

Fostering Creative Culture in Education for Open Source Innovation

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ABSTRACT

Open source innovation can increase the efficiency and effectiveness of resource utilization at a macro level, and it can also benefit various stakeholders in the process of innovation and creation. However, the creative intention of the open source developers might be affected by the unavailability of monetary rewards. It is easy to trace back through history that many great inventions and innovations did not originate from a search for economic benefit, but resulted from the creative consciousness and the intrinsic motivation of the individual. Thus, the promotion of open source innovation depends on increasing the creative consciousness of the individual and developing a creative culture in our society. The author of this article provides a theoretical framework showing how to foster creativity and build an innovative culture in education. This theoretical framework is based on the “Investment Theory of Creativity” of Sternberg and suggestions of other scholars. It mainly focuses on the development of (1) a Creative Thinking Style, (2) an Independent Personality, (3) the possession of Intrinsic Motivation, and (4) the need for a Supporting Environment; and this framework also provides practical methods of how to cultivate and achieve the goal. No matter whether it is open source innovation or maker culture, both depend on the pursuit of innovation and cultural creativity. This article discusses the elements affecting innovation and creativity and provides methods of cultivating one’s creative and innovative impulse. It aims to be especially helpful for teachers, scholars and policy-makers who intend to promote creative culture.

Keywords

Creativity, Creative Culture, Open Source Innovation, Motivation

如何在教育上培养创意文化以达至开源创新

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摘要

从广义的经济观点看开源创新,它能增加资源运用的效能及效用,在创新及制作过程中,能够令不同的持份者受惠。但亦有不同的理论指出,在开源文化下会因创新者不能得到经济上的回报,因此直接影响创新的意欲。在历史中我们常看到不同时代的伟大发明及创新,都并不源于个人的经济效益,而是创作者个人的创新意识及内在的原动力。如何增强个人的创新意识,营造一个创意文化,便成为推动开源创新的原动力。如何建立及推动创意及创新文化,本文作者提供一个在教学上的理论框架。此理论框架基于 Sternberg 的「创意投资理论」(Investment Theory of Creativity)及不同学者的建议。包括:(1)创意思维风格;(2)独立自主个性;(3)内在推

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动力及(4)支持发展环境,而理论框架更提供如何培养及达到目标的方法。不论是开源创新还是创客文化,都建基在我们文化中对创新及创意的追求,本论文会论述影响创新及创意的元素,从而提供方法培养个人的创新及创意态度。此论文尤其适合对推动创意文化的老师,学者及政策制订者。

关键词

创意, 创意文化, 开源创新, 推动力

OPEN SOURCE INNOVATION

Open source innovation has a long tradition in the software industry. The impact of open source innovation in recent years has generated a critical mass of open source software developers to enter the mainstream market. The major contribution of open source development can be traced back to early 1980s when Richard Stallman launched the GNU Project and the Free Software Foundation. The GNU General Public License (GPL) promotes the development of free software in which the source code is freely distributable, and it also ensures that the software developed under the GNU license should remain free. Many successful cases show how open source innovation builds strong communities and receives public acceptance, with examples such as Linux, Apache and Mozilla.

Lerner and Tirole³ suggested that the unpaid open source developer faces both costs and benefits in their open source development project. Obviously, the major cost for an open source developer is the opportunity cost of time. The time an open source developer invested in his open source project could have been used in generating monetary return from working for a commercial project or firm, or used in some other activities that can benefit the open source developer in some other way. On the other hand, the open source developer is willing to take up the project because he can benefit through gaining extra knowledge and experience from working on the project. This experience and knowledge, plus the contribution to the open source development, allow him a higher future monetary return. Moreover, the open source developer might enjoy the intrinsic pleasure that came from working on an activity he finds fulfilling, and has control and ownership of, and above all might give him gratification through peer recognition in his communities⁴. A survey result from the Boston Consulting Group⁵ indicated that the most important factor that encourages developers to work on open source project is their intellectual curiosity. It is the intrinsic motivation to challenge oneself to pursue creative and innovative development. Thus, in order to facilitate the growth of open source innovation, it is important to build a creative culture. Fostering creativity in our education system can help to cultivate a creative and innovative culture in our society.

