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FABCLUB: HIGH SCHOOL CLUB AND EXTRACURRICULAR ACTIVITIES FOR EARLY EXPOSURE IN STEAM FIELDS AND INDUSTRY 4.0

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ABSTRACT

STEAM (Science, Technology, Engineering, Art and Math) education has become a trend due to the importance of bringing STEAM fields knowledge to middle school and high school students. But, for such an traditional education system in Vietnam countries, STEAM Education might be very hard for both students and teachers and it also takes time to gain some beneficial results from this form of education. FabLab is a world wide network of makerspaces for makers gathering, collaborating or joining activities in STEAM fields. By using the model and methodology of FabLab, FabClub consists a makerspace and a community of high school students and teachers who have interest in STEAM fields. By providing creative and specialized extracurricular activities, a well-equipped makerspace and a professional community, FabClub brings STEAM education closer to high school environment. The paper gives you details of the FABCLUB, including the model, methodology and processes of FabClub to develop high school extracurricular activities for early exposure in STEAM fields. This paper also reviews 2 creating years of WIMP, a STEAM club of High School for the Gifted (VNU-HCMC), following the idea of FabClub to develop activities and makers community the school.

Keywords: STEAM, FabClub, Wimp.

INTRODUCTION

One of the most important inspirations of FabClub is the FABLAB network. Started as a collaboration between Grassroots Invention Group and the Center of Bits and Atoms at the Media Lab at Massachusetts Institute of Technology (MIT) since 2001, FabLab is a small-scale workshop including co-working space and maker space and offering digital fabrication for personals and groups. Equipped with various digital tools and machine, FabLab helps makers in the community make their prototypes or projects, encourages the maker movement in the neighborhood, including DIY (Do It Yourself) and open-source movement. The position of FabLab in the community is the friend of makers, people who interesting in inventing by themselves, the place for people gathering and sharing ideas, solutions or products that involved technology. In other words, FabLab helps people in the community bring their ideas that solving or improving the community's problem. As of November 2018, there are 1614 FabLabs around the world in total.

As a volunteer for 2 years in FabLab Saigon, an Ho Chi Minh City based FabLab, I learned and saw a lot of ideas, not only in digital fabrications but also how to develop a community of makers that are ready for changing lives and fixing problems. Since March 2014, FabLabs Saigon have raised a wide spirit in the makers community of Ho Chi Minh City, not only engineers, technicians but also high school students, college students, entrepreneurs and

foreigners living and visiting in Ho Chi Minh City. Based in Binh Thanh district, FabLab Saigon provides 4-story building which includes a makerspace, a co-working space, an office, a meeting room and a roof-topped garden. Since the opening day, FabLab have provided 92 STEAM workshops, supported 80 prototypes and held 90 events for Ho Chi Minh City based innovators and some other provinces such as Vung Tau, Da Lat, Vinh Long, Can Tho and Phu Yen through Mobile FabLab program.

As we can see, FabLab and FabLab perform a professional model of a community for makers. But, the concept of FabLab might be so big and ambitious for a club for high school students. From this problem, I decided to bring up the idea of FabClub as a club for high school student who have interest in STEAM fields and the FabClub itself shares the same ideas and targets of FabLab about the community of makers. This paper will cover the process of developing FabClub, from the beginning until running it as an ecosystem of makers inside a high school.

BODY

Methodology of FabClub

Methodology of FabClub is based on 3 elements: bringing STEAM education in high school environment, providing extracurricular activities to students and forming an ecosystem for future innovators.

STEAM including Science, Technology,

Engineering, Art and Math. This kind of educational approach guides student to critical thinking, analytical thinking and creative thinking. STEAM education's target is students that have enough preparation in knowledge, skills, mindset and creativity for practical problems. Those students are able to learn and use knowledge to solve problem, have appropriate level of skills such as researching, inventing, expressing ideas, collaboration. These students are the next generation of engineers, scientists, artist in 21st century, the era that needs them to be leaders. For that reason, STEAM education should be a part of high school education, not separately into fields but combining them as one, because this is an important preparations for future innovators. Viet Nam's high school curriculum provides students 10+ subjects such as Math, Literature, Physics,... and around 20 to 35 learning hours per week. The schedule is pretty crowded and the whole curriculum is too big to be changed in a short time. One more problem is the lack of extracurricular activities in STEAM fields for high school students, even in the active city for youth like Ho Chi Minh City. Without appropriate extracurricular activities for early exposure, high school students have confusion in choosing career and academic path in STEAM fields. The result is many of them lose the interest in fields and major that related to STEAM like pure sciences, engineering, art,... and this will cause the lack of high level workers, managers, researchers and developers in those fields. This is the problem that we need to fix as soon as possible, because this is the root for developing future generations of innovators for the country, especially in the era of Industry 4.0.

