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Accommodating Critical and Creative Thinking of Disable Students Through a Design Thinking Approach

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Improving the ability to think creatively and critically among students with disabilities requires adjustments to learning in heterogeneous classes. The modified design thinking approach provides an opportunity for students with disabilities to manage creative ideas. This study used a descriptive survey study of 72 students including 6 disabled students and 66 non-disabled students. The results of the study mentioned the participation of visual impairment students in active categories, namely 72%, 76% and 71%, hearing impairment students' participation in the acting categories were 72% and 70%. There is urgency in accommodating the learning needs of students with visual impairment at the empathy and prototype stages. The urgency of accommodating needs in learning for students hearing impairment is at the stage of empathise and desperation.

Keywords: *students with disabilities, design thinking, creative and critical thinking*

Introduction

Implementation of higher education for students with disabilities in Indonesian Regulation No. 8 of 2016, mandates learning must be able to accommodate the diversity of students with disabilities according to their needs. The current issue is the interest in understanding and advancing evidence-based practices that facilitate, validate, and support the involvement of students with cognitive disabilities in the Education curriculum (Agran, Wehmeyer, Cavin, & Palmer, 2008; McMahon, Mason, & ..., 2009). Schools are now held accountable for ensuring that educational goals for students with disabilities are based on standards that are in line with the general curriculum, and students with cognitive or significant disabilities are not exempt from this expectation (Carter & Kennedy, 2006; Janzen & Carter, 2001).

Essentially part of the academic community in higher education, students with disabilities have unique and diverse needs (WOLF, 2006). Perceived learning needs can be based on the visibility function of students with disabilities, but some disability students have more hidden learning needs due to their disability (Livneh, 2002). The heterogeneity of persons with disabilities tend to be regarded as more a matter of individual differences than aspects of diversity (Gaudet & Savoie, 2007; Vaughn, Bos, & Schumm, 2000; Woodhams & Danieli, 2000).

The Higher Education curriculum in the 20th century emphasises life-based learning. Students are faced with problems that will occur in the future. Education directs students to produce innovative solutions through critical and creative thinking skills. One approach used to stimulate creativity and critical thinking is Design Thinking. Simons (2011) explains design-thinking influences the process of creative work in various fields, including in the world of education or learning. Exploratory cognitive approaches to problem-solving are considered effective using a problem-based learning approach (Bagherpour & Jahanian, 2012). The nature of creative thinking is more flexible and this condition cannot be separated from student autonomy, self-regulation, and metacognition (Cubukcu, 2009). Universities can answer by facilitating the development of students' career adaptability. Learning in accordance with the characteristics of student learning is believed to provide pre-career experiences that foster career readiness and student confidence in building future career success (Muslihati, Praherdhiono, & Sobri, 2018).

The design thinking process is described as a five-stage process based on The Stanford D-School (Henriksen, Richardson, & Mehta, 2017; Matthews & Wrigley, 2017). Importantly, these stages are not always sequential but can be run in parallel, and can be done repeatedly (Rossman & Duerden, 2019; Siang & DAM, 5AD; Swartz & Parks, 1994). This learning illustrates design thinking as a five-stage process. This framework was designed as a model for assessing 21st century skills. Ten different skills were grouped into four categories: Category 1 - ways of thinking, Category 2 - ways of working, Category 3 - tools for working, and Category 4 - living in the world. Category 1 comprises skills related to creativity,

innovation, critical thinking, problem solving, decision-making, learning, and metacognition. These skills go beyond content acquisition and information reproduction; they emphasise essential thinking and learning skills such as divergent thinking, reasoned judgments, as well as reflective and reflexive learning. In comparison, the OECD framework does not emphasise such kinds of thinking skills. The skills in Category 2 emphasise communication and collaboration as the ways of working. It focuses on oral and written linguistic competencies, as well as the skills for interacting and managing groups in work contexts. By focusing on information literacy and ICT literacy, Category 3 emphasises the learners' ability to manage ICT information and harness for effective work which is similar to the OECD model. Category 4 consists of the competencies for local and global citizenship, the management of life and career, as well as the management of personal and social responsibilities. These competencies prepare students with the cultural mobility to manoeuvre the increasingly global job markets (Panel, 2002; Tsakissiris, 2016).