³ Lerner, J. and Tirole, J. "The Economics of Technology Sharing: Open Source and Beyond". *Journal of Economic Perspectives*. 2005, 19(2): 99-120.

⁴ Hoche, M. W. A Note on Economics of Open Source. ResearchGate.
<http://www.researchgate.net/publication/272943351> accessed on 30 Oct 2015.

⁵ Lerner, J. and Tirole, J. The Economics of Technology Sharing: Open Source and Beyond. *Journal of Economic Perspectives*. 2005, 19(2): 99-120 quote Boston Consulting Group. 2003. Boston Consulting Group/OSDN Hacker Survey. Boston: Boston Consulting Group.

IMPORTANCE OF CREATIVITY

We are living in fast-changing times. Knowledge and skills are becoming obsolete much faster than in the past. Education institutes should not limit themselves to knowledge transfer, but must also promote flexibility and openness for our students. Fostering creativity can help our students meet future challenges⁶. In the National Advisory Committee on Creative and Cultural Education (NACCCE⁷) report, it indicated that education worldwide faced unprecedented challenges in economic, technological, social and personal areas. Rapid changes in the nature of work, in which communities move from being traditional industries to being knowledge and information societies, call for new types of workers. The expanding area of open source innovation also creates a demand for young people who can generate new ideas. The rapid development of technology has already dominated all areas of our lives. It offers tremendous opportunities for people to develop and transform, but on the other hand it might also be harmful in social, emotional and imaginative development. Both economic and technological changes are transforming the social landscape. These changes will affect the balance of relationships and responsibilities between generations. Traditional academic quality will not satisfy future demands which emphasize powers of creativity, of communication, of empathy and of adaptability. Creative abilities are needed to meet the challenges of economic, technological, social and personal development.

DEFINITION OF CREATIVITY

Creativity is difficult to define. Csikszentmihalyi described it as follows: “Creativity was recognized to be a complex, contested concept that is poorly theorized, as acknowledged in many accounts”⁸. Guilford⁹ saw “creativity” as an ambiguous word. Child¹⁰ suggested that there does not exist a clear, unambiguous and widely accepted definition of creativity. Stein¹¹ proposed that “creation” is an activity which brings some things which are “new” and which have “utility”. Sternberg and Williams¹² also had a similar thought, that creative ideas are both novel and valuable. Boden defined creativity as “the ability to come up with ideas that are new, surprising, and valuable”¹³. Most of the scholars agreed that creativity involves thinking that is aimed at producing ideas or products that are relatively novel and compelling¹⁴.

⁶ Cropley, A. J. Creativity in education & learning: A guide for teachers and educators. Psychology Press. 2001.

⁷ National Advisory Committee on Creative and Cultural Education. All Our Futures: Creativity, Culture and Education. 1999.

⁸ Csikszentmihalyi, M. Implications of a systems perspective for the study of creativity. In R. J. Sternberg (Ed.), Handbook of creativity. 313-335. New York: Cambridge University Press. 1999. Page 313.

⁹ Guilford, J. P. “Creativity: Retrospect and prospect”. Journal of Creative Behavior. 1970, 5: 77-87.

¹⁰ Child, I. L. “Esthetics”. Annual Review of Psychology. 1972, 23: 669-694.

¹¹ Stein, M. I. “Creativity and culture”. The Journal of Psychology. 1953, 36: 311-322.

¹² Sternberg, R. J. and Williams, W. M. How to Develop Student Creativity. ASCD. 1996.

¹³ Boden, M. A. The creative mind: Myths and mechanisms. Psychology Press. 2004.

¹⁴ Sternberg, R. J. and Kaufman, J. C. (Eds.). The International Handbook of Creativity. The Cambridge University Press. 2006.

The NACCCE defined creativity as “imaginative activity fashioned so as to produce outcomes that are both original and of value”¹⁵. The definition was based on the understanding of the nature of creative processes and this indicative definition aims to serve for education purposes. Creative processes always (1) involve the act of thinking or behaving imaginatively; (2) require that the imaginative activity is purposeful; (3) need the activity to generate something original, and (4) require that the outcomes must be of value to the purpose. As Runco & Jaeger¹⁶ pointed out, Stein was the first to offer the standard definition in an entirely unambiguous way, and Stein’s standard definition is completely adequate for general purposes.

