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# Development of Technology Tools in Next-Generation Learning Spaces (NGLS) Framework: A Fuzzy Delphi Analysis

**By**

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## ABSTRACT:

**The Malaysia education has embarked on its digitalization journey and the Malaysia Digital Economy Blueprint is formulated as the action plan. To reform the initiative with a focus toward change in teaching and learning with technology integration. This article aims to design and develop Next Generation Learning Spaces (NGLS) conceptualize framework in technology tools using Fuzzy Delphi (FDM) method. Therefore, this research study aims to obtain experts consensus from 13 experts about the construct and the elements of technology tools in the framework. An instrument that involves 7 elements of technology hardware, 4 elements of using technology for homework, 4 elements for test and quizzes, 5 elements for codingandprogramming,4elementsof onlinetutorialand5elementsofonlinelearning. The findings illustrated are mostly agreed by the experts with all the elements of the technology that suggested in the framework. The threshold value for accepted elements is between 0.000 to 0.183 which is the acceptable elements that must be lower than ($d \leq 0.2$). From the FDM analysis, it is also indicated the expert consensus percentages value in range between 75 % to 100 %, which is shown the acceptable percentage value more than 75% as required by FDM requirement. The third requirement in FDM is the value of alpha cut which is the value of $\alpha$- cut $\geq 0.5$. In term of technology tools, all the elements illustrated that value of alpha cut is higher than 0.5. Thus, mostly the acceptable elements have the qualified of alpha cut value between 0.874 to 1.000. Therefore, the defuzzification process will shift to ranking all the technologytools elements in the framework based on experts' consensus. This research study definitely come out with a list of technology tools in NGLS conceptualize framework.**

## KEYWORDS:

**Nextgeneration learningspaces, technologytools, FuzzyDelphiMethod.**

## Introduction

Teachers are in need of the transition of pedagogies and working with new technology toolsinsupportingtheirteachinginnewlearningspaces (Mahatetal. 2018).The2030Agendafor Sustainable Development (UNESCO, 2016, 2020), is a plan to ensure environmental sustainabilitytosupporttheneedsofpresentandnextgenerationsleaners.Toensurethe agile andcompetentdigitaltalentamongsecondaryschoolteachers, Ministry of Education (MOE)

With the initiative of MYDIGITAL have introduced "My Digital Teacher" which is to encourage and upskill teachers' knowledge to embed technology tools in teaching and learning (EPU, 2021). In this context, teachers need to find the best pedagogy strategies embedded with suitable technology tools to transform and disseminate skills, knowledge and value in future education. In addressing the challenges, teachers need to prepare and empowering their pedagogies with technology to encourage formal and informal learning (Ishak & Jamil, 2020; Nurul Natrah & Ahmad Shidki, 2020).

In dealing with the recent phenomena in education, the Digital Educational LearningInitiative Malaysia (DELIMA) is the latest digital technologies which support the digitalization' transition among teachers in Malaysia. Technology must be used into the next generation learning spaces (Ling & Fraser, 2014). Next generation learning space is refer to the relationship between pedagogy, space and technology (PST) framework (Radcliffe et al., 2008). The nature of next generation learning spaces have been discussed and debated especially on the roles of physical spaces, virtual spaces and the technologies will play in the learning spaces (Fraser, 2014; Edwards et al., 2021) . Types of technology tools and the concept of learning spaces related to technology and its application in education must be highlighted by stakeholder in preparing the next generation outcomes. In this context, teaching and learning activities in NGLS must be active and interactive between teachers and students or students and students without any bounded by the perimeters of the learning spaces. They are allowing connection for the wider world through the technology digitalization as well as online tutorial and online learning using the suitable devices.

An inadequate learning spaces and low technological knowledge might issue the low acceptance rate of the integration of technology tools in teaching and learning (Athirah & Azlina, 2020; Jalil et al., 2021; Mardhiah et al., 2021) . According to the report of Smart School Qualification Standard (SSQS) in 2020 by MOE, implies that only 41 % - 60% teachersusevirtuallearningenvironmentandtheindicatorillustratestheweaknessvalueof

0.76 from 5 scale of indicator for use of ICT tools for teaching and learning. Although,mostly teachers find teaching through technology and online is useful (Azlan et al., 2020; Hashim, 2014).In spite that, teachers face tough challenges because lack of technological knowledge, limited accessibility and lack of effective training to integrate technology in teaching and learning (Cheok & Wong, 2014; Ghavifekr et al., 2016; Muhamad Khairul etal., 2019). The failure of the teachers transition to technological approach will impact the MOE aims to ensure teachers fully embrace the use of technology in pedagogies (Mohamed Nazrul Ismail, 2020). Hence, the development of technological framework for enhancing teachers' pedagogies which incorporate the suitable practice, strategies and technology tools in next generation learning spaces as a benchmark for Malaysia teachers improving their pedagogies with technology tools.