The challenge of higher education institutions that have students with disabilities is to facilitate learning needs following their obstacles. Access to improve creative abilities and critical thinking must be felt by non-disabled students and students with disabilities. The application of design thinking in heterogeneous classes must be adjusted adaptively through classroom management and the use of active learning methods must be in accordance with the characteristics of students. In this case, lecturers are the learning designer who help student learning as a complex process (Henriksen et al., 2017). Lecturers must believe in the adaptive approach to minimise the barriers of students with disabilities (Efendi, 2018; Hornby, 2014). Student diversity can be a capital in increasing attitudes, knowledge and participation in the classroom.

The innovation process as a learning model suggests that teams be composed of individuals who are polar opposites in how they take in and transform information. Some take in information through symbolic representation or abstract conceptualisation, while others take it in through direct sensation. Some process information by watching others and reflecting on what they see, while others jump in and participate themselves (Plattner, Meinel, & Leifer, 2010; Razzouk & Shute, 2012). Each of these diametrically opposed sets of approaches presents a choice that an individual must make and, over time, individuals gravitate to a preferred style. Similarly, when working in teams, teams must make a choice at a given point in time as to which learning style it will allow to dominate its activities. The choice about that style is directly related to where it is in the innovation process.

Research methods

This study uses a descriptive survey design. Participants involved were 81 students of Universitas Negeri Malang, including 76 non-disabled students and 5 disabled students. The

disability category consisted of 3 students with visual impairment and 2 students with hearing impairment. The research sample used is the total population method, researchers used 3 classes using an adaptive design thinking approach. Learning is performed independently and collaboratively. Disability student participation is observed based on stages including empathise, define, ideate, and prototype. The demographic data of students with disabilities collected concerning the innovation management study group is as follows.

Table 1. The demographic data of students with disabilities

Aspect	**Si**	**Ut**	**Wi**	**Wa**	**Dh**
Disability Category	Visual Impairment	Visual Impairment	Visual Impairment	Hearing Impairment	Hearing Impairment
Gender	Male	Female	Male	Male	Male
Ages	20 years old	22 years old	21 years old	22 years old	23 years old
Learning characteristics	- Good cognitive - Auditory learner	- Good cognitive - Auditory learner	- Good cognitive - Auditory learner	- Good cognitive - Visual learner	- Good cognitive - Visual learner
Learning Needs	- auditory Teaching materials - Concrete learning media - Mobility companion	- auditory Teaching materials - Concrete learning media - Mobility companion	- auditory Teaching materials - Concrete learning media - Mobility companion	- auditory Teaching materials - Concrete learning media - Mobility companion	- auditory Teaching materials - Concrete learning media - Mobility companion

Participation includes a readiness, willingness to pay attention to, and participate in a activity (dan Mudjiono, 1994).

Table 2. Participatory learning instrument design thinking

Aspect	Indicator	Item No.	
		(+)	(-)
Participation of students in receiving the subject matter	Attention students in the explanation of matter	1	2
	Student access to instructional materials given faculty	3	4
	Students understand the examples of innovation instructions	5	6
	Students answer the questions given by the teacher	20	21
	Students make small notes individually thinking results	7	8
Student participation in group discussion activities	Students and members of the group communicate / discuss the problems that the teacher	9	10,11
	Students are able to work together with members of his group	12	13
	Students give an idea / opinion on a given issue	14	15
	Students give a chance to a friend to deliver the opinion	16	17
	Students ask questions to the teacher about what is not understood	18	19
	Students write group discussion of results	22	23
Participation of students in the presentation	Students are able to present the results of their discussion	24	25
	Students pay attention to another group while presenting	26	27
Student participation in the work on the problems / tasks	Students work on the problems / tasks given by the teacher	28	29,30

Research result

There are 5 teams / groups in this design thinking learning. Lecturers apply the Project Based Learning model to stimulate groups of students to experience the innovation process. Learning is carried out in 16 meetings for 4 months.

Students build and use knowledge to gain experience in the innovation process through critical and creative thinking. The innovation process undertaken is Analytical and Synthetic. In the analytical design phase, the student group focuses on finding and discovery. While in the synthetic design phase, the student group focuses on investment and making.

Learning design thinking in student groups adapts the stages of EDIPT (Empathise, Define, Ideate, Prototype, and Test). Implementation of learning is 4 stages, the innovation process undertaken is Empathise, Define, Ideate, and Prototype. Specifically for the prototype phase, a group of students design innovative ideas based on the synthesis of findings.