CATEGORIES OF CREATIVE MAGNITUDE

Creativity can be realized as creative expression (a product) or creative experience. These creative outcomes are different in creative magnitudes as well as methods of measurement. Differentiating the categories of creative magnitude helps us to understand the various approaches of creativity research.

The categories of creative magnitude address the differences of internal and external frames of reference of creativity. They are commonly divided into four categories, namely (1) Big-C, (2) Pro-c, (3) Small-c, and (4) Mini-c¹⁷.

1. Big-C refers to the eminent creative expressions that are generally recognized. Works of great poetry or substantial invention are considered to be in this category. These are eminent levels of creative expressions, like Emily Dickinson’s Poetry, John Coltrane’s Jazz or Sigmund Freud’s Psychology.
2. Pro-c refers to creative expressions that exist at a professional level but do not yet attain, or never attains, the eminent level¹⁸.
3. Small-c refers to the objective creativity of everyday life. These creative expressions and experiences can be accessible in our daily life like creating a novel recipe that produces something which is enjoyed by family and friends¹⁹.
4. Mini-c refers to the more subjective creativity of actions taken in everyday life including personal, internal, or mental forms of creativity.

FOUR Ps MODEL OF CREATIVITY

Rhodes²⁰ developed a framework for a unifying approach to creativity. He studied 56 different definitions that were preset in the literature and found those definitions clustered around four

¹⁵ National Advisory Committee on Creative and Cultural Education. All Our Futures: Creativity, Culture and Education. 1999. Page 30.

¹⁶ Runco, M. A., & Jaeger, G. J. “The standard definition of creativity”. *Creativity Research Journal*. 2012, 24(1): 92-96.

¹⁷ Merrotsy, P. “A note on Big-C Creativity and little-c creativity”. *Creativity Research Journal*, 2013, 25(4): 474-476.

¹⁸ Kaufman, J. C., & Beghetto, R. A. “Beyond big and little: The four C model of creativity”. *Review of General Psychology*. 2009, 13: 1-12.

¹⁹ Richards, R. E. “Everyday creativity and new views of human nature: Psychological, social, and spiritual perspectives”. American Psychological Association. 2007.

²⁰ Rhodes, M. “An analysis of creativity”. *Phi Delta Kappan*. 1961, 42: 305-310.

overlapping and interrelated strands. Those strands were the creative person, the creative process, the creative product, and the creative press (environment). Isaksen²¹ extended Rhodes's approach and introduced the concept of 4 Ps model. It is based on the assumption that creativity can be defined as a holistic multi-dimensional concept. This model of creativity addresses the emphasis on the particular aspect of creativity. It includes (1) Person (or personality), (2) Product, (3) Process, and (4) Place (or press).

Person theories study creative people and their personalities that might be indicative or contraindicative of creative potential. Some common traits which have been identified are intrinsic motivation²², wide interests²³, openness to experience, and autonomy²⁴. Moreover, a recent study shows that personality is considered as an influence on creativity rather than directly leading to creativity²⁵.

Product theories study highly creative individuals through their eminent creative expressions like works of art, inventions, publications, musical compositions etc. It is the most objective approach with which to study creativity. However, the drawback is that it cannot show the relationships between the process and the product, and it does not help to identify creative potential for not-yet-successful people.

Process theories are those which focus on the creative process. They aim to understand the nature of the mental mechanisms that occur when a person is engaged in creative thinking or creative activity²⁶. This line of study mainly investigates different stages of processing or particular mechanisms as the components of creative thought. For example, Graham Wallas²⁷ proposed four steps for a problem-solving process that include preparation, incubation, illumination and evaluation.

Place (or press) theories focus on how interactions between persons and environments affect creative personality. Some general tendencies indicate that "creativity tends to flourish when there are opportunities for exploration and independent work, and when originality is supported and valued"²⁸. Creativity can be encouraged or discouraged through environmental conditions. Sternberg and Williams²⁹ also confirmed that fostering creativity demands a criticism-free environment.

