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**SUSTAINABLE INNOVATION IN TEACHING AND LEARNING
OF PATTERN MAKING SKILL**

Sharifah Maryam Syed Azman (a)*, Mahyuddin bin Arsat (b), Nornazira binti Suhairom (c)
*Corresponding author

(a) Universiti Teknologi Malaysia, UTM Skudai, Johor, sharifahmaryam@utm.my

(b) Universiti Teknologi Malaysia, UTM Skudai, Johor, mahyuddin@utm.my

(c) Universiti Teknologi Malaysia, UTM Skudai, Johor, p-nazira@utm.my

Abstract

Pattern making is one of the most important skill-based courses in fashion education curriculum, where students learn clothing construction through drafting, draping and creating basic pattern for garment production. The impact of textile waste and fast fashion to the environment has been widely discussed in the fashion realm, locally and globally. To address the issue, fashion education becomes the potential platform to integrate pattern making skill and sustainable innovation which can be delivered through teaching and learning activities. The ultimate goal of this research is to develop a framework of sustainable innovation in teaching and learning of pattern making skill for fashion educational programs. In the qualitative approach, the data were collected from document analyses, interviews and observations. 21 participants including fashion educators, designers and pattern makers are involved in interview sessions. The elements of sustainable innovation emerged from the thematic analysis are upcycling, zero-waste, minimization and technology advancement. The study suggests that: 1) The learning objective must be concise and include Design for disassembly, Up cycling and Transformational Cutting. 2) Learning activities to involve more peer and industry collaboration. 3) Teaching strategies to infuse more problem-based learning and be technologically inclined and 4) Assessment on sustainable innovation knowledge must be evaluated. The developed framework can be utilised as a guideline for higher education institutions to implement sustainable innovation specifically in the teaching and learning for pattern making skills.

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1. Introduction

Fashion industry has high environmental and social impact. It is a highly polluted industry which utilizes huge amount of water and energy. It pollutes the air and contaminates water resources with chemicals besides producing waste and micro plastics. Fashion industry is one of the industries having issues of sustainability (Kozlowski, 2016). Of the total fabric waste, textile waste constitutes 4%, amounting to 1000 metric tons of textile waste daily (Wai Yee et al., 2016). A study of landfills in 2018 by Southern Waste Corp Malaysia indicates a growing trend of fabric waste which is of concern, as the amount or volume has doubled since 2012, from 2.8% to 6.3%.

Previous studies and the environmental issues posed by the fashion industry in general prompted this research study to be carried out with a predetermined interest on fashion education, focusing on sustainable innovation in the teaching and learning of pattern making skills in particular. It is the responsibility of all parties involved in the fashion education to acknowledge issues concerning the fashion industry as graduates from fashion education institutions will most likely be in the industry eventually. Thus, all educators and students in the fashion educational programs must be exposed to, be aware of, and most importantly practiced sustainability in their engagements through teaching and learning.

Many aspects of sustainability are yet to be included in the educational systems; that is, curriculum, pedagogy, extracurricular and campus based activities. Iskandar et al. (2016), suggested a formative conceptual framework on models of teaching strategies in fashion design course to be applied by fashion design tutors in their pedagogical practices. A study about sustainability awareness carried out by University College Sabah Foundation showed that sustainability knowledge and sustainability information have significant influence in determining the level of sustainability awareness of the students (Mojilis, 2019).

Sustainable innovation refers to a system approach with new ideas which take into considerations the global challenges of sustainability development, namely economics, environment and social challenges. Sustainable innovation is a process of considering the elements of sustainable development (environmental, social and economical) into organizational system through research and development and commercialization (Reza, 2016). Sustainable innovation incorporates quality, style, affordability and accessibility (Morse & McNamara, 2013). Sustainable innovation is an important knowledge which the students must learn because they are the future of the fashion industry and part of the *fashionpreneur*.