Learning adaptive thinking design for students with disabilities is done by providing accommodation in accordance with the portion of learning needs. The results o:f the adaptation of learning design thinking to students with disabilities are as follows

Table 3. The learning outcomes of the disability students innovation process

	Si	Ut	Wi	Wa	Dh
Empathize	66	68	64	60	61
Define	76	80	71	61	64
Ideate	80	85	84	86	78
Prototype	67	69	65	83	86
Total	72%	76%	71%	73%	72%
Category	Enough	Good	Enough	Enough	Enough

Table 4 of disability student participation in Design Thinking learning

Aspect	Si	Ut	Wi	Wa	Dh
Acceptance of teaching material	72	76	71	73	72
Participate in group discussions	74	84	70	69	66
Contribute to the presentation of results	74	75	71	73	76
Final project contribution	70	73	73	75	75

Based on the data obtained, overall disability students in both categories are above 70%. In more detail, the success of students with disabilities following each phase shows the diversity of achievements.

Students with visual sensory disabilities consist of Si, Ut and Wi, generally showing poor performance at the empathise and prototype stages. Sequentially, the learning outcomes of the empathic stage are 66, 68, 64. The learning outcomes at the prototype stage are 67, 69, and 65. While the learning outcomes of the innovation process at the define and ideate stages

show good performance to very good. The sequential learning outcomes of the define stages are 76.80, and 70. The learning outcomes of the ideate stages are 80.85, and 84.

During the empathy phase, visual impairment students have difficulty in observing what people are doing and how they interact. Visual impairment students reflect the phase of empathy that is by direct involvement and feeling. The problems offered are subjective, based on personal experience. During the prototype phase, students with visual impairment find it difficult to draw innovative ideas in 2 or 3 dimensional shapes. Visual impairment students do prototype designs with demonstration activities and lectures.

Define phase shows good results, visual impairment students are able to describe problems that focus on the user and the problem based on user needs. The role of the group is very good, some group members become companions / volunteers in the orientation of the problem inventoryed. In the ideation phase, visual impairment students can contribute ideas and problem solutions very well.

Sensory audio/Hearing Impairment students consist of Wa and Dh, generally showing poor performance at the empathise and define stages. The learning outcomes of the empathic stage are 60 and 61. The learning outcomes in the define stage are 61 and 64. While the learning outcomes of the innovation process at the ideate and prototype stages show sufficient performance. The sequential learning outcomes of the define stages are 86 and 76. The learning outcomes of the prototype stages are 83 and 86.

Students with hearing impairment in the empathise phase showed difficulty in expressing involvement with the user immediately. Interaction conducted on the user is not included in the development question. Hearing impairment students are only able to tell the user's basic views and have not been able to express the values they hold. During the define phase, hearing impairment students conduct analysis that are limited to determining the problems experienced by the user.

In the ideation phase, hearing impairment students show activity to create mind maps, sketches, bodystorming and design innovation ideas. The group jointly synthesises and illustrates innovation ideas in the resulting sketch. Wa and Dh provided an opinion on the development of the design of group ideas. In the prototype phase, hearing impairment students contribute significantly to performance. Wa and Dh became group members whose role was to visualise the innovation ideas of the group. With group collaboration and the role of a companion/volunteer, they can contribute their final work.

Discussion

The results approving the design provide an overview of critical and creative thinking for disabled students in heterogeneous classes (Beckman & Barry, 2007; Johansson-Sköldberg, Woodilla, & ..., 2013; Simons, Gupta, & Buchanan, 2011). EDIP Transfer stage becomes EDIP (Empathize, Define, Idea, and Prototype). Discussion of learning accommodation for students with disabilities is conducted every hour. Learning support provided by instructors for visual impairment students is auditory teaching materials, concrete learning media, and companion/voluntary mobility. Learning assistance for deaf students is a teaching material for visual and voluntary interaction for Sign Language.

Empathise

The empathise stage is the first stage and an essential starting point of the Design Thinking process. The aim is to get an empathic understanding of the problems the group will solve. Students immerse themselves in the physical environment so as to gain a more mature understanding. The method used by the group in the empathise phase is to observe, engage, and immerse for getting indepth understanding the experience and perspective of the user. These insights allow the student to approach the rest of the process with a stronger understanding of the context and problem (Henriksen et al., 2017; Taajamaa, Eskandari, Karanian, & ..., 2016).