CREATIVITY EDUCATION

Many educators and scholars proposed different methods for fostering creativity. These methods vary in their approaches to the question and in the level of nurturing of creativity achieved. Among all these

²¹ Isaksen, S. G. *Frontiers of Creativity Research: Beyond the Basics*. Buffalo, NY: Bearly. 1987.

²² Hennessey, B. A. and Amabile T. M. "Creativity". *Annual Review of Psychology*. 2010, 61: 569-598.

²³ Sternberg, R. J. "The nature of creativity". *Creativity Research Journal*. 2006, 18(1): 87-98.

²⁴ Torrance, E. P. *Guiding Creative Talent*. Englewood Cliffs, NJ, US: Prentice-Hall. 1962.

²⁵ Kozbelt, A., Beghetto, R. A. and Runco, M. A. *Theories of Creativity*. In Kaufman, J. C. and Sternberg, R. J. (Eds.). *The Cambridge Handbook of Creativity*. Cambridge University Press. 1987.

²⁶ Simonton, D. K. *Genius, creativity, and leadership*. Cambridge, MA: Harvard University Press. 1984.

²⁷ Wallas, G. *The Art of Thought*. London: Cape. 1926.

²⁸ Amabile, T. M. Within you, without you: The social psychology of creativity, and beyond. In M. A. Runco & R. S. Albert (Eds.), *Theories of creativity*, 61-91. Newbury Park, CA: Sage. 1990.

²⁹ Sternberg, R. J. and Williams, W. M. *How to Develop Student Creativity*. ASCD. 1996.

methods, Sternberg's confluence theory provides a comprehensive and practical framework for enhancing creativity. This theoretical framework has been proven to be successful and is also useful in education to support teaching for creativity³⁰. Robert Sternberg is a renowned psychologist. He is currently Professor of Human Development at Cornell University. He was the former President of the University of Wyoming and Dean of Arts and Science at Tufts University. He has also served as the President of the American Psychological Association. His confluence theory of creativity indicates that creativity is a compound of various creative elements, and these elements influence each other in constructing the creativity of an individual. His theory is a confluence of theories from various scholars, but it uses them to build a foundation for his "Investment Theory of Creativity." He points out that creativity is not only some kind of ability, but also a "decision" that supports the practice of creativity³¹. Joubert also shares the same thought, that to be creative, "you must apply yourself to the creative process and you must want to find a solution or a new perspective to a problem or situation"³².

INVESTMENT THEORY OF CREATIVITY

The core concept of the Investment Theory of Creativity is "buy low and sell high"³³. Creative people can identify potential ideas that are not recognized and appreciated by people, and persuade people of the value of these concepts. People do not recognize the value of these ideas in the beginning, and they even might challenge the value of them. Creative people will not hesitate to meet these challenges and their persistence will finally convince people of the value of these ideas, finally. Starting from identifying unrecognized and valueless ideas to successfully convincing others of the values of these ideas, creative people possess the confidence of defying the crowd and have the practical ability to convince others of their beliefs. These are the core concepts of the investment theory of creativity.

According to the Investment Theory of Creativity, three specific abilities are needed to generate creative ideas or products. They are synthetic ability, analytical ability and practical ability. Synthetic ability allows us to generate novel ideas. It enables us to connect different things effectively and generate new ideas. Analytical ability is a kind of critical thinking ability. It enables us to make appropriate analysis of ideas and judge the effectiveness of these ideas. By possessing the analytical ability, it helps us to judge which novel ideas is more appropriate to pursue.

However, ideas which are only novel and appropriate might still not good enough to be successful. We still need the practical ability to promote these ideas. As mentioned in the Investment Theory of Creativity in the previous paragraphs, really creative ideas normally would not be accepted by people in the first instance. Without a strong practical ability that can defy crowd sentiment and convince people of the value of these not yet recognized potential ideas, creative ideas will never be recognized and appreciated by others. So a successful creative person should possess these three abilities. Sternberg has suggested various ways to enhance these abilities in a number of his studies. By carefully rearranging his suggestion, we can consolidate four major categories of elements that can help in

³⁰ Sternberg, R. J. *Wisdom, intelligence, and creativity synthesized*. Cambridge University Press. 2003.

