

A proposed Invention in Science Labs (ISL) Framework for Teaching Science

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Abstract: The proposed Invention in Science Labs (ISL) framework conceptualizes invention within science labs by four elements representing phases of reaching inventions in a group context: Theoretical thinking: fluency, flexibility, and originality, Solution, Materials and Context. Four phases should lead to a product that can be commercialized, while the whole process monitored through four procedures under the teacher's dwelling the activities: Objectives, Procedures, Discussion, and Evaluation. The study listed the challenges that can face implementing ISL which can be overcome if policy makers have the awareness of using ISL in teaching, while teachers can change their approaches of instruction when they have the opportunity to practice it. Beside of that, Ministry of Education in general can conduct competitions between students and schools to have more inventions thus encouraging using ISL framework. More over the study proposed appropriate solutions for overcoming those challenges.

Keywords: Physics, Science labs, Creativity, Invention, Innovation

Introduction

Little attention has been given for invention within education previously, a study conducted by Jwaifell and Kraishan (2019) which carried out in 2018 about exploring elementary students invention ingenuity in science labs for testing the ISL frame work. The study participants were (50) male and female students of the ninth graders. The study used the mixed approaches of both qualitative and quantitative methodologies to assure the effectiveness of ISL framework. The results were very promising for the use of ISL. This paper describes how the ISL works does and what is consisted of beside the challenges it may face its implementation.

Back ground

Most of researches conducted under the claim of students' acquiring epistemology of disciplines through teaching by creativity without transforming the theoretical ideas into products that can be commercialized, which is the main ISL concern. While researchers tried to form creativity as a concept of invention. Bostrom and Nagasundaram (1998) provided suggestions for future research in creativity factors, where they classify their work in terms of whether it addresses the creative Person, Product and Press as adapted from Fellers and Bostrom (1993):

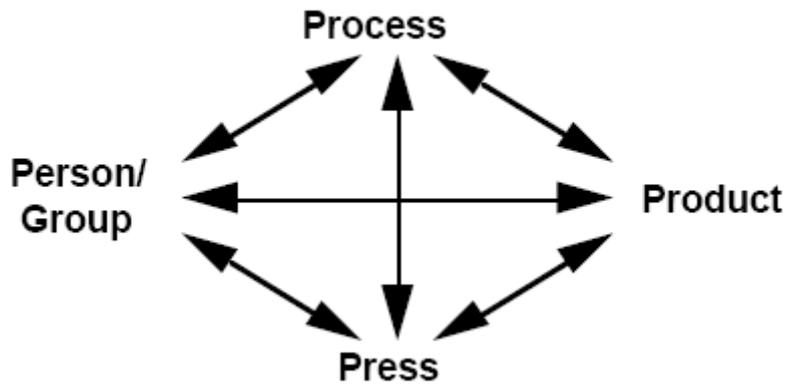


Figure 1. Creativity factors (Bostrom & Nagasundaram, 1998, p391)

Other scholars framed teaching and learning innovation and invention. Schull, Maytychak, and Noel-Storr (2009) described the practices they used in their course on Innovation and Invention which had been taught at Rochester Institute of Technology as Figure 2 describe:

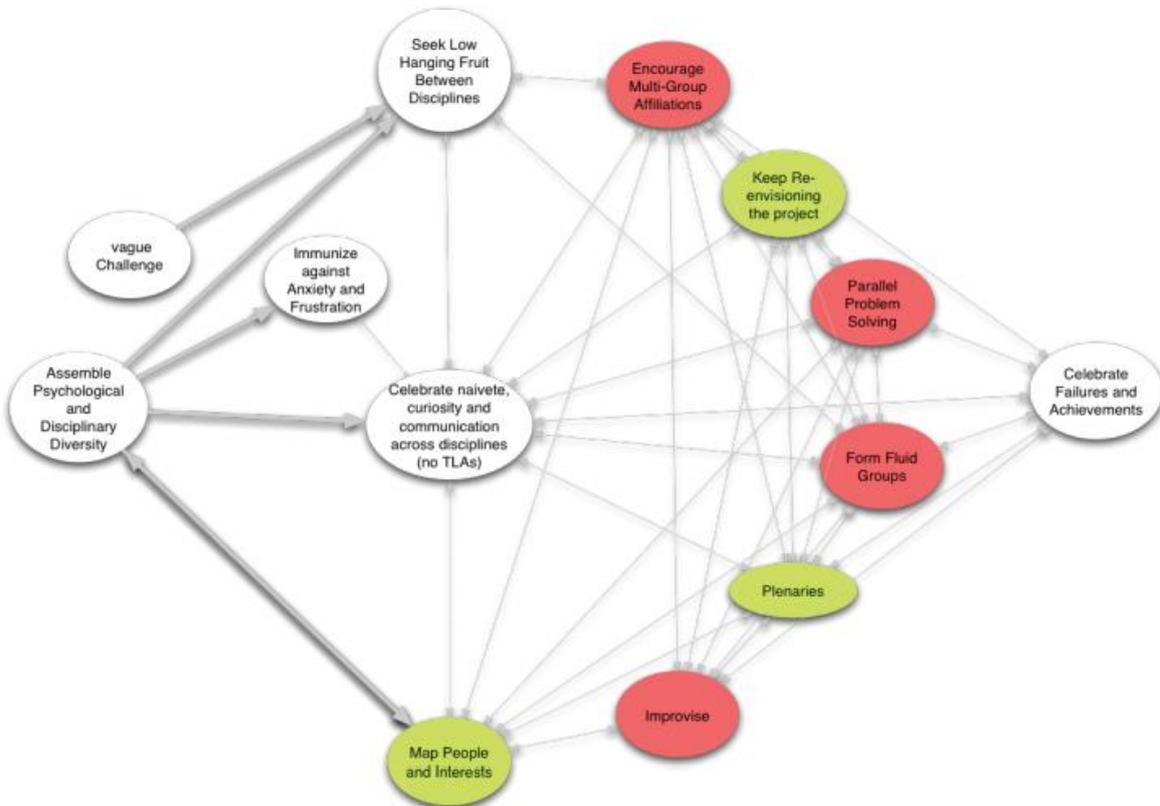


Figure 2. Key practice of a course on Innovation & Invention (Schull et al, 2009. 4)

A framework suggested by Meyer and Lederman (2013) to explore the pedagogy of ingenuity in science classrooms as a guide to analysis of each of the activities the teachers shared on the questionnaire and observed by the researchers. This facilitates the researchers' assessment of whether each activity had the potential to permit fluency, flexibility, and thus potential for responses that are significantly different across a group of students (original) as shown in Figure3:

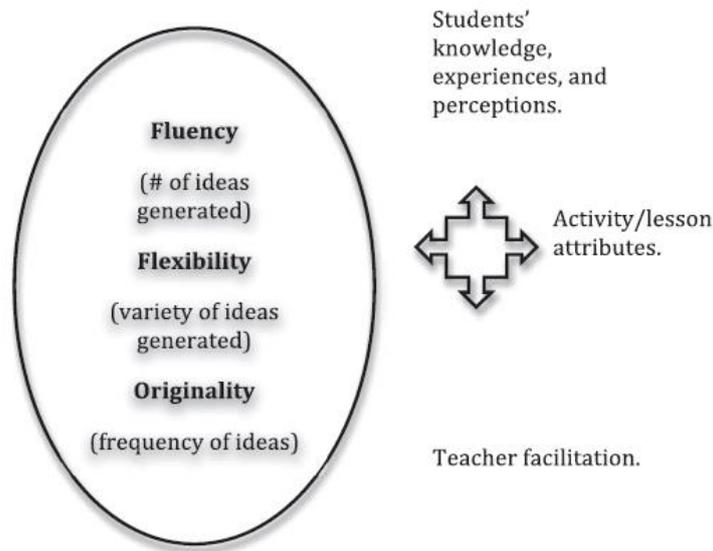


Figure 3. Creative thinking in the science classroom analysis framework (Meyer & Lederman, 2013, p403)