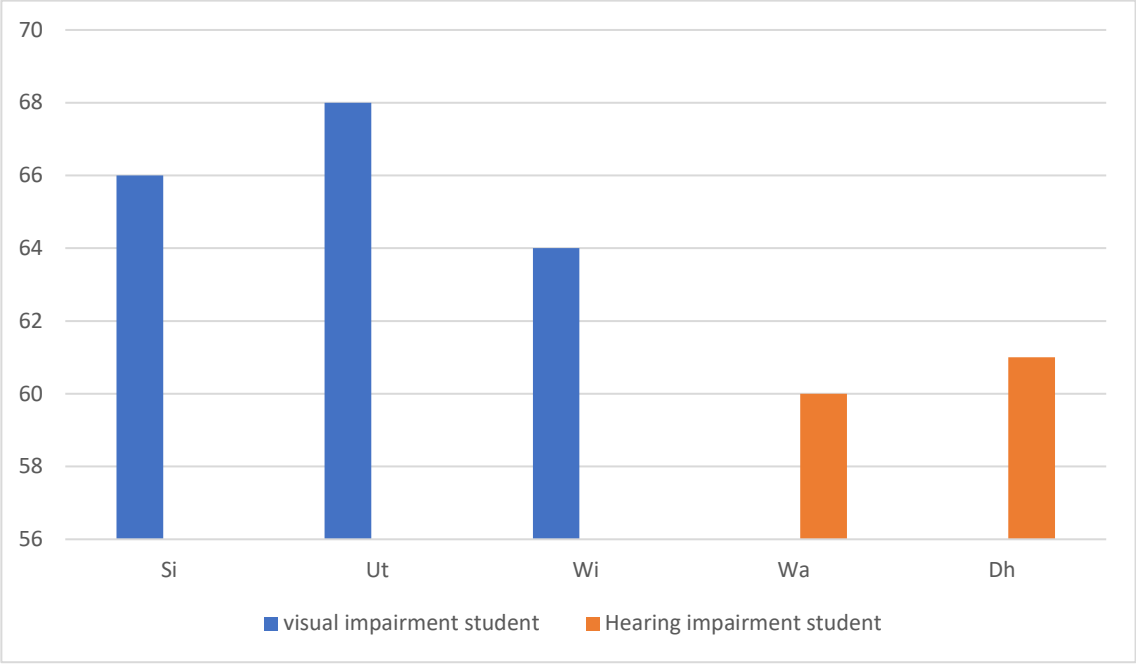

Figure 1. The learning outcomes of the empathy stage

Students with disabilities demonstrate learning performance that requires more support in the empathising phase. Proven with results below 70. If compared, visual impairment students

show better results than hearing impaired students. This achievement is obtained based on the learning characteristics that are unique to students with disabilities.

Visual impairment students encounter a big challenge in observation activities. Visual impairment student participation in observing activities is supported by the role of volunteers. The trick is to describe the cases that occur and are experienced by people (users). Another obstacle encountered is the lack of interaction with the user. They often show feelings of loneliness and difficulty in making friends as social skills are lower in students with visual impairment than in normal students (Huurre & Aro, 1998).

Visual impairment students find it difficult to combine images, simulations, and other resources to make fair use policies (Warpechowski, Orzeszek, & Nielek, 2019). These problems lead them to be involved minimally in the phase of analysing user needs. The group provides learning support by describing physical forms of user needs. The empathise phase is optimised for visual impairment students through immerse activities. They involve themselves and feel directly what has been experienced by the user.

Students with hearing impairments encounter challenges when interviewing activities. The role of the volunteer is to convey verbal information to students with disabilities. They have difficulty in receiving compound messages from people (users). The process and mechanism for receiving information through oral and written of hearing impairment students plays a strong predictive role (C. M. McCann, Beddoe, & ..., 2013; D. C. McCann et al., 2008)). Compared with children whose hearing is normal, the communication of children with hearing loss depends on a greater level of movement, on awareness of social cues and on other skills that compensate for their reduced hearing acuity (Bishop & Snowling, 2004; Fisher, Yefimova, & Bishop, 2016). Optimizing the empathising phase of hearing impaired students can be done through engaging activities. They discover user problems through perceived experience.