1.1. Concept of Sustainable Innovation

Sustainable innovation refers to a system approach with new ideas which take into considerations the global challenges of sustainability development: economic, ecological, and social. Sustainable innovations can be implemented in any fields like education, where such improvements go beyond technological changes, such as changes in the business thinking, business models and systems, operational practices and processes which are all related. In education, sustainable innovation can be seen through the application of technology; Web 2.0, seamless learning (Zhang & Looi, 2011), education programme (Leal Filho et al., 2018), upcycling design process in fashion education zero- waste design

(Almond & Power, 2018) and (McQuillan, 2019a), pedagogy (Agarwal, 2018), 3D printing (Sung et al., 2016). Comparably, in fashion education, sustainable education is also important in terms of the pedagogy. Agarwal (2020) has stressed on the need of a pedagogical change in the fashion education. Newer knowledge sources and materials must be developed which are eco-friendly to reduce carbon footprints on the earth. More “Free Thinking” orientation and interaction needs to be introduced in the curriculum. Information of technological advances of materials and processes which are energy efficient and less waste post production are essential.

1.2. Sustainable Innovation in the World of Fashion

The Fashion Industry which comprises of the textile and apparel industries are well known for their high utilization of resources and impact on the environment (Rathinamoorthy, 2019). It is the second most harmful and polluting industry in the world after the oil industry, and UN Conference Trade and Development (Kituyi, 2019). Fashion is a complicated business involving long and varied supply chains of production from the beginning until the disposal of the garment eventually. From raw material extraction, textile manufacturing, clothing construction, shipping, retail, and usage.

In the past few years, more fashion industry player has made some changes in developing more sustainable designs. More eco-friendly designs have finally been confirmed. Global and local fashion councils have come to agreement to create the first ever sustainability community. For example, ZARA and H&M (among the notable fashion industry players in Malaysia) for instance have announced a number of events show-casing sustainable creative designs, in tandem with the current demand for clothing which highlights ethics and sustainability. Apart from aiding towards a pollution free environment, these initiatives and inclination actually bring into existence an entirely new employment opportunity favouring those with sustainable education background an advantage in the industry.

1.3. Current Practices of Sustainable Innovation in Pattern Making Skills

1.3.1. Knitting method

There are two sub-division of knitting: Pattern Piece Knitting and Seamless Knitting. Domestic hand knitting is the best and most common Zero Waste Fashion (ZWF) design around (McQuillan, 2019a). Sewing together knitted individual garment pieces is known as Pattern Piece Knitting. Reduction of waste from knitted garments has a considerable impact on the sustainability issue of textile waste on the environment, with regards to raw material pollutants in landfills (Marques et al., 2019).

1.3.2. Layer method

Layer method basically employs the line, surface, and figure principle. Many pieces of strands or strips are cut out from a piece of fabric or cloth which are then laid or arrange together in layers to form a surface. A figure is then created when these surfaces are bound together. This figure can be a garment or a part of a garment. Nothing is subtracted or discarded by adding layers, thus no waste is generated.

1.3.3. Minimal cutting method

This method literally explained itself. A design is cut using very minimal cutting or no cutting at all. Thus, it comprises two methods, but in both methods, there is only one pattern. The No-cut method design does not involve any cutting at all as in traditional costumes like the Indian Sari. In Minimal Cutting method, draping is used to minimize the number of cuttings and subsequently it designed the shape of the garment, depending on the measurement of the fabric (McQuillan, 2019b).

1.3.4. Jigsaw Puzzle Method

In this method, patterns are designed to precisely locked-fit into each other on fabrics, thus there is no waste at all. It is applicable on a flat pattern or draping. Traditional zero waste garment designed using Jigsaw puzzle method usually involved geometrically shaped patterns like squares, rectangles, triangles and patterns with intricate non-straight-line features (Kumari, 2017).

1.3.5. Subtraction Cutting Method

This method basically uses a technique called the Tunnel technique (Almond, 2018) where a whole cloth is creased-fold into halves and stitched together so that a tunnel is formed. Openings or holes are precisely cut out to allow body parts to enter through. It is a case or barrel-like technique applicable in pants, skirts, and sleeves. This method is fabric consuming but a creative alternative in fashion designing (Feori & Mckinney, 2017).