## LITERATURE REVIEW

Next generation learning spaces (NGLS) provides the new environment for learning interaction. The interaction between pedagogy, learning spaces and emerging technologies willenhancefutureleaners skills, attitudeand knowledge,with appropriatelearningspacethat

optimize future generations 'engagement (Keppell, 2014). The 21st century learning environment is the ability to support different teaching strategies, installing flexible and technology setting that would transform the traditionally fixed environment into an adaptable settingsuitedforvarious teachingandlearningstyleinformalandinformal learning(Allison, 2019; Grannäs & Stavem, 2020; Nambiar et al., 2018; Radcliffe et al., 2008).

Virtual learningspaces is referred to the types of platforms that support teachingand learning asdigitalmediaintechnologytoolsforonlinetutorialandonlinelearninginvirtualspaceand physical spaces (Huang et al., 2019). (Elkington & Bligh, 2019; Kariippanon et al., 2019). Next generation learners are characteristic by having relationship and interact with technology. Teachers also need to adapt and customize teaching interactions to suits for next generation leaners (Ana Haziqah A.Rashid et al., 2021; Omar & Ismail, 2020). In spite that, (Joshi et al., 2020) highlighted that virtual learning is debatable in term of absence of face- face relationships among teachers and leaners as well as lack of direct communication between teachers and leaners in virtual learning space may causes some problem(Khaydarova & Uz, 2020).

The integration of digitalization in the digital age requires a range of knowledge and skills in handling the hardware and application technology tools (Siemens, 2005). The technology tools such as tablets, laptops, notebook, PCs, interactive audio visual, smartphone as example of support devices in learningspaces (Nurbanati et al., 2021;Sage et al., 2020; Sundar, 2020) as new ways of teaching and learning in educational settings. The effective use of technology tools improving the teachers and students' knowledge. While traditional print-based teaching aids (textbook, manuals), technologytools are used in learningspaces in introducing students to new material, interactive audio video conferencing and rapid exchange of the homework over the network (Galway et al., 2020; Nambiar et al., 2018; Sage et al., 2020).

According to Lazar (2015) "Educational technology is a systematic and organized process of applyingmoderntechnologytoimprovethequalityofeducation". Thatisawell-plannedway in teaching and learningtakes place through the use of technology tools as well as design and production of teaching and learning materials (Bala, 2020). Teaching and learning in NGLS was forced to move into the internet space, possible through technology. The elements of video conference classrooms on Google Meet, Zoom, YouTube, telegram become new elements of technology tools in learning space (Ahmad Alif Kamal et al., 2020; Hidayat & Shafie, 2020; Kadek et al., 2021; Khaydarova & Uz, 2020; Muhamad Khairul et al., 2019). The online learning and tutorial attempt to provide flexibility to teachers and leaners in ubiquitously spaces. Teaching and learning connect via virtual and physical and can move in wider range of spaces as well as able to teach, learn, work whenever and wherever they want (Edwards et al.,2021; Johnson, L., Adams Becker, S., Cummins, M., 2014; Siemens, 2005).

In conclusion, the rapid transition in term of technology in education has raised different issues for further discussion in promoting stakeholder engagements, especiallyfor responsive teachers'

knowledge and skill for next generation learners. Critical issues raised include connectivity,teachers'rolesinlearningspacesandneedofteacherstrainingand development

in applying the technology in their learning spaces (Langdon Warren, 2021; Edwards et al., 2021).

## METHODOLOGY

The purpose of this study is to developed an NGLS conceptualize framework in teachers' pedagogy and technology tools.The Fuzzy Delphi Method (FDM) is use in this research study, which is Fuzzy Delphi has been introduce by Murray, Pipino and Gigch (1985) and been improved the uses of Fuzzy Delphi by Kaufman and Gupta (1988). The Fuzzy Delphi method has been measured with futuristic research to enrich the effectiveness and reduce the research time frame compare with the traditional Delphi (Fadzilah Bee Abdul Rahman et al., 2021; Ridhuan & Hussin, Zaharah, 2013; Sanura Jaya et al., 2021; Sukor Beram et al., 2021; Saedah Siraj et al.,2021).

Fuzzy Delphi method procedure was selected to validate as well as to identify, evaluate and justify the key components and contents of NGLS conceptualize framework in teachers' pedagogy and technology tools. To indicates the acceptable constructs and elements in the framework, the main three requirement in Fuzzy Delphi method are used in terms ofthreshold (d) value, percentage of expert agreement and the value of Fuzzy score (A) in defuzzification process. The researcher will focus on technology tools construct in development of next generation learning spaces (NGLS) conceptualize framework. The elements of the technology construct as show in Table 1.