Define

The define stage is the second stage of the Design Thinking process. The aim is to determine the problem with the user. Problem formulation focuses on the specific type or characteristics of the user and is based on insight and user needs. In this activity, students gain experience in analysing cases in the empathising stage. In this step students articulate a problem statement based on details and understandings they gained previously. They focus in and frame the problem, to guide design efforts moving forward (Henriksen et al., 2017).

Disability students show varied learning performance in the define phase. Students with visual impairments show results proven with results below 70. If compared, students with visual impairments show good results while students with hearing impairments show performance that requires more support.

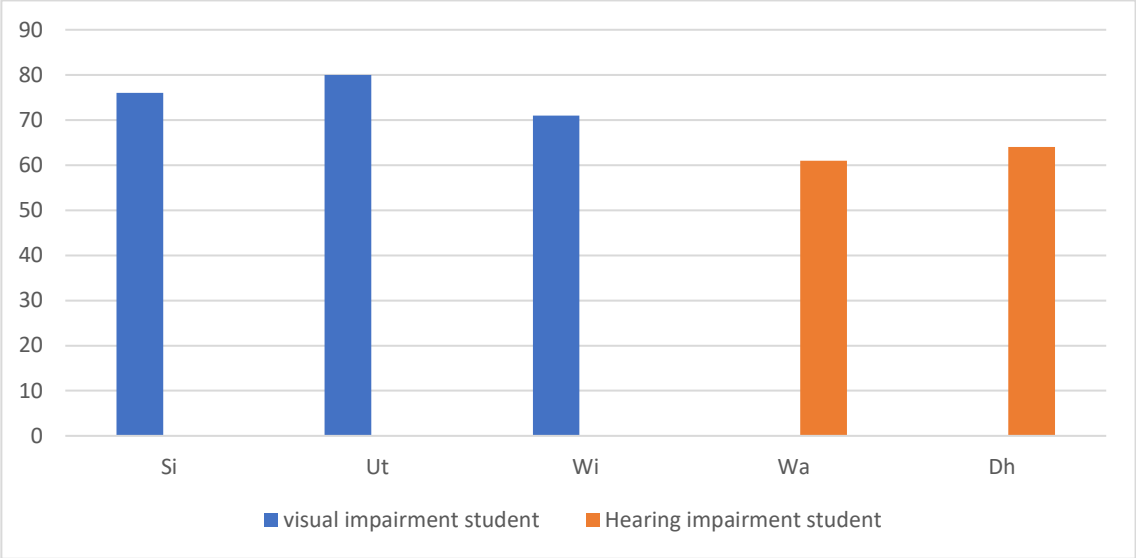

Figure 2. the learning outcomes of the define stage

Students with visual impairments can elaborate and explore cases obtained by the group. Ut shows good results, she is able to describe specifically who is the user and what the user needs. Likewise with Si and Wi, but it's just that Ut shows better presentation skills. The achievement of students with visual impairment is also determined by their communication abilities. The communicative styles of the mothers of eight children with total blindness and eight children with severe visual impairment in daily interaction (Moore & Parker, 2009). Results showed that totally blind children and children with critical visual impairment received more exhortations to act than any other type of request. The long-term language outcomes for children with congenital blindness suggest that visual impairment per se does not give rise to major difficulties with regard to the development of structural language skills (Baine, 1988; Keefe & Copeland, 2011; Millar, 2007).

The type of conduct to solicit their children's participation teaches them the purpose (and rules) of a game, or determines that their children understand instructions. The authors did not rule out, however, that this interactive style might have negative effects on children with blindness (although they formulated no clear-cut interpretive hypothesis to this effect). Concerning a group of adults with congenital blindness, through demonstrating that the mental state with respect to attachment of a person with blindness does not depend on the onset age of visual impairment (Congdon, Friedman, & Lietman, 2003; Huurre & Aro, 1998; Resnikoff, Pascolini, Etya'Ale, & ..., 2004).