2. Problem Statement

The current scenario of fashion industry and fast fashion has impacted the environment. The impact can be seen in textile waste and raw materials, which related to pattern making process. Findings from the preliminary studies on fashion education institution in Malaysia revealed that; learning objectives in the current course of pattern making skills does not embed the significance of sustainable innovation practices. Raw materials such as fabrics and papers required for teaching demonstrations and garment sampling, contribute to the textile waste. Pattern making projects are not towards real-world problem that uplifting the importance of sustainable fashion. As a result, the end of teaching and learning does not assess on the knowledge and application of sustainable innovation. Therefore, the purpose of this study is to develop a sustainable innovation framework in teaching and learning for pattern making skill. To develop the framework, the researcher must first explore on the elements of sustainable practices in both fashion institutions and industry. Feedback from fashion educators and students will be compared to be integrated in the teaching and learning. At the end of this research, the developed framework will comprise different practices of sustainable innovation for pattern making skill for each construct of teaching and learning; Learning Objective, Learning Activities, Teaching Strategies and Assessment.

3. Research Questions

- i. How do educators deliver sustainable innovation in teaching and learning of pattern making skills in local fashion institutions?
- ii. How do industries implement sustainable innovation in pattern making practices?
- iii. How sustainable innovation can be integrated in teaching and learning of pattern making skills?

4. Purpose of the Study

The objectives of this study are as follows:

- i. To explore on the current practices of sustainable innovation in pattern making skill
- ii. To identify the suitable approaches of sustainable innovation practices in pattern making skill for higher education

5. Research Methods

The aim of this stage is to explore on the elements of sustainable innovation in the current teaching and learning in higher education institutions and practices in fashion industry. The exploration in the higher education institutions including feedback from the educators and also the students. Any suitable elements of sustainable innovation in the fashion industry will also be considered to be part of teaching and learning framework. The data is collected concurrently through qualitative and quantitative method in the next discussion.

Through reviewing literature in the area, some of the existing models were captured to be part of the framework development process. Interviews with academicians, fashion designers and pattern makers were carried out to explore the current practices in pattern making skills related to sustainable innovation. Besides that, observation was also part of the method to conduct the research.

5.1. Data Collection

5.1.1. Document Analysis

The sources of the documents are from digital print such as academic papers from journals article collection. The platforms are Scopus, Research Gate, UTM Digital Library and Google Scholar. The documents are important for the purpose of identification of elements of sustainable innovation in teaching and learning in pattern making skill. The articles (Aaijaz & Ibrahim, 2010; Agarwal, 2018; Almond, 2018; Başaran et al., 2019; Dissanayake & Sinha, 2013; Jewitt et al., 2017; Kaystha & Sharan, 2017; Marques et al., 2019; McQuillan, 2019a, 2019b; Townsend & Mills, 2013) mentioned about the sustainable approach in pattern making. Although the literature about sustainable in pattern making have been analyzed, to make the resources more concrete, interviews were conducted.

5.1.2. Interviews with Fashion Educators

Educators from fashion institutions are the most important sources of information as the objective of this study is about teaching and learning. They are the ones who transfer the theoretical and practical knowledge, and know what is expected in the learning curriculum. Semi-structured interview has been conducted to explore on the current practices of sustainable innovation through learning objectives, learning activities, teaching strategies and assessments in pattern making skills. The semi-structured interview guide, provides a clear set of instructions for interviewers and can provide reliable, comparable qualitative data. The format to conduct semi- structured interview can be from individuals or group (Corbin & Strauss, 2014). Through this method, the researcher is able to explore the thoughts and experiences of the participants. Apart from that, this type of interview allowed the researcher gain depth of the real situation through communication.

5.1.3. Interviews with Pattern Makers and Fashion Designers

Individuals such as fashion designers and pattern makers were interviewed to identify the current practices of sustainable innovation in fashion industry. Semi structured interviews had been carried out with the fashion designers and pattern makers. This method is very important in order to recognize the pattern making skills which are not implemented in the fashion institutions. These individuals were interviewed to share their thoughts, current technology, software and practices in pattern making skills. Apart from that, the practice of sustainable innovation for both type of production can contribute to the suitable elements to be adapted in the framework.

5.1.4. Observation

The practices of sustainable innovation in the current teaching and learning were also conducted through descriptive observation (Smit & Onwuegbuzie, 2018). Descriptive observation means that the researcher observes everything that occurs during the lesson, act like a novice. The researcher act as the non- participant to simply study on the behaviour and activities occurred in the teaching and learning setting. Observation in this study took place in Kolej Komuniti, Giatmara and Politeknik, where the classes were observed before, during and after teaching and learning process. Sustainable innovation practices not mentioned during interviews can also be observed, which described the real practices in the institutions. Therefore, this method is important to visualize the current practices of sustainable innovation in pattern making skill.