ISL Framework

The proposed ISL framework designed and developed through a pre-experimental research conducted by Jwaifell and Kraishan (2018) where it was followed since 2017 and both of its validity and reliability for its instruments have been assured. The research was reliable on a team work of two male\female teachers and the two researchers. The role of the two teachers understood of the applying ISL, while the researchers analysed the literature related to teaching strategies and methodologies with respect to constructivism theory and creativity approaches in teaching. Figure 4 showing the ISL framework:

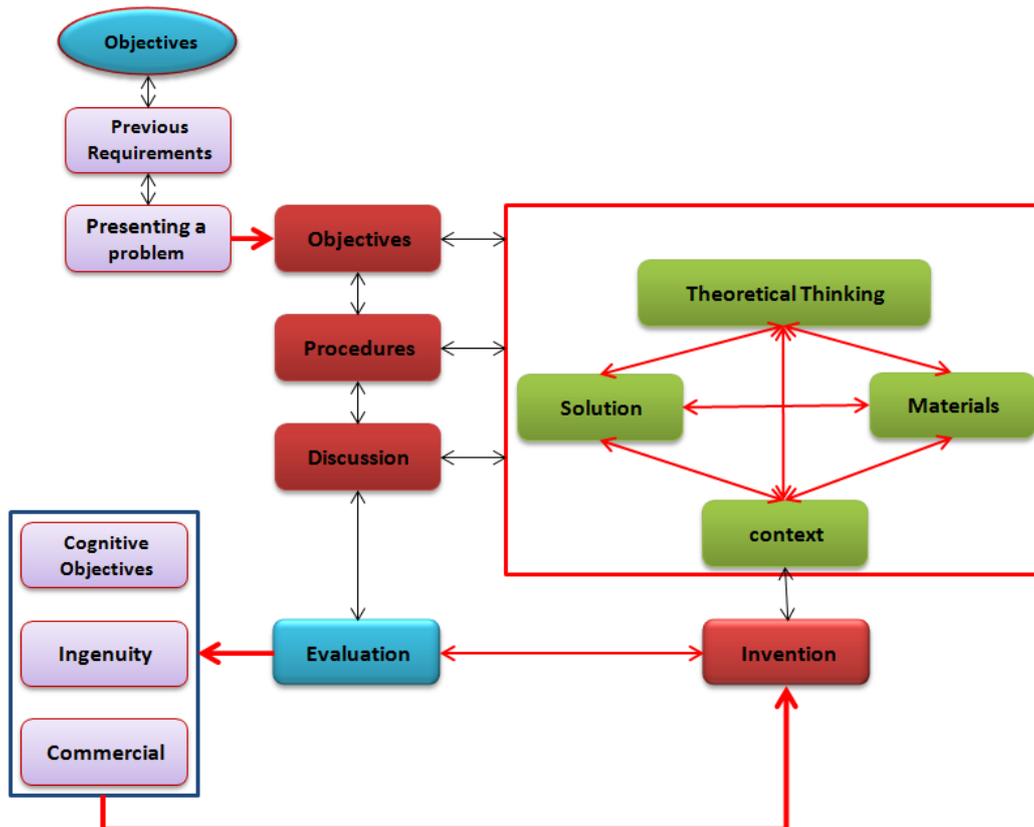


Figure 4. ISL Framework

Teachers with respect to ISL design and plan learning\teaching situations through the following phases:

Phase 1: Stating Objectives

Stating Objectives begins with the common goals will be achieved by students and understanding the environment where the process of Invention will be conducted in; which is in this situation is science laboratories at the school. This phase aims at exploring materials, equipments and media availability, so that outcomes can be reached according to this availability.

The objectives cover cognitive, affective, and psychomotor domains of the subject of the study. While teachers should assure the previous requirements those students should posses to accomplish the outcomes, it will be essential to choose the suitable problem with relevant to exploring materials, equipments and media availability that should be solved by an invention.