Students with hearing impairments show exploration and elaboration performance of cases with minimal contribution. The role of groups is more dominant than they are. This is very closely related to the communication and information processing capabilities of students with hearing impairments. Cochlear implants are provided for young children in the expectation that immediate benefits in the domain of auditory receptive capabilities will trigger a cascade of further benefits in spoken communication skills, educational achievements, social independence, and quality of life (Hétu, 1996; Morton, 1991; Uhlmann, Larson, Rees, Koepsell, & ..., 1989). Among children without implants, many outcomes are poorer, the greater the severity of hearing loss.

Ideate

Ideation stage aims to explores a wide variety of solutions and produce ideas (Henriksen et al., 2017). This process stimulates students to come up with ideas that can be solutions to problems. The way to do this is through bodystorming, sketching and making mind maps. Sensory disability students show good and excellent learning performance. Evidenced by the learning outcomes are 78-86.

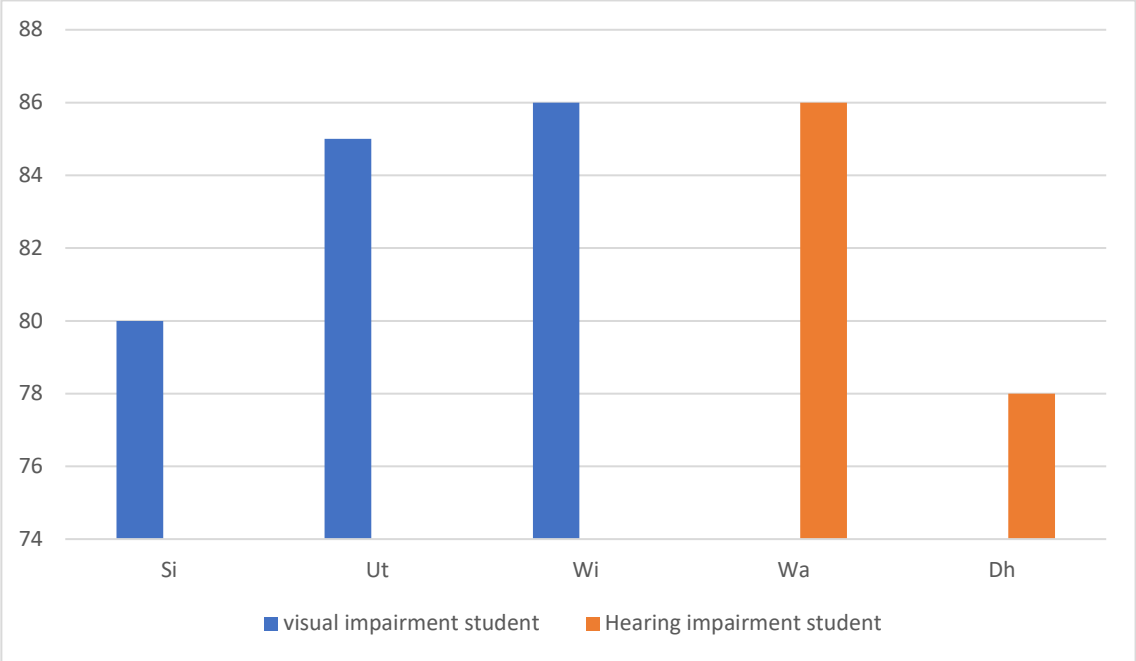

Figure 3. The learning outcomes of the ideate stage

Students with visual impairment show results above 80. In principle, the ability to produce ideas including the synthesis phase of design thinking. Problem solving through solution ideas is the result of students' intelligence and knowledge.

Other studies have shown that children with visual impairments compensate for these deficiencies through other senses, especially hearing (Holbrook, 2006; Rubin, West, Munoz, & ..., 1997). Individuals with visual impairment store memories in verbatim form, which causes better ability to discriminate sound than normal people, and process verbal words faster than people who have normal vision, as well as having auditory localisation capabilities (Pascolini, Mariotti, Pokharel, & ..., 2004; Taylor, Livingston, Stanislavsky, & ..., 1997).

Blind children show similar performance patterns to normal people in mental tasks that require object rotation, the use of imaginary mnemonics and spatial configuration memories. Blind people may use mental images to make associations with sensory modalities other than vision with the involvement of visual and somatosensory areas. There are three limitations to mental images in blind people, namely (1) the slow mental image process, (2) the difficulty in generating interactive images involving more than 1 object and 1 place, (3) performance obstacles when asked to imagine the object configuration movement 3 dimensions rather than 2 dimensions (Jadoon, Dineen, Bourne, & ..., 2006; Klaver, Wolfs, Vingerling, & ..., 1998; Kocur & Resnikoff, 2002).