³¹ Sternberg, R. J. "The nature of creativity". *Creativity Research Journal*. 2006, 18(1): 87-98.

³² Joubert, M. M. *The Art of Creative Teaching: NACCCE and Beyond*. In *Creativity Education*, ed. Craft Anna, Jeffrey, B. and Leibling, M. Continuum. 2001. Page 19.

³³ Sternberg, R. J. "The nature of creativity". *Creativity Research Journal*. 2006, 18(1): 87-98.

nurturing students' creativity in our education system. They are: Creative Thinking Style, Independent Personality, Intrinsic Motivation and Supporting Environment.

Creative Thinking Style

The NACCCE report suggested “Four Features of Creativity”, with the use of the imagination as the first feature in the list. In the NACCCE report, imagination is not only the mental representation of some novel idea or concept, but “the process of generating something original: providing an alternative to the expected, the conventional, or the routine”³⁴. It is a process or thought, but on the other hand, it is also a kind of behavior or preference for a thinking style that combines or reinterprets existing ideas in unusual ways. Creative thinking style means knowing the preferred ways of thinking and making a decision to think in a new way³⁵. Most of all, it does not concern itself with the ability to think in a new way, but with whether a decision is made to pursue thinking in a new way.

Creative activity is a highly dynamic process. Although this activity normally has an objective to pursue, it often changes as new ideas or possibilities are noticed. Sometimes people run into certain problems that they cannot solve, they are stuck in this problem and the situation is just like a dead end. However if they can look at the problem from some other perspectives, they might have a different understanding of the problem. By “**Redefining Problems**”, people can come up with alternative solutions to problems³⁶.

“**Questioning Assumptions**” is another element that enhances a creative thinking style. Assumptions are widely shared values. However, they might not necessarily be correct or free of limitations. Creative people question these assumptions and open up new possibilities that might finally lead to a breakthrough³⁷. As Sternberg, Kaufman and Grigorenko explain, “Society tends to make a mistake by emphasizing the answering and not the asking of questions”³⁸. Students who can recite information and provide a quick answer are considered as good students. However, John Dewey suggested that “how we think is often more important than what we think”³⁹. So challenging assumptions and asking provoking questions are important elements for enhancing students' creativity and students should be allowed and encouraged to do so.

Independent Personality

³⁴ National Advisory Committee on Creative and Cultural Education. All Our Futures: Creativity, Culture and Education. 1999. Page 31.

³⁵ Sternberg, R. J. (Ed.). Handbook of creativity. Cambridge University Press. 1999.

³⁶ Sternberg, R. J., Kaufman, J. C., & Grigorenko, E. L. Applied intelligence. Cambridge: Cambridge University Press. 2008.

³⁷ Sternberg, R. J. and Williams, W. M. How to Develop Student Creativity. ASCD. 1996.

³⁸ Sternberg, R. J., Kaufman, J. C., & Grigorenko, E. L. Applied intelligence. Cambridge: Cambridge University Press. 2008. Page 296.

³⁹ Sternberg, R. J. and Williams, W. M. How to Develop Student Creativity. ASCD. 1996. Page 13.

Many researches have shown that certain personal attitudes would have a positive effect on creativity⁴⁰. They include the willingness to “**Take Sensible Risks**”, the willingness to “**Tolerate Ambiguity**”, the willingness to “**Take Self-responsibility**”, and the presence of “**Strong Self-efficacy**”.

History tells us that lots of great discoveries or theories were initially rejected by society. The people who figured out the novel ideas had to face many challenges and take tremendous amounts of risk to persuade others that their ideas were valuable. If such people are not willing to take these sensible risks, they might not have a chance of success. Similarly in the creative process, creative people always encounter a lot of obstacles. They need to deal with a continuous stream of emerging difficulties. Moreover, creative ideas demand time to nurture, and in this particular period, creative people have to face a period of ambiguity when they don’t know what to pursue. If they could not tolerate the state of ambiguity in this period and make a rushed choice instead, then the best creative idea might not have adequate time to develop and they would lose a chance of success. Promoting the freedom to innovate and taking sensible risks are also recommended in the NACCCE report⁴¹.