Three main properties of extracurricular activities is: easy to access, easy to learn and easy to collaborate. For easy access, activities should be free to join for every students. For easy to learn, activities should not only be in topics and approach that closed to students, but also valid for students. For easy to collaborate, activities should be the able to build student-student and student-teacher relationship in term of learning each other, sharing ideas among individuals and working on projects. In other words, joining extracurricular activities is the way that teachers and students continue to learn after class time in a different atmosphere of learning that is more creative, energetic and interesting. And, more important, extracurricular activities should help students to learn everyday, not only during the activities but also continue to think, to form ideas about things they learn and make somethings from

what they learn.

An ecosystem for future innovators starts from an academic community, including students, teachers and alumni (optional), where everyone collaborate to prepare knowledge and skills for students at their beginning of learning and understanding, to support their project at their stage of applying knowledge and to guide them to the further path of career and academy. This ecosystem is sustainable than other activities such as competitions, job fair, talkshow,... The key here is the amount of time that we let students to learn, understand and work on STEAM fields. The vision they get, the clearer it is, the better result they will achieve. So, learning, understanding, applying, sharing and learning again, this circle keeps the whole system sustainable because new values, achievements and human resources come continuously. And from here, generations of innovators keep growing.

In summary, methodology of FabClub is:

- Using STEAM education as an exposure for students to practical-problem solving knowledge and skills.
- Providing appropriate extracurricular activities that students and teachers can join together.
- Forming an ecosystem that sustainable and support further path of students.

Facilities in FabClub

Facilities of FabClub is including space and tools for people collaborate on knowledge, ideas, projects or products. 2 main parts of space in FabClub is a co-working space and makerspace. Each of them comes with tools determined by the needs of activities happen there.

Co-working space the place for knowledge exchange and collaborating on ideas. A good co-working space might be similar conditions inside a classroom, but the design must be easy for people to work together rather than stage - audition setting. Board is also needed.

In co-working space, we focus on knowledge and ideas exchange and we need tools for that purpose. Some simple stationary is required, here is a list of them: pen, pencil, crayon, marker, paper, scissors, cutter, clay dough, tape,... These tools help us forming sketches of ideas on paper. Also, co-working space can be a place for holding workshops, talk shows, events, community activities or meeting. In term of knowledge and idea exchange, we should not limit the usage of co-working space as a place for working together or earning together, it should be the heart of the community. The co-working space fits for activities in various subjects and topics, such as arts, science,

creativity and so on.

Makerspace is the place ideas come alive. Digital fabrication brings ideas into real life with supporting from technology, equipments and technicians. List of tools and equipments for makerspace consists of basic electronic tools and kits such as nipper, screwdriver, soldering iron, Arduinos. Here is a short list of them.

Beside tools, professional machine for digital fabrication in makerspace is very vital. 3D-printer and CNC cutter are among the most important machines for makerspaces. With help of these machines, we can have the prototype or to test the design very quickly and accurately. But the disadvantage of them is the price, usually cost around \$1000 for a pair of machines, and they need technician to run them. But modern technology allows everyone to use them easily after training, so that, teachers and students can be the one who maintain those tools and machines as technicians. Furthermore, the key role of technician is also the one who guide and give advices to the community going through technical problems. Technicians in FabClub are not required high-skilled and professional individuals, it can be students or teachers that took training course on using machine and tools that needed in FabClub. The concept of makerspace is designed for projects related needed involvement of engineering and technology. The facilities of FabClub is now completed as a full support for STEAM education.

For optional, FabClub facilities can be included with library and small gaden. The library can have hard-copy books, e-books or articles in STEAM fields or skills for students. The purpose of library is providing knowledge as fast and easy as possible to the community of FabClub. Traditional library in high schools are lack of technical documents and books, especially new arrivals in science and technology. The library of FabClub needs to bring up university standard in both quality and variety to the community. The garden in FabClub will be the place for relaxing and refreshing the air. Also, the garden can inspire students into projects, some IoT projects in gardening for examples.

