element in Collaborative Learning

It is similar with creativity that learning is also a concept that has been increasingly regarded as a social-cultural phenomenon [28]. The social-cultural theory posits that intellectual development is achieved through dialogue and that education is enacted through the interactions between students and teachers reflecting the historical development, cultural values and social practices of the societies and communities in which educational institutions exist [29]. Thus, difficulty should be highlighted in separating out creativity from process of collaborative learning. The co-participative, co-constructive approaches have been explored, discussed, and advocated [30]. This involves the acknowledgement that each individual plays a role in a wider social fabric of idea construction and development of identity through relational engagement and individual integration into collaboration [19]. In the contexts of successful group learning, individual members build on each other's ideas in the process of reaching an understanding that was not available to any of the members initially. However, in order to make this happen, the members need to be committed to shared goals, and have enough trust in each other to participate into the shared endeavor. Meanwhile, the members must also enter into creative, critical, and constructive negotiation of each other's ideas. This also needs well-grounded arguments and counter-arguments to be shared that involves critical evaluation in the group discussion. These conditions of successful group learning are similar to those needed for collaboration in creative endeavors. Thus, educational professionals are increasingly coming to realize that learning and creativity go hand in hand [28].

2.3. Creative Climate as an Indicator of Collaborative Learning

According to Runco [31], climate is defined as the recurring patterns of behavior, attitudes, and feelings that characterize life in the organization. At the individual level of analysis, the concept is called psychological climate. At this level, the concept of climate refers to the individual perceptions of the patterns of behavior. When aggregated, the concept is called organizational climate that has also most often been regarded as shared perceptions at the work groups [32]. This shared perception approach emphasizes the joint experiences of individuals as the linchpin of the concept of climate [33].

As mentioned above, creativity can be viewed as providing many opportunities of learning new knowledge. In both activities of creativity development and learning in group settings, new ideas are proposed and elaborated in a wide-ranging critical dialogue. Through dialogical interaction, new conceptions are collectively constructed [28]. This further indicates that creativity development is influenced by and influence a creative learning environment, where learners may negotiate solutions, exchange ideas, and produce collective learning outcomes [28]. Accordingly, creative climate is a key indicator of assessing collaborative learning. The situated learning contexts seems to be characterized by a commitment to ambitious goals, freedom, and autonomy regarding the choice of tasks and how the learners are performed, encouragement of ideas, and sufficient time for creating ideas, as well as appropriate feedback, recognition, and rewards for creative work [33]. In other words,

when collaborate with others, there is clearly a need for common references (common mental model) to prevent misunderstandings, facilitate communication, and channel the idea generation along avenues likely to be relevant to the problem to be solved by the group members [34].

In addition, some instruments assessing climate such as CCQ (Creative Climate Questionnaire) [35] and KEYS (Work Environment Scale) [36] have been developed in order to identify both promoting and impeding factors of group or organizational creativity. Meanwhile, qualitative methods such as interviews and observation have also been employed in recent studies [37].

2.4. Student Project as a Sustainabile Pedagogy for Developing Creativity

According to Sterling [38], a sustainable pedagogy calls for the following key philosophies: learning is an experience happened in groups, organizations, and communities; the appreciative and cooperative inquiry of learning should be focused in the curriculum design; learners are viewed as whole persons with a full range of needs, skills, and capacities; teachers should be change agents in teaching and learning processes and, therefore, they should be reflective practitioners; learning and teaching styles should be experiences of being spiritual, manual, affective, and physical; the assessment of learning should be focused on the critical, creative, and functional competencies. Briefly, the core value of a sustainable pedagogy is about the quality of learning, which should be seen as essentially a creative, reflexive, and participative process. Accordingly, knowing is seen as experiences of being approximate, relational, and provisional, so learning should be continual exploration through practice. In this sense, to encourage and organize students to learn by solving real-life projects is full of potential to be developed towards a sustainable pedagogy.