Students with hearing impairments show a high contribution to the determination of solution ideas. In order to meet the challenge, the project adopts a participatory design approach to learn about the sociocultural practices and expectations of deaf people with the aim of developing solutions that meet the real needs and ways of living and understanding deafness, which are many and highly varied, as described above. While the loss of hearing for deaf people implies a loss of status in the mainstream society and therefore a disability to overcome through the use of hearing aids, the reality is different for those who were born deaf (Dewantoro, 2016). They experience a fundamental language barrier when communicating with hearing people, but not within their community. People with hearing loss can take advantage of hearing aids and assistive technology to communicate in most situations. Deaf people can also rely on sophisticated hearing aids or implants to understand speech even if not perfectly clearly.

Prototype

Prototype phase is to apply the ideas that have been gathered into a physical form, can be a note affixed to the wall, role play activities, objects, or even a storyboard. In this study, the prototype phase is done by visualising ideas through the design drawings / sketches. Learning outcomes are shown by students with sensory disabilities varies between 65 - 86. Students with visual impairment shows the performance of the categories require more support. Students with hearing impairment to demonstrate the performance is good to very good.

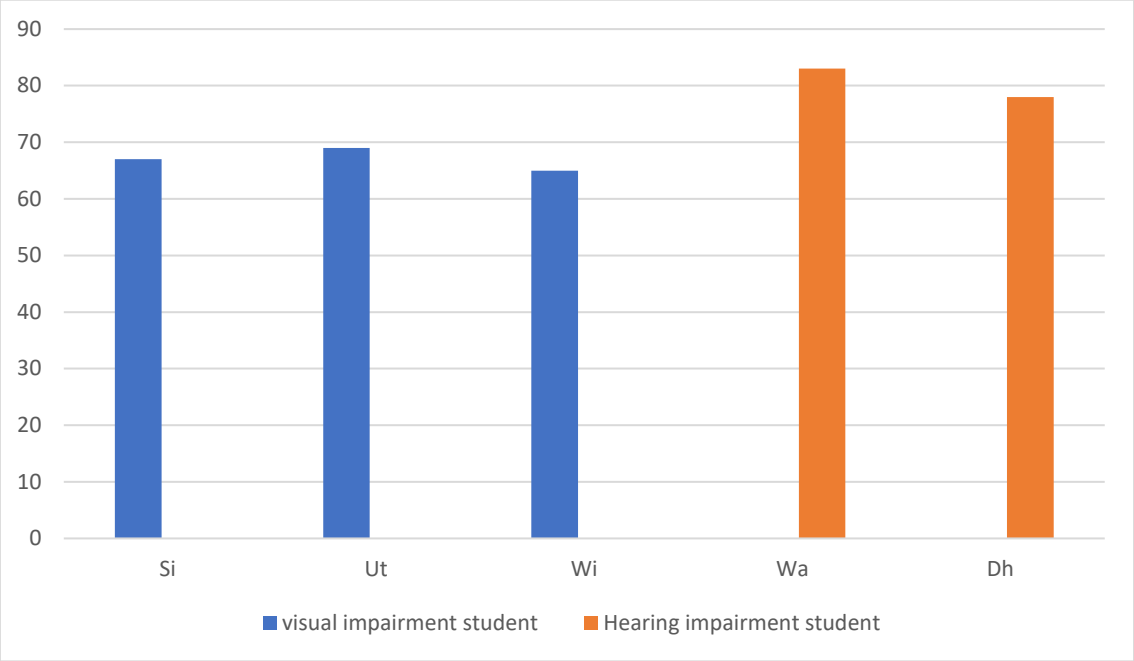

Figure 4. The learning outcomes of the Prototype stage

At this stage, students of visual disability need help more. They are limited in the perception of space and are limited on some major aspects. There are three serious limitations on the development of visually impaired cognitive function, namely (1) the scope and variety of experience, (2) the ability to move in the environment, and (3) interaction with the environment. Generally, they are difficult to control the environment and control the position yourself for not having the perception of space outside which he occupied (Barletta & Watson, 2001; Vitale, Cotch, & Sperduto, 2006).