Organization of FabClub

The organization of FabClub consists of a community and operational teams. The community comes from students and teachers within the high school running FabClub. Alumni can join to level-up the quality of FabClub. The connection among members of FabClub's community is knowledge and ideas.

Operational teams of FabClub are operating team

and specialized teams. Operating team hold responsibility of running the whole system of FabClub. Five main task groups of Operating team are:

- Overall managing: Hold the total responsibility of FabClub, networks inside and outside FabClub and resources of FabClub (members, facilities, documents,...).
- Activities - Content - Event: Develop contents, activities and event for FabClub, also review contents from the community.
- Media - Design: Run media activities (branding, notice,...) for FabClub.
- Community developing: Manage members in FabClub (online and offline), which including Facebook group and Facebook fan pages, and attract new members.
- Specialized teams managing: heads of specialized teams join in this task group and collaborate to run their teams. The key properties of this task group is to provide comprehensive and multidisciplinary mindset among members. Specialized teams represents STEAM fields (or subjects) that members in FabClub have interest in, for example: engineering & technology, physics, chemistry, biology,...Each team has unique targets and activities due its members. In FabClub, the idea of specialized team is to make students and teachers learn further than what they have know in the field (subjects) willingly. More than that, those teams provide content (knowledge, skills, topics) and activities in there fields (subjects) to the community (including other teams). The content can be articles, case study, handbook,...Activities can be workshops, talk show, event...

Advisors of FabClub can be professionals or experts in STEAM fields that willing to join the community or teachers that do not have much time. Usually, this role is for alumni.

Activities of FabClub

Activities in FabClub are designed to follow principles of STEAM education, considered the Bloom's Taxonomy of educational objectives and appropriate for students and teachers to join. Activities should forming an ecosystem of innovators in FabClub.

STEAM education, as I introduced it in the Methodology of FabClub, brings science, technology, engineering, art and math majors (subjects) closer to students through practical topics and projects. When we apply STEAM education in to education objectives in Bloom's taxonomy, we can easily define which activities is appropriate to each objectives.

So, from up-side-down, here is suggested activities for FabClub based on STEAM education and Bloom's taxonomy:

- Remember: books or documents reading session, lectures.
- Understanding: topics discussion, doing mini case study, topics presentation.
- Apply: workshops, doing experiments, small problem solving session.
- Analyzing: doing case study, writing articles, fieldtrip, topic discussion which has outcome is ideas or solution for the problem, doing reports.
- Evaluate: simulated conference, debate on topics, ideas discussion.
- Create: projects, research, prototyping, hackathon, science fair.

These activities should no be limited within FabClub. Activities also can be joining events from other organizations, lab visiting and so on. Operational teams should be active to bring activities to the community, with help from the school and outside network. Topics and activities can be suggested by members in the community, those members can join with operational teams to develop the activities. Topic discussions should be every one or two weeks. This requirement help the community has time to gather and meet each other. Some big activities like science fair, hackathon or simulated conference should be done annually to keep the quality.

In FabClub, every members including students and teachers share the same idea of learning from each other, so activities also mean joining together. The host can be students, teachers or a collaboration and topics pick from suggestions from both.

The ecosystem for further learning steps of innovators is very important. Topics about guiding career path and academic path must be included regularly or anytime that members suggest them. Learning, applying, sharing and learning again, FabClub must prepare for students' higher stages of learning. After that, students can go back as alumni to continue contributing the community and develop next generations in the community. This ecosystem is allowed the community to run sustainably without any holes in positions. Of course, this require few years of preparation (which I will introduce in the following section).

Selection of activities can be based on the condition of FabClub and the high school.

How to develop FabClub from the beginning and the story of WIMP

The idea of FabClub might seems ambitious, but after 2 years founding and running WIMP, a

STEAM club of High School for the Gifted (VNU-HCMC), FabClub is possible if we put enough effort into it and have a good plan for it. So now, I will introduce how to begin a FabClub by telling the story of WIMP since August 2016 to the present.