6. Findings

6.1. Current Practices of Teaching and Learning in Pattern Making Skills

6.1.1. Learning Objective

Based on the interview sessions, there are some sustainable innovation practices in the current teaching and learning of pattern making skills.; Minimisation of Material, Pattern Manipulation and

Upcycling. Most of the educators believed that the knowledge of sustainable practice is important today. However, it is quite impossible to integrate sustainable innovation for the whole course but the knowledge of sustainability can be adapted in certain modules as how the current students are learning. Upcycling technique is one of the sustainable innovation elements which is currently practiced in the institutions. Most of the educators shared the same notion by introducing Upcycling technique in pattern making process, where fabric waste was used for embellishment and decorations for contemporary fashion.

6.1.2. Teaching Strategies

The teaching strategy for this course is Project- based Learning, which required the lecturer to do some lectures and demonstration, by showing step- by- step instructions. Apart from that, students would be able to develop and solve problems regarding pattern making related to real world situation. They can experience different ways of pattern making techniques for every type of fashion design that they will create. Digital learning was also part of the teaching strategies, where the educators applied technology in the teaching and learning for pattern making subject.

From the analysis, it shows that class demonstration was the most favoured teaching strategy. This type of teaching method is suitable for hands- on course, so that students can follow and understand better. Educators and students are able to engage with each other through class demonstration, where students will be able to make any enquiries. Engagement is important because through the step-by step process from the early stage of pattern making, ongoing process until the final production.

Another teaching strategy was through digital learning. The lecturer present slide shows and use pattern making software to attract the students' interest. For example, videos about sustainability, creative pattern making technique and pattern making software. Students were able to explore different tools in pattern making. However, not all institutions have the facilities of using pattern making software. Software such as Tukatech is useful to grade patterns, but the tool will only help to minimize the work load. Manual pattern making is still essential for the students' ability to construct pattern from scratch.

Apart from that, feedback from the lecturers were also one of the strategies. Based on the findings, lecturers provide feedback for the student's work. The lecturers monitored the students during the self-independent working time, starting from the earlier phase until the final phase of pattern making process. Students need to do corrections on the spot if there were any mistakes in the pattern. Lecturers were able to explain further to the students so that students would have a clearer understanding.

Some of the lecturers shared that there are students who faced difficulties in understanding the pattern making techniques. In order for all students to be able to apply the knowledge and skills, lecturers had created their own method in pattern making skills, which is pattern manipulation. For example, pattern for jackets. The element of sustainable innovation is from the dart transfer technique, where the manipulation of the dart will minimize the folding part of fabric, instead, of stitching the dart. This technique is essential for every fashion student, as they have to design different style and apply them during pattern drafting stage. This is how students explored on different techniques in pattern making, to simplify the problem that they encounter and are able to conceptualize in the pattern making skill.

6.1.3. Learning Activities

From the findings, the analysis shows that Fashion Competition and Projects had been actively engaged to integrate sustainable innovation practices. Some of the competitions were organized for the purpose of sustainable awareness, not only for students, but also for the communities. The sponsorship was from established and well-known fashion company such as YKK. Students had also been exposed to the world of fashion industry which had been mentioned from the interview.

Peer collaboration and discussion are also one of the learning activities that had been mentioned. It shows that students were actively engaged with their peers, not only for class discussion. Based on the excerpts, peer collaboration was apparent in classroom activities. Self-revision is also part of the learning activities where students reflected on their learning independently, and to develop the understanding.

6.1.4. Assessment

The sub constructs for assessments are based on the educator's feedback. The researcher found that there were formative and summative assessment. Based on the excerpts above, assessments are important to enhance the students learning outcome in pattern making. Through formative and summative methods, lecturers can keep track on the students' development for both theoretical and technical knowledge.