In a learning context of working on real-life projects, there are conditions of supporting a fostering a creative climate. For example, Zhou [12] determine the elements, including problem solving, facilitation, interdisciplinary learning, group learning, and project management. These elements interplay with each other and meanwhile commonly construct a learning community. They also can be seen as a stimulus of social practice in a learning context and provide appreciate conditions of group interactions, which further facilitate both individual and group creativity. Accordingly, a creative climate is developed through interplays between different elements, students, teachers and the practice of solving a real-life project: therefore, creativity development happens in these interplays and such process is embedded in a situated-learning community built by project work [12]. Accordingly, Zhou [19] proposed a metaphor by viewing a student project as an 'extra group member' in developing creativity. This means that creativity is generated from 'conversations' between students and an 'extra group member', which are 'back and forth' processes: the 'extra group member' 'asks' students to challenge their project tasks, 'requests' group meetings or discussions, 'speeds up' decision-making, and 'reminds' the time schedule of project work; the students react in collaborative ways in order to 'respond to' the 'extra group member'. This metaphor further addresses that creativity is social-constructed as dialogic and not as unitary [30] and the 'relationship' in such social-construction is a form of dynamic interaction between learners, and between learners and the discipline itself.

3. Research Context and Empirical Work

3.1. Project-Organized Groups (POGs) in China

In Chinese universities, the project-organized groups (POGs) have been considered as a promising sustainable pedagogy in science and engineering education on postgraduate levels. POGs usually work in university laboratories managed by the faculties or departments and they work on projects supported by government, companies, or universities. Usually, the groups consist of supervisors and their students from different levels and diverse backgrounds. The supervisors are university professors with the responsibilities of group leaders, as well as being experts in certain fields. Usually, the supervisors are project leaders who are in charge of the whole process of project management; while the students can gain opportunities to participate in the projects and their tasks are assigned by

supervisors. In this sense, POGs provides students opportunities of solving real-life problems and collaborating with other members; and meanwhile, they learn to how to move on projects in order to meet the project milestones made by their supervisors.

As an overall curriculum framework in science and engineering education in China is still a lecture-centered system, POGs have their significances of facilitating science and engineering students to apply theories into practice. However, any pedagogical approach requires a self-evaluation in order to figure out its both strengths and weaknesses and make strategies to improve better for sustainable development. In this sense, this study takes POGs as a research context, and carries out empirical work centered by an investigation on drivers and barriers to a creative climate among POGs.

3.2. A Mixed Methods Research Design

This study made a choice of a mixed methods research design that is mainly based on the statement of research question that basically requires both drivers and barriers to fostering a creative climate in the research context of POGs in China. This also indicates the inquiry of combining and associating both qualitative and quantitative forms. As suggested by Creswell [39], one of the reasons for combing both qualitative and quantitative data could be to better understand a research problem by converging (or triangulating) broad numeric trends from quantitative research and the detail of qualitative research. Thus, this involves not only simply collecting and analyzing both kinds of data, but also the use of both approaches in tandem, which may lead to the overall strength of this study which is greater than either qualitative or quantitative research [39].

This directed the empirical work in this study to be conducted by sequential procedures, which involved beginning with a quantitative questionnaire survey (n = 126) with a large sample so that this generalized the results to a population that was further followed by a qualitative interview (n = 15) involving detailed and deeper exploration with a few of individuals from a participant perspective.

3.3. Data Collection

The first part data collected by the questionnaire survey was to seek students' evaluations of the creative climate in relation to their collaborative learning experiences in POGs, from which conclusions may be drawn on both drivers and barriers to a creative climate. The participants (n = 126) were second-year undergraduate students (male = 83, female = 43) from 25 POGs in seven universities in Northeastern China. The universities included Northeastern University, Dalian University of Technology, China Medical University, Shenyang Medicine University, Shenyang Agriculture University, Shenyang Industry University, and Shenyang Jianzhu University. The disciplines of POGs included electricity, process management, material engineering, environmental management, chemistry, ocean engineering, production engineering, biology, medicine, and civil engineering. The 25 POGs were investigated one by one in their working places. In each group, 5–6 members were volunteers to fill in the questionnaires. Before the investigation, a clear guide on how to finish the questionnaire survey was explained, and during the survey, the researcher of this study stayed with participants to ensure a complete rate response.