The origin of WIMP started from the sudden meeting between a group of students having interest in technology and a group of students having interest in physics. At first, we just discuss among members in the group, but 2 two groups started to discuss about how to do projects that involve both technology and physics. With the support from FabLab Saigon, we start our electronic water rocket project for a competitions. Some teachers encourage our activities, told us to form a club for other students. And WIMP started from that period with 2 specialized team: Physics and Technology - Engineering.

WIMP is an acronym for We are Innovators in Makerspace of PTNK (PTNK is an acronym of my high school's name). Our targets was providing activities, topic discussion and support students join competitions. The motto of WIMP is:

- W - Work on problems.
- I - Innovate everything.
- M - Make differences, make changes, make chances.
- P - Pass it forward.

In the first year, we aimed for raising maker movements, raised the spirit of learning STEAM fields and inventing. We hold workshops and talk shows every month, including some activities and topics such as: creative thinking, watching documentary Shenzhen: the city of future, how to make project proposal, introducing to arduino,... We had field trips to FabLab Saigon for members and joined some competition such as Young Makers Challenge (10 over 20 regional projects belong to WIMP's members, 1 project went to national grand finale), Ho Chi Minh City's competition for young computerist,... The most important event of the first year was the 1st Innovation Day held on May 2017, attracted more than 200 students to join, more than 10 booths and over 20 project and activities. The special thing about the 1st Innovation Day is booth's activities were designed to make student actually play with it, from big-scale chemical reactions to big-size physics experiments and interactive machines. After the 1st Innovation Day, we have 1 training session for Technology - Engineering team. In the second year, we aimed to upgrade members' knowledge along with preparing documents, network and recognition. Members of specialized teams are encouraged to self-learned, collected

documents, participated competitions and events. Due to this target, the second year of WIMP did not have any activities, except the 2nd Innovation Day on May 2018. During the second year, the outside network of WIMP expanded with nearly 10 organizations and start-ups in educations, some of them are FabLab Saigon, GaraSTEM, FUV's STEAM Club, Precious plastic,... Some members of specialized teams join science camps as candidates and mentors to work on projects.

In the third year, which is this year, we started to run the full properties of FabClub in WIMP, from setting-up community and develop new activities. Also, we are designing the co-working space and makerspace for FabClub. Tools and kits for FabClub have been bought. New generation of operational teams have created and we added 3 more teams: Chemistry, Biology and soon we will have Art team. This year is the period to complete the idea of FabClub and successfully run the first club based on FabClub's methodology.

In summary, the process of building FabClub consists of 3 stages:

- Raising maker movements: Gathering students into groups, show them the world of STEAM fields through talk show, workshop and science fair. Then, raising the spirit of invention, learning STEAM fields and willing to find and fix practical problems.
- Preparing for future: preparing the human resources, knowledge, documents and recognition. Previous members train themselves to improve the quality of members in the club.
- Complete the methodology: completely building the co-working space and makerspace with full set of facilities, forming a community for FabClub, starting new activities.

WIMP is still running on the third stage of building FabClub, but we have hope that we can successfully make it happens with a team of nearly 50 members of students, teachers and alumni.

Expected outcome and further development

When FabClub successfully runs, the ecosystem itself will be able to give differences, give changes and give chances to students and teachers in STEAM fields. It opens new opportunities for students on their further career path and academic path. Also, this form of extracurricular activities might give the society a better view into STEAM fields, that their children really have capability to challenge future problems by themselves and be ready for Industry 4.0. By stepping into STEAM education, students in FabClub can use knowledge they gain here for subjects they learn in class and teachers can give more knowledge or activities to students in their class. Forming critical, multidisciplinary and creative thinking is another outcome FabClub expected to achieve.

For further development, FabClub needs more recognition and support from high school and the society to evaluate the effect of it on students, teachers and the learning environment. FabClub needs time to run, try and fix problem that have not been detected.

CONCLUSION

In conclusion, the idea of FabClub aims to bring appropriate extracurricular activities in STEAM fields in to high school environments. By using the concept of STEAM education, FabLab network and things that I have learnt while running WIMP, I hope that FabClub can be used widely not only in Viet Nam but also ASEAN or worldwide. When the world steps 1 step forward to the Industry 4.0, developing countries should step 1 step back in STEAM education by giving those knowledge and skills to high school students for their early exposure.

I hope by this paper, many of FabClub can be created to deliver such high quality and variety extracurricular activities to high school students. It simple, well-constructed and yet fitted all requirements for early exposure in STEAM fields.

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