As Sternberg and Williams claim: “Creative people take sensible risks and produce ideas that others ultimately admire and respect as trendsetting”⁴². In the current education system, students are not encouraged to take sensible risks. This is owing to the fact that failure or undesired grades in the school might mean an inferior standard⁴³. Moreover, most current education emphasizes knowledge absorbing, and the assessment criteria might overemphasize the memorization of facts. Students are not interested in taking sensible risks. In order to enhance students’ creativity, teachers have to encourage and even reward students for “**Taking Sensible Risks**”.

Creative activity involves both a generative mode of thought and an evaluative mode of thought. The former always includes imaginative activity that involves novelty generation while the latter involves critical activity that makes value judgements. Creative activity consists of critical evaluation of what works by shifting the focus of attention and modes of thought. This type of shifting in modes of thought and focus of attention creates a certain ambiguity in most creative works.

Like artists and writers, when they start to work on a creative project, they have to go through a period of ambiguity to let their creative ideas grow. Normally they will generate a lot of ideas and try out many ways to make their projects work before they finalize their approaches or ideas. The period can be characterized as in this explanation by Sternberg: “Part of the reason everyone needs time to be creative is that a creative idea tends to come in bits and pieces and develops over time. But the period in which the idea is developing tends to be uncomfortable. Without time or the ability to tolerate ambiguity, you may jump to a less than optimal solution.”⁴⁴ “**Tolerating Ambiguity**” is also important to students’ works. Sometimes, teachers notice that students are not progressing well in their work, and they might urge the students to make a quick decision. This move might interrupt the creative

⁴⁰ Sternberg, R. J. “The nature of creativity”. *Creativity Research Journal*. 2006, 18(1): 87-98.

⁴¹ National Advisory Committee on Creative and Cultural Education. *All Our Futures: Creativity, Culture and Education*. 1999.

⁴² Sternberg, R. J. and Williams, W. M. *How to Develop Student Creativity*. ASCD. 1996. Page 25.

⁴³ Sternberg, R. J. and Kaufman, J. C. (Eds.). *The Cambridge Handbook of Creativity*. The Cambridge University Press. 2010.

⁴⁴ Sternberg, R. J. “The nature of creativity”. *Creativity Research Journal*. 2006, 18(1): 87-98. Page 28.

process of the students and prevent the students from learning to deal with a state of ambiguity. As Sternberg, Kaufman and Grigorenko say: "To help students become creative, teachers need to encourage them to accept and extend the period in which their ideas do not quite come together. Students need to be taught that uncertainty and discomfort are a part of living a creative life."⁴⁵

"Taking Self-responsibility" does not seem to have a direct relation with creativity development; however it plays an important role in letting creative people have a better understanding of their creative process, allowing them to criticize themselves and enjoy their creative results. Many studies found that self-responsible people tend to have better intellectual success. This is credited to the fact that self-responsible people engage in a more serious and detailed consideration of the situation when they decide to challenge the assumptions or take sensible risks to pursue creative ideas.

Self-efficacy is a concept of psychology. It is the strength of confidence with which a person believes in his ability to complete a task or reach a goal. The theory of self-efficacy does not concern the actual ability of a person but focuses on the confidence of the person in his ability. It can be viewed as the persistence of a person in completing a work. It also affects the decision making processes of a person in facing up to challenges. As Sternberg writes: "The main limitation on what students can do is what they think they can do ... Sometimes teachers and parents unintentionally limit what students can do by sending messages that express or imply limits on students' potential accomplishments"⁴⁶. Sternberg and Williams also argue that people always limit themselves in accomplishing goals because they believe that they cannot work them out or they believe other people who tell them that they are incompetent to work them out. Building a **"Strong Self-efficacy"** in students can make them strong in their willingness to take risks, surmount obstacles and develop creativity.