The Creative Climate Questionnaire (CCQ) was employed in this questionnaire survey. The original version of CCQ was developed in Sweden [35]. Wu and his colleagues [40] revised the Chinese version in their study. The CCQ was selected for this work because it has previously been applied in research in Europe and Asia [41]. CCQ includes a range of factors covering factors that both stimulate and hamper creativity. There are 10 climate dimensions and are designed to measure each dimension with five items. Nine of the dimensions include items hypothesized to promote creativity. The tenth dimension "conflict" is assumed to be negatively related to creativity (Table 1). Fifty questions were constructed to fit 10 dimensions. Each dimension consisted of statements and the respondents were required to determine the degree to which the statements were true of the organizational creative climate occurring in their groups [41].

Table 1. CCQ dimensions and descriptions.

Dimension	Description
Challenge	The degree to which the people of the organization are emotionally involved in its operations and goals and find pleasure and meaningfulness in their job.
Freedom	The independence of behavior exerted by the members of the organization. In climates with a great deal of freedom people are given autonomy to define much of their own work.
Idea support	The ways new ideas are treated. In the supportive climate managers and colleagues receive ideas and suggestions in an attentive and receptive way and there are possibilities for trying out new ideas.
Trust/openness	The degree of perceived emotional safety in relationships. When there is a strong level of trust, everyone dares to present ideas and opinions since initiatives can be taken without fear of reprisals or ridicule in case of failures.
Dynamism/liveliness	In a dynamic climate, new things happen all the time and there are frequent changes in ways of thinking about and handling issues.
Playfulness/humor	The perceived ease and spontaneity, a relaxed atmosphere with laughter and jokes.
Debates	Encounters, exchanges, or clashes among ideas, viewpoints, and differing experiences and knowledge. Many voices are heard and people are keen on putting forward their ideas.
Idea time	The amount of time one can use for developing new ideas. Organizations characterized with much idea time are giving possibilities to discuss and test impulses and suggestions that are not planned or included in the task assignment.
Risk taking	The tolerance of uncertainty in the organization. In the high risk-taking climate, decisions and actions are rapid, arising opportunities are seized upon, and concrete experimentation is preferred to detailed investigation and analysis.
Conflicts	The degree of emotional and personal tensions in the organization. In climates with high levels of conflict, groups and individuals dislike each other and there is considerable gossip and slander.

In addition to the data collected by the questionnaire survey, qualitative interviews also were conducted with 15 undergraduate students at Northeastern University (NEU), China, which has a long tradition of POGs. All the interviewees were invited in the first instance, and participated voluntarily in the data collection. They were identified as Interviewee 1 to Interviewee 15. They came from three disciplines in science and technology education including electricity, chemistry, and environmental management. The age of interviewees arranges from 22 to 26 years old. There were eight boys and seven girls. Each interview lasted around 30 min and was recorded and transcribed as text. The interviews were semi-structured, allowing in-depth follow-up of initial responses to questions asked by the interviewer. Many open questions were used to find out students' perceptions on a creative climate in POGs. The interviews were recorded with the permission of interviewees, and, after interviews, transcription was made that provides the data resource for analysis.

3.4. Data Analysis

According to Creswell [39], data analysis in mixed methods research relates to the type of research strategy chosen for the procedures. Thus, the procedures of data analysis need to be identified within the design. In this study, analysis occurred both within the quantitative (descriptive and inferential numeric analysis) and the qualitative (description and thematic text analysis) approach and between the two approaches.

After the data collection of questionnaire survey, the mean of variable was measured by SPSS (IBM SPSS Statistics) that may show an overall situation about group members' perceptions of drivers and barriers to a creative climate in POGs. However, the questionnaire survey only provided a limited range of factors that were available to be chosen by participants.

The later qualitative interviews provided an open assumption of investigation. Content analysis was used to analysis of interview data. Categories are usually derived from theoretical constructs or

areas of interest devised in advance of the analysis (pre-ordinate categorization) rather than being developed from the material itself, though referencing the empirical data may in turn modify the categories. So the features of the content analysis process in this study are [42]:

(1) to break down text into units of analysis;
(2) to undertake statistical analysis of the units; and
(3) to present the analysis according to the results of step 2.