6.2. Sustainable Innovation Practices of Pattern Making Skill in Industries

In this study, two types of fashion industry participated in the interview sessions. These industries were factory based (mass production) and boutique based (made-to-measure and ready-to-wear). All of the ten individuals including fashion designers and pattern makers had agreed to share their thoughts and ideas about sustainable innovation practices in the current pattern making industry. Semi-structured interview sessions had been conducted via face to face, email, and social media: Facebook Messenger and Instagram.

As for boutique based, the participants were expertise in both pattern making and fashion design skills. From the interview session, the researcher found that there were limited findings that are related to sustainable innovation, because as boutique fashion designers, the resources were only about fabrics, sewing machines and pattern making technique. Moreover, they only design clothing which are functional such as traditional clothing, contemporary, bridal, evening and red carpet.

On the other hand, factory based is different from boutique based as can be seen in the production level, where factory is more about mass production. In this type of industry, each participant has their own specific role. Based from the interview with the pattern makers, they described their role as the most important in production. Pattern Makers will collaborate with Fashion Designers, because not all fashion designs would be suitable for all kinds of pattern. Pattern Makers need to work accordingly based on the measurement, to transfer into the pattern grading software.

From the findings, it shows that some of the sustainable practices which can be adapted and assimilated into the teaching and learning of pattern making are about the use of advance technology such

as pattern making software, upcycling, draping technique, time management, and minimisation technique. As for the material, most of the designers are reluctant to use natural fabrics as their design collection.

6.3. Integration of Sustainable Innovation in Teaching and Learning of Pattern Making Skills

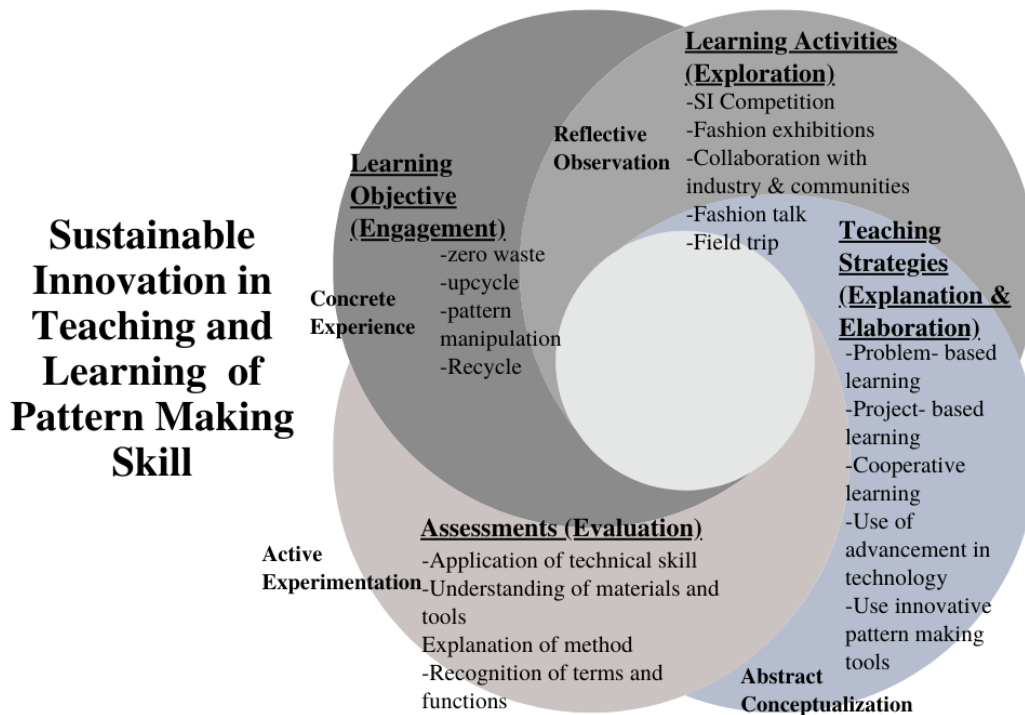


Figure 1. Framework of Sustainable Innovation in Teaching and Learning for Pattern Making Skill

The outcome of the study is a framework of sustainable innovation in teaching and learning for pattern making skills is shown in Figure 1. The visual display of the framework is the content emerged of the findings from the interview and document analysis. The explanation of the sustainable innovation elements had been discussed in the previous section.