For example:

- Objective: connecting of a simple electrical circuit.
- Materials etc: welding device, wires, lump, battery ...etc.
- Presenting a problem: a doorbell for a deaf person.
- ISL design and plan learning\teaching situations its phases.

Phase 2: Procedures

Dividing students into groups and assigning tasks for each individual of the team. The teacher in this phase reforming students' previous knowledge and shape it by giving scaffoldings for students' acquisition of subject matter objectives.

Phase 3: Discussion

Discussion phase conducted through all learning\teaching situations. Teachers will discuss all relevant needs to understand the task devoted for the outcome of that should be accomplish by the students. Teachers will change their moves within ISL approach to facilitate learning and explore students' way of thinking for reaching the best solution of the problem presented to each team.

The students will gain subject matter through thinking theoretical thinking of the problem and what they will assume of solutions based on the knowledge they need to understand the relationship between what they are going to solve and the concepts that they have to understand. Theoretical thinking also will include solutions of the problem that should be discussed with the teacher and other students through brain storming and elimination of improper solutions. The context of applying those solutions as a product will be supervised by the teacher with the relation of the product evaluation card. Here an example of a problem that needs a solution:

- Problem: Help a blind/deaf person to know if someone at the door of his home?
- Tools/Materials available: Electrical kill key, Electrical lamb, Remote control toy car, Wristwatch, Bill hanged inside a room.
- Describe the above tools and materials functions?
- Discuss the relationship between these tools?
- What is the relationship between these tools and the addressed Problem?
- Can those tools be helpful to solve the problem?
- Address solutions to help the blind/deaf person by using these tools and materials?
- What is the most suitable solution?
- What are the implementation procedures?
- Suggest how this product can be developed?
- Suggest how this product can be developed commercially?

Phase 4: Invention

The whole team will use every skill they have according to each individual of the team to make the solution they proposed as a product that work properly according to the evaluation card.

Phase 5: Evaluation: the evaluation phase will measure students' achievements of subject matter they were learned and evaluating the product they invented by an evaluation card which contains the following standards:

Table 1. Product evolution card

| Invention Ingenuity | Score (1-10) |
|-----------------------------|---------------------|
| Consistency with religion | |
| Applicability | |
| Novelty | |
| Community needs | |
| Efficiency | |
| Power saving | |
| Easiness of use | |
| Cost of materials | |
| Safety | |
| Total (cut Score=63) | |

The production card consisted of 9 items: Safety, Cost of Materials, Easiness of use, Power saving, Efficiency, Community needs, Novelty, Applicability, and consistency with religion hence people do not change the perceived connection between religion and science, even if they were in a scientific course which integrated activities explicitly addressing the nature of science (Aflalo, 2018).

Challenges of ISL Implementation

The implementation of the proposed ISL may face some challenges derived out of Jwaifell and Kraishan (2018) study. The most challenge was what the researchers faced in the pre-experimental study, which is cost of materials that students need to accomplish the product. Over all challenges can be summarized in four categories:

1. Cost: the previous study of Jwaifell and Kraishan (2018) showed the cost of each product reached in average (52 US\$) which can be considered in a poor country like Jordan is very costly. To overcome this kind of challenge it would be very helpful if the materials that used can be reused again in different situations.
2. Teachers' readiness: teachers are a very understanding of those new methodologies of teaching, but at the same time they need more training in dealing with ISL and the equipments needed for its implementation. This challenge can be overcome by more training courses and virtual courses will be least costly. While teachers' readiness for new methodologies and integrating technologies are high Jwaifell, Abu-Omar, & Al-Tarawneh. (2018).
3. Policy makers awareness: in countries such as Jordan, policy makers can really make the difference and assure changes if they were aware of the outcomes and benefits of using ISL as a learning and teaching framework which lead to quality assurance. This challenge can be overcome by media and community pressure.

Conclusion

Challenges can be overcome if policy makers have the awareness of using ISL in teaching, while teachers can change their approaches of instruction when they have the opportunity to practice it, while students can be more active and enjoy learning. Beside of that, Ministry of Education in general can conduct competitions between students and schools to have more inventions thus encouraging using ISL framework.

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