The conclusion generated thus emerges both deductively and inductively from the data collection and analysis through the mixed methods and that is also based on the interplay between the results of the questionnaire survey and interviews, and appears as the end findings.

4. Findings of Empirical Work

According to the results of the CCQ survey, an overall self-evaluation of a creative climate by students has been obtained, which can be indicated by the statistics of mean value for every factor in the CCQ (Table 2).

Table 2. Mean scores of factors of creative climate.

Dimension	Min	Max	*N*	Mean	SD
Freedom	2.00	5.00	126	3.90	0.62
Idea Support	2.00	5.00	126	3.90	0.72
Trust/Openness	2.00	5.00	126	4.00 *	0.65
Dynamism/Liveliness	2.00	5.00	126	3.86	0.71
Playfulness/Humor	2.00	5.00	126	3.58	0.66
Debates	1.00	5.00	126	3.72	0.74
Conflict	1.00	4.00	126	1.95 ***	0.69
Risk Taking	1.00	5.00	126	3.41 **	0.64
Idea Time	2.00	5.00	126	3.71	0.67
Challenge	2.00	5.00	126	4.23 *	0.63

Note: Five-point scale, 1 = not at all applicable strongly, 5 = applicable to high degree; * factors are evaluated with higher score than others (challenge, trust/openness); ** factor is evaluated the lowest score in nine positive factors (risk taking); *** negative factor, a lower score is generally better (conflict).

As shown in Table 2, 126 group members positively evaluate 10 factors meaning that the climate is inspiring in these groups. The statistics results for four factors including "challenge", "openness/trust", "conflict", and "risk taking" should be noted as follows:

(1) "Challenge" and "openness/trust" are evaluated with a higher score than the other factors by all group members, which means that these two factors are most inspiring to group climate.
(2) "Conflict" is evaluated with the lowest score of all factors, while it is a negative factor, for which a lower score is generally better. Therefore, conflict seldom exists in groups.
(3) "Risk taking" is evaluated with the lowest score for the nine positive factors, so members consider it as the most unwelcome factor in their climate.

In contrast to the statistical nature of the questionnaire survey, qualitative interview is more naturalistic, interpretive, and multidimensional. According to the features of content analysis on the interview data and centered by research questions of this paper, both drivers and barriers to a creative climate were also summarized, as Table 3 shows.

Table 3. Summarized drivers and barriers to creative climate by interviews.

Themes	Interview Findings
Drivers of Creative Climate	• Freedom of participating in project work • Challenge of project task • Group openness • Trust and support between group members • Help from experts (professors, supervisors, or senior students) • Group diversity • Shared leadership in group management • Milestones and project deadline • Finding online information • Group common goal and clear individual tasks • Group meetings and knowledge sharing • Group disagreement • Qualified group leader
Barriers to Creative Climate	• Fear of authority • Limited working time and urgent deadlines • Relying more on experience rather than potentially risky new ideas • Ineffective communication between members • Large group size with poor group management • Lack of group supervisors • Tasks assigned by supervisors • Lack of group work experience • Group membership changes

As indicated by Table 3, the interviews have revealed more detailed perceptions of students' collaborative learning experiences in relation to both drivers and barriers to developing a creative climate in POGs. As Ten Have [43] suggested, the crucial feature of qualitative study is to "work up" one's research material, to search for hidden meanings, underlying features, multiple interpretations, implied connotations, and unheard voices. Thus, the interview data helped to explain why the basic results were achieved through the first part data collected by questionnaire survey and, meanwhile, provide more insightful points to answer the research question of this study. This will also lead to the next section of discussions.

5. Discussion

The findings indicate both drivers and barriers to a creative climate in POGs that reflects both the advantages and weaknesses of POGs. The advantages include stimulating motivation, filling the gap between theories and practice, and enhancing both collaborative and self-directed learning abilities, etc. The weakness reveals the student project management problems such as adoring authority and leadership and avoiding group conflicts. This has implications for the future improvement of POGs toward a better sustainable pedagogy.