Motivation

Effective leadership and motivation are conditions that foster creativity (Joubert, 2001). Motivation is widely used in management practice (Ma, 2011). In some selling activities, the commission received by the sales person is proportional to the quantity of product sold. The more product he sells, the more commission he earns. In order to earn more, the sales person has to work harder in his selling. The commission is a kind of extrinsic motivation to the sales person. However, some scholars consider extrinsic motivation has a negative effect on creativity, and only intrinsic motivation can help to promote creativity⁴⁷. Intrinsic motivation is defined by Hennessey and Amabile as "the drive to do something for the sheer enjoyment, interest, and personal challenge of the task itself (rather than for some external goal), is conducive to creativity."⁴⁸ Creative people always have strong incentive behind their willpower, and they keep challenging themselves and refining their ideas or works. Actually what makes them work in such a way is their intrinsic motivation. The ultimate returns are their satisfaction and self-actualization. However, Sternberg mentioned that this motivation is not inherent in a person,

⁴⁵ Sternberg, R. J., Kaufman, J. C., & Grigorenko, E. L. Applied intelligence. Cambridge: Cambridge University Press. 2008. Page 300.

⁴⁶ Sternberg, R. J. and Williams, W. M. How to Develop Student Creativity. ASCD. 1996. Page 8

⁴⁷ Amabile, T. M. Creativity in context: Update to "the social psychology of creativity." Westview press. 1996.

⁴⁸ Hennessey, B. A. and Amabile, T. M. "Creativity". Annual Review of Psychology. 2010, 61: 569-598. Page 581.

but is a kind of decision that is made; they choose to be motivated by their work⁴⁹. Sternberg suggested several ways to develop students' intrinsic motivation in creativity.

“**Finding Excitement**” helps students find what excites them to develop their intrinsic motivation. As Amabile⁵⁰ suggests, people can do truly creative work if they really love what they are doing. So encouraging students to work on something they are interested in will increase their intrinsic motivation and creativity.

As Sternberg and Williams indicate, sometimes teachers limit our students' creativity by asking the wrong questions. For example, by using multiple-choice tests, we can only test the students' understanding of the information given. By asking students to go beyond the information given, it opens up an opportunity to be creative. So teachers can encourage students' to develop their creativity by “**Instructing and Assessing Creativity**” through providing assignments that demand factual recall, analytic thinking, and creative thinking. As Sternberg and Williams say, “the only limitations in the assignment are those set by the imagination of the teachers and students”⁵¹.

If we want to nurture students' creativity, we should not just talk about it but we also have to reward students for their creative efforts, since students will sooner or later recognize the teachers' actual thinking if they just talk without acting accordingly. In “**Rewarding Creative Efforts**”, it does not really matter if the ideas or products that the students come up with are good or bad: the main point is they generate ideas that are a synthesis between their own thoughts and existing ideas⁵².

Supporting Environment

As suggested by the NACCCE: “The roles of teachers are to recognize young people's creative capacities; and to provide the particular conditions in which they can be realized”⁵³. In order to nurture students' creativity, we should provide a supporting environment for them to grow⁵⁴. This environment should encourage and appreciate new idea generation, encourage cross fertilization and creative collaboration and allow making mistakes.

Sometimes the learning environment is not fully supportive to creative expression. Normally there is negative feedback on creative thinking because creative ideas do not follow conventions. In order to “**Encourage Idea Generation**” from students, they should be allowed to express their ideas no matter whether they are valuable or not, and they should also be free of criticism. The purpose for encouraging idea generation is not to ask for good ideas, but to encourage students to develop a habit for new ideas.

Traditional curriculum design always separates disciplines into subjects. This might create an impression to students that learning occurs in discrete boxes. However, creative ideas do not come

⁴⁹ Sternberg, R. J. “The nature of creativity”. *Creativity Research Journal*. 2006, 18(1): 87-98.

⁵⁰ Amabile, T. M. *The Social Psychology of Creativity*. New York: Springer-Verlag. 1983.

⁵¹ Sternberg, R. J. and Williams, W. M. *How to Develop Student Creativity*. ASCD. 1996. Page 22.

⁵² Sternberg, R. J. and Williams, W. M. *How to Develop Student Creativity*. ASCD. 1996. Page 23.

⁵³ National Advisory Committee on Creative and Cultural Education. *All Our Futures: Creativity, Culture and Education*. 1999. Page 11.