The framework consists of sustainable innovation elements for each construct of teaching and learning in pattern making skill. The researcher had explored and analysed suitable elements of sustainable innovation which are considered to be effective in learning objective, learning activities, teaching strategies and assessment.

In learning objective, the sustainable innovation elements are focus on zero waste, upcycle, pattern manipulation and recycle. It is recommended for educators to be enhanced on these learning objectives, so that students would recognize the purpose of these SI elements. In the current practice of pattern making skill, pattern manipulation is already implemented, where students creatively innovate the style lines of the pattern piece, to get better shape and fit of the garment. Learning objective is the introduction phase of the lesson, therefore by enhancing the elements of sustainable innovation as the focus of the project or task, the impact of sustainable innovation can be seen in the outcome or product. Students

might relate each design and pattern making process with sustainable innovation. Educators can also mention on the pillars of sustainability and explain to the students on the issues of fashion sustainability.

Next in learning activities, the researcher found that the current activities of pattern making is focused on individual projects. It is indeed recognized that pattern making is an essential subject and important for technical skill of the students, but there could be some group- based project where students can share ideas and work together with peers. This will actually develop their interpersonal skills among themselves, and boost their confidence in giving opinions about pattern making. Besides that, most of the competitions are also an individual basis project. Apart from that, not all institutions organize fashion talks, field trips and collaboration with communities actively. Therefore, this sustainable innovation framework recommends educators to conduct more teamwork project and get involve with communities.

For teaching strategies, the current practices are towards project- based learning and educators practicing demonstration as the core teaching strategies. In this sustainable innovation framework, it is recommended that educators could inject the elements of environmental, social and economics in the teaching and learning. Teaching strategies such as problem- based learning and cooperative learning might trigger their cognitive skill, apart from technical skill. Students can also construct their garment based on the demand or any issues related to sustainability. They can apply their knowledge on sustainable innovation to address the real- world problem. In addition, educators can also utilize the advancement of technology tools such as computer aided design (CAD) or Tukatech. The application of CAD in pattern making is currently in demand in fashion industry, hence students need to acknowledge the function of the software. Thus, educators should enhance the use of pattern making tools in the teaching and learning.

Finally, evaluation and assessments are a must in teaching and learning. This is an important phase for both educators and students to know how effective is the teaching and learning. There are two types of assessments: formative and summative. To assess the knowledge of sustainable innovation in pattern making skill, educators can apply different methods, such as recap, quiz, test and even question and answer session. Simple types of assessments are easier to conduct and students can quickly reflect on their learning experience. As for summative, the rubric of the assessment can include the elements of sustainable innovation, where educators can specifically state which SI elements need to be applied in the design of pattern making.

Sustainable innovation is a good practice to be enhance in education, especially pattern making skill. It is a lifelong learning where fashion students will be aware of the current issues in fashion sustainability. Through integrating elements of sustainable innovation in teaching and learning of pattern making skill, students can practice the suitable approaches to reduce the impact of fashion sustainability to the environment, economy and social. By regularly practicing and applying sustainable innovation in the daily process of pattern making, students would be able to recognize and solve issues related to textile waste and fast fashion. Apart from that, they will be able to apply in the future career, be it in industry based or individual based. As currently, fashion industry is using advance technology in garment production, so by having the digital learning skill in pattern making, it is a bonus for the students. Sustainable innovation needs to be enhanced in the current teaching and learning because education is one of the medium to deliver new knowledge to the learners.

7. Conclusion

Sustainable innovation is a good practice to be enhance in education, especially pattern making skill. It is a lifelong learning where fashion students will be aware of the current issues in fashion sustainability. Through integrating elements of sustainable innovation in teaching and learning of pattern making skill, students can practice the suitable approaches to reduce the impact of fashion sustainability to the environment, economy and social. By regularly practicing and applying sustainable innovation in the daily process of pattern making, students would be able to recognize and solve issues related to textile waste and fast fashion. Apart from that, they will be able to apply in the future career, be it in industry based or individual based. As currently, fashion industry is using advance technology in garment production, so by having the digital learning skill in pattern making, it is a bonus for the students. Sustainable innovation needs to be enhanced in the current teaching and learning because education is one of the medium to deliver new knowledge to the learners.

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