5.1. Drivers and Barriers to Creative Climate in POGs

The findings from both the questionnaire survey and interviews show that "challenge of task" is one of the drivers to a creative climate. This is in line with previous studies [15,19,44] that discussed the advantages of using student projects in creativity development: to solve real-life problems brings changes to students, because many problems start off by being under- or ill-defined setting work that is both critical and difficult. This means some projects involve explorations by means of repeated simulations and a hands-on personal experience that necessarily instills the development of initiative and enhances the power of creative thought. Meanwhile, the students realized the need to work as a professional or group of professionals [19,44]. The interviews revealed the above points:

- "At the beginning, we did not know how to choose the appropriate hardware. This required us to discuss the problems and we needed everyone's creative thoughts until we reached a

satisfying result. But after that, we all felt the challenges were good, because we learned so much." (Interviewee 3)

Group discussion, as the students mentioned, is the main activity in the group meeting that facilitates knowledge sharing. It is conducted on the condition of group openness whereby everyone is welcome to express his or her opinions. As Hennessey [45] discussed, the exchange and evaluation of ideas, the modeling of creative processes, and the championing of new products or proposed solutions to problems all involve interactions between group members. The climate of group openness brings psychological safety to individuals in developing new ideas, where the students feel free to search for information and seek the support of others. However, when arguments and friction do occur, they are centered on ideas, not people. However, the data from the interviews shows that this kind of open climate is much encouraged by the group supervisors who assume the role of qualified project leaders.

- "The right working direction is a key to effective collaboration and successful products. This is mostly expected from the leadership role of our supervisor. And his support is very important when the group encounters uncertain situations, this is also the reason for saying the supervisor is qualified." (Interviewee 11)

In addition to the above points, two further characteristics of group openness were found in the interviews: (1) the students' participated voluntarily in the project work; however, their qualification should be assessed by supervisors in the projects, and also should meet the principle of group diversity; and (2) any group welcomes help from external experts working in the field of the project work, and the experts may be professors or senior students who have more knowledge and project experience than the group participants. In addition, to seeking information or possible solutions for project work is also an important way of learning from "experts", as the students said:

- "I introduced myself to the supervisor and the group members, and was offered the possibility of membership when new hands were needed. Personally, I joined in the project because I desired to learn more knowledge and group skills." (Interviewee 1)
- "One of the usual ways of getting help is to ask others. We are encouraged to meet with many professors. Students who are in the higher years can also provide good suggestions and they are very easy to approach." (Interviewee 8)
- "It does not matter if sometimes you are working alone. To type the keywords relating to the problems into the computer, you will find a long list of references. We cannot move on anything without online information." (Interviewee 12)

This further indicates that within the group, members' diverse backgrounds are helpful to fruitful discussion and knowledge sharing in POG; at the same time, the multiple channels of getting help from outside of the group ensures the group dynamic. As Nijstad and Paulus [46] discussed, individuals do not operate in isolation, and neither do the groups. The outside contacts can be seen as the group's social capital and provide the group with information, support, or other resources. Creative cognition is in the degree to which a work group considers multiple alternatives before committing to any one decision or course of action. Sharing unique information is essential to a creative process. The more information that is available in a work group, the more likely it is that some element will provide a novel approach to a particular problem or task. The sharing of unique information may also enable members to successfully recombine old ideas and apply them to the current task, thereby creating something new [6,47]. Furthermore, the interviews also showed students enjoyed the shared leadership in the group management that requires clear group goals and individual tasks:

- "Everyone is in charge of one part of the project. It sounds like playing building blocks together. Therefore, we have to be clear about the group goal and individual tasks, this is the first step to working together and also guides us in figuring out how negotiation between the group members should take place." (Interviewee 6)

This underpins the findings of previous studies [12,19,48] that the student project facilitates the interplay between individual creativity and group creativity. When students are working on solving problems for a common group goal, they are engaged in an active search for meaningful information, a proactive immersion in the task, a conscious and subconscious investment of time on the task, and a search for meaning and explanation, along with the adoption of the goal and future orientations. Meanwhile, the students' individual learning helps them to construct "being a group member" as part of their identity. As Wenger [49] addressed, because learning transforms who we are and what we can do, it is an experience of identity. Viewed as an experience of identity, learning entails both a process and a place. It entails a process of transforming knowledge, as well as a context in which to define an identity of participation. As a consequence, to support learning is not only to support the process of acquiring knowledge, but also to offer a place where new ways of knowing can be realized in the form of such an identity. As mentioned, POGs usually work in university laboratories where provides conditions of meeting both learning needs of process and place.