⁵⁴ Sternberg, R. J. *Wisdom, intelligence, and creativity synthesized*. Cambridge University Press. 2003.

from memorizing and reciting materials, but from integrating and synthesizing materials across subject areas. So we “**Encourage Cross-fertilizing Ideas’ to stimulate students**” creativity by helping them to think across subjects and disciplines⁵⁵. Creative collaboration can also help to improve students’ creativity. It allows our students to “imagine things from other viewpoints”⁵⁶.

New ideas might not always work, but they allow us to learn from our mistakes and build a basis for other successful ideas. However, “schools are often unforgiving of mistakes. Errors in schoolwork are often marked with a large and pronounced X.”⁵⁷ In order to encourage students to generate ideas, we should help them to build their confidence. “**Allowing Mistakes**” is to let students know that everyone makes mistakes and the only failure is if they cannot benefit from their mistakes.

Based on the above information, a theoretical framework for nurturing creativity is constructed as below:

Ways to Develop Students’ Creativity	Opportunity	Encourage-ment	Reward
Creative Thinking Style			
Redefining problems (allow students to make their own decision)	○		
Questioning assumptions (how students think and how they ask)	○		
Allowing time for creative thinking	○		
Independent Personality			
Taking sensible risks (take intellectual risks)	○	○	
Tolerating ambiguity (creative ideas come up in bits and pieces)	○		
Taking self-responsibility		○	
Strong self-efficacy (ensure students’ ability)	○	○	
Intrinsic Motivation			
Instructing and assessing creativity (ask stimulating questions)	○		○
Rewarding creative ideas and products			○
Supporting Environment			
Encouraging idea generation (free of criticism)	○		
Encouraging cross-fertilizing ideas	○		
Allowing mistakes	○		

Theoretical Framework of Teaching for Creativity
(The matrix shows the various elements that contributed to the teaching for creativity)

⁵⁵ Sternberg, R. J. and Williams, W. M. How to Develop Student Creativity. ASCD. 1996. Page 18.

⁵⁶ Sternberg, R. J., Kaufman, J. C., & Grigorenko, E. L. Applied intelligence. Cambridge: Cambridge University Press. 2008. Page 303.

⁵⁷ ⁵⁷ Sternberg, R. J. and Williams, W. M. How to Develop Student Creativity. ASCD. 1996. Page 29.

CONCLUSIONS

Open source innovation contributes a lot of benefits to the development of society. In order to facilitate open source innovation, fostering creativity in education and cultivating a creative culture in our society is very important. Research in creativity has only a short history and there is no commonly agreed approach on how to deal with this topic. Moreover, creativity is a complex concept and difficult to define. Most of the scholars agreed that creativity involves thinking that is aimed at producing ideas or products that are relatively novel and compelling. Stern's definition of creativity suggests novelty and appropriateness are two important elements for creativity. There are different approaches and focuses on studying creativity. The 4Ps model focuses on 'Person', 'Product', 'Process' and 'Place'. Categorizing creative magnitude into Big-C, Pro-c, Small-c and Mini-c also helps to understand the various approaches of creativity research. Fostering creativity in education is an important topic in the recent education reform. The fast developing economy and society induces lots of changes. Nurturing students' creative ability and attitude can help them meet the future challenges in economic, technological, social and personal areas. Many scholars have suggested various ways to promote creativity education. Sternberg's Investment Theory of Creativity is an amalgamation of different theories. However, the theory emphasizes the fact that creativity is not only some kind of ability, but also a "decision" that supports the practice of creativity. The four elements that can enhance our creativity are "Creative Thinking Style", "Independent Personality", "Motivation" and "Supporting Environment". Creative Thinking Style means the preferred ways of thinking and a decision to think in a new way. Independent Personality strengthens our self-confidence so that we are willing to take sensible risks and take responsibility when facing problems, and have the ability to learn from successes and failures. Motivation assists us in finding the sense of achievement from our task which makes us continually challenge our creativity and strive for the best. Supporting Environment provides us with a freedom in cultivating mature creativity, and creative cooperation could support and stimulate ourselves to generate thinking from different angles. Implementing the above approaches in our teaching policy and practice should help to build a better creative culture in our society.

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