Deaf students show a good performance in the sketch / design. Deaf students basically have the same physical characteristics in normal people. Deaf intelligence capability is equal to a normal person, but because of limited hearing to obtain information the development of intelligence is slow. Deaf students many also have an incentive to learn a considerable amount, but a deaf person may realise and undersand the importance of learning to make life better. They also need guidance and education services are the same as normal people. Therefore, they need encouragement or motivation to develop their potential.

Overall, learning design-thinking approach can be followed by students of disability inclusion. The innovation process as a learning model suggests that the team consists of individuals who are opposites in the way they pick up and change the information. Some receive information through a symbolic representation or abstract conceptualisation, while others take it through direct sensation. Others process information by watching others and reflecting what they saw, while others jump in and participate themselves. An individual must make a choice to their preferred style. Similarly, when working in a team, they had to make a

choice at the point in time for that style of learning that will allow them to dominate the activities. The choice of style is directly related to where it is in the process of innovation. The stages of modification 4 stages of design thinking are a disability-friendly.

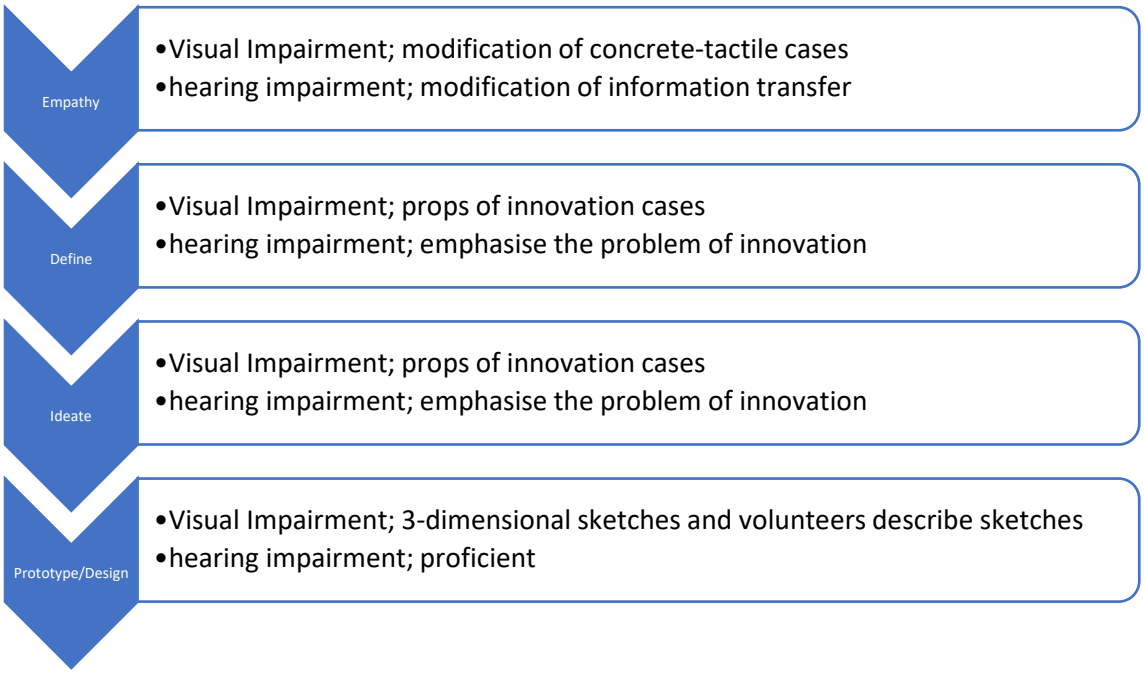

Figure 5. Modified design thinking accommodation for disability designs

Conclusion

Modified design thinking learning can help students with disabilities to think creatively and critically. Stimulation provided by lecturers with the help of groups is crucial for the development of their learning. Lecturers need to imply various methods of active learning in design thinking learning. There are several stages that need to be prepared by lecturers before implementing adaptive design thinking learning especially for students with sensory disabilities who are blind and deaf.

The important thing students must experience is understanding the innovation process and the need to move between abstract and concrete and between analysis and synthesis to carry out the process. Second, it means assembling the right mix of people on the team to carry out the process. Finally, it means providing leaders for teams who not only have classic leadership skills, but who understand the process and who are able to smoothly leverage and integrate the diverse ways of thinking represented in the team.

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