However, group disagreement and conflict is not regarded as a barrier to creativity, which is indicated by both the questionnaire survey and interviews. As Ngeyen and his colleagues [48] suggested, in a Chinese group setting, the harmonious relationship between members is underpinned. Thus, Chinese learners suppress their personal desires, avoid conflicts and, hence, avoid criticizing their peers or claiming any authority. Furthermore, another problem showing POGs does not welcome the "risk taking" of new ideas was also found by both research methods. It is mostly due to the urgent project deadline of—the student group has to finish the given task before a certain date to report to the industry or government or for being ready for the competition. Therefore, the students expressed that sometimes their supervisors delivered too much of their own experience in solving problems instead of exploring new solutions. Some students were even fearful of challenging existing solutions because they were worried about antagonizing their supervisors. Therefore, they had to finish the given task assigned by the supervisor otherwise they risked losing their membership of the group:

- "Although we have a lot of new ideas, sometimes the time does not allow us to put them into practice. We know that it is not good to repeat the previous solution, but it is a very realistic method for us." (Interviewee 2)
- "I feel lucky the group needed me. To learn from the older members, to follow the supervisor and to make everyone satisfied with my work is the way to win trust and keep my membership, because I am new." (Interviewee 10)

These problems reflect some realistic management problems of POGs. As mentioned, the students have ownership of participating in a group and proposing their own ideas within the group discussion, however, they do not lead the project by themselves. This means the strategy of POGs only provides students with opportunities to finish the given tasks within the limited time under the leadership of their supervisor, instead of letting students participate in the management of project work. This is due to the overall curriculum system of higher education in China that is still traditional and based on the lecture. Thus, learning by POGs is quite an innovative strategy filling the gaps between learning theoretically and the practical application of knowledge. However, it seems to be an accessory to the current curriculum system, since both supervisors and students have to use their spare time to work on it. Therefore, there is a phenomenon that one supervisor is in charge of three or four groups, which is the core reason that students feel lacking in support and supervision. Some groups are loosely organized with a large membership of around 20 people and frequent membership changes that lead to the problem of ineffective communication.

Meanwhile, this also involves rethinking the influences of traditional Chinese culture on today's higher education in China. As Bush and Qiang [50] argued, although the new cultural elements, such as the socialist culture and the enterprise culture, have been developed in the current educational system in China, the predominant elements of Chinese culture remain in place and continue to exert influence; thus, a love of authority and leadership are balanced with hierarchy and collectivism. According to

traditional Chinese teaching, children are expected to comply with the requirements of adults without question. This is closely linked with the concept of "filial piety", which requires absolute obedience and complete devotion to teachers or parents. This stance clearly influences classroom activity where there is an emphasis on teaching through lectures and demonstrations rather than learning through discussion or student questions [41]. Such a culture influenced the behavior of some students in the POGs context, leading to fear of asking questions, challenging authority, or worrying about a supervisor's unsatisfying response to questions [20,51]. Undoubtedly, this is negatively correlated with the characteristics of a creative personality and incompatible with creative expression [48].

To summarize, the findings indicate both the advantages and weaknesses of POGs in developing creativity. The advantages include stimulating motivation, filling the gap between theories and practice, and enhancing both collaborative and self-directed learning abilities, etc. This is in line with what previous studies have argued [5,12,52], projects may serve as the ideal setting for developing inquiry skills that enable us to better understand our assumptions and the consequences of our actions. They provide the conditions for reflective practices and group efforts. They involve exploration through a hands-on personal experience that necessarily instills the development of initiative and enhances the powers of creative thought. However, it also reveals the Chinese cultural conflict with creativity due to existing problems, such as adoring authority and leadership and avoiding group conflicts. This has implications for the future improvement of POGs toward a sustainable pedagogy.

5.2. Improving POGs towards a Better Sustainable Pedagogy

To improve POGs practically one has to rethink creativity, collaborative learning and creative climate as social-cultural conceptions, which is also guided by the core value of sustainable pedagogy that may be helpful in addressing the current weaknesses of POGs. As Sterling [38] suggested, to accept cultural differences is important in educating global citizens, thus "diversity" should be a key concept of sustainable education that involves cultural, social, economic, and biological issues. As the results of this study demonstrated, the barriers to creativity are calling for a restructuring between learners in POGs. It requires as a first step adapting teachers' roles to that of expert learners rather than learning leaders that will then improve the equality of relationship between all the learners [12].

Teachers in China are traditionally regarded as an occupation enjoying relatively high prestige compared to other professions. The teaching styles arising from the Confucian ethic lead to Chinese societies often being described as "didactic and trainer centered" which means teachers are coaches who own authority in quiet classrooms [20,51,53]. However, the current situation in China has already suggested one way out of the paradox of promoting a creative climate in Asian classrooms is to promote an egalitarian approach based on self-determination theory with fulfillment of the basic psychological needs of competence, relatedness, and autonomy [54]. Thus, the teacher is no longer merely the one-who-teaches, but one who is, himself, taught in dialogue with students, who, in turn, while being taught, also teaches. They become jointly responsible for a process in which everyone grows [19,55]. Especially within the context of problem-solving education, students are not only taught facts, information, and knowledge as in banking education, they also learn along with their teachers how to think and how to reflect on their experiences, lives, and activities with others around them. They are no longer passive learners in their community [5,6,38,54]. Accordingly, the supervisors in POGs should no longer lead students; they are expected to be expert learners among their students.

Thus, in China, a further improvement of POGs need a better application of the egalitarian approach requires to build a learning culture, where calls for the equal relationships between all learners, and where may help all the learners to fully engage themselves in problem-solving communities. As Sterling [38] suggested, there are two key functions that sustainable education should play: one is the liberal function that means to develop the individual and his/her potential; and one is the transformative function that means to encourage changes towards a fairer society and a better world. However, the traditional Chinese culture clearly shows the importance of family in society and account for its paternalism which still influences today's relationships between Chinese people

in working contexts, for example, the principles of seniority and modelling between the elder and younger. However, an apprenticeship is finite. Ultimately the novice becomes a newly-fledged expert, letting go of the sides, standing without scaffolding, making their own map [20,56]. Accordingly, the best management strategy is to develop a creative climate in which the best young people are free to express their creative ideas, apply creativity into practice, and set their own agendas, without being entrained in hierarchies of deference to their authorities or seniors, no matter how distinguished these might be.

The main framework of Chinese higher education today is the lecture-based curriculum, although innovation in education has been supported by recent national policies [57]. However, creative learning cultural change is always problematic, and given the powerful effects of its history, it seems likely that change will be slow and incremental in Chinese education. However, POGs are a small step of change towards sustainable education. Practically, it calls for measures of staff development in order to integrate values of sustainability into the curriculum and pedagogical design, and deeper collaboration between universities and industry in order to providing co-design courses to students in the future.

6. Conclusions and Limitations

The link between sustainability and education has been discussed more about environmental education than in a wider context of the ecological paradigm for education. This paper takes an innovative, emerging pedagogy of POGs in Chinese universities as an example, to assess both the drivers and barriers of POGs to fostering a creative climate, in order to rethink how to improve POGs toward a better sustainable pedagogy. By using both questionnaire survey and interviews, this study unpacks the influences of POGs on a creative climate in collaborative learning settings. This responds to the debates in questions such as: is it possible to organize life in education in such a way that young people not only have the opportunity to express their creativity, but systematically become more creative [58]? The findings of this study reflect advantages of POGs in providing a series of drivers to a creative climate including group openness, task challenges, group diversity, and group leadership, etc., and some barriers including students' fear of authority, limited working time, and lacking of students' leadership of project management, etc. So much reflection on future efforts against existing problems of POGs are about how to restructure the relationships between teachers and students in order to solve the problems of group and project management. In other words, the key for future improvement is about better applying the egalitarian approach. This also requires co-efforts from other stakeholders of sustainable pedagogy development, such as political support from government and economic support from industry in China, which has not been discussed much in this study indicating the limitations of this study.

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