**Table 1:**Elements of theTechnologyTools

| **BIL** | **TypesofhardwareapplicationinNGLS** |
|---|---|
| E1 | InteractiveAudioVisual(AV)display(interactivescreen) |
| E2 | In-schoollaptops/PersonalComputer(PC)(incomputerlab) |
| E3 | Desktop computers |
| E4 | Tablets |
| E5 | Smart phone |
| E6 | Videoproduction |
| E7 | Digitalcameras |
| **BIL** | **TypesoftechnologyapplicationtoolsforOnlineTutorial** |
| E1 | *Zoom* |
| E2 | *ScreenCasting* |
| E3 | *Loom* |
| E4 | *GoogleMeet* |
| **BIL** | **TypesoftechnologyapplicationtoolsforOnlineLearning** |
| E1 | *YouTube* |
| E2 | *GCSE POD* |
| E3 | *Telegram* |
| E4 | *WeChat* |
| E5 | *WhatsApp* |

The researcher identified the 13 experts which is involved in various of expertise in field of curriculum, pedagogy, learning spaces and technology as well as senior university lecturer that have experienced in education for 10 years and above.According to Adler & Ziglo (1996), the numbers of experts are 10 to 15 experts while Jones & Twiss (1978) suggest the numbers of experts can be 10-50 experts. The purposive sampling in this study based on the experienced, knowledge and skill that they have in learning space, pedagogy and technology (Saedah Siraj, Norlidah Alias, Dorothy DeWitt, 2013). Table 2 shown the number of selected experts.

**Table2: Number of selected experts**

| Field | Numberof experts |
|---|---|
| Curriculum expert | 4 |
| LecturerinTeachers'TrainingCollege | 3 |
| Technologyexpert | 3 |
| Learningspace expert | 3 |

The 13 selected experts have the criteria such as have a Doctor of Philosophy in the related field, experienced in learning spaces, pedagogy and technology as well as senior lecturer in university and teachers training college in the field of curriculum. The questionnaires areused in this FDM and the Fuzzy Delphi technique is used to analysis the data. The researcher needs to identified the linguistic variables used in this study and conversion to triangular *Fuzzy* number. The triangular Fuzzy number have 3 value which is (m1, m2,m3) indicates the minimum value, the reasonable value and maximum value as show in Figure 1.

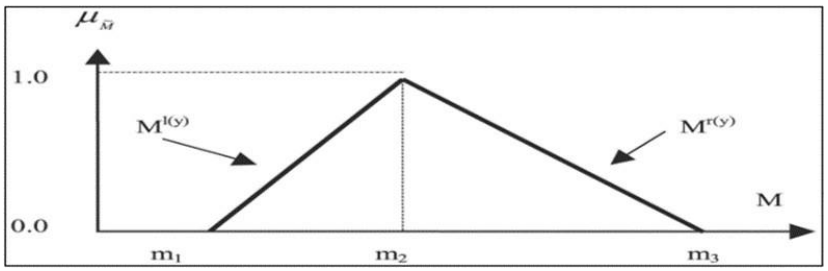


Figure1 TheTriangular FuzzyNumber

Referto Figure1, thethresholdvalue (d)iscalculatedusingthe formulaasbellow:

$$d(\tilde{m},\tilde{n}) = \sqrt{\frac{1}{3}\left[(m_1 - n_1)^2 + (m_2 - n_2)^2 + (m_3 - n_3)^2\right]}.$$

expert agreement have to obtain more than 75 %(Chen ,2000; Cheng & Lin, 2002; Chu & Hwang, 2008; Murray & Hammons, 1995) . The other requirement in this Fuzzy Delphi methodisrefertotheaverageofFuzzynumberwhichisrefertotheFuzzy(A)≥valueαcut

=0.5(Tang&Wu,2010; Bodjanova,2006)todefinetherankingand acceptableelements for the technology tools construct.

The 7 Likert scale is used in this research to identified the constructs and the elements of the technology used in the NGLS framework. To ease the experts to answer the questionnaires, the 7 Likert scale is used to replace the linguistic variable (Fuzzy scale) as show in Table 3.

**Table3: LinguisticVariable Scale**

| LinguisticVariables | LikertScale | FuzzyScale |
|---|---|---|
| Stronglydisagree | 1 | (0.0,0.0,0.1) |
| Moderatelydisagree | 2 | (0.0,0.1,0.1) |
| Slightlydisagree | 3 | (0.1,0.3,0.5) |
| Neutral | 4 | (0.3,0.5,0.7) |
| Slightlyagree | 5 | (0.5,0.7,0.9) |
| Moderatelyagree | 6 | (0.7,0.9,1.0) |
| Strongly agree | 7 | (0.9,1.0,1.0) |

**Source:**SaedahSirajetal.,2021

Refer Table 3, the Fuzzy scale based on 7 Likert scale is show the value m1 (0.9 indicate the assumption of 90% agreed), m2 (1.0 indicate the 100% agreed) and m3 (1.0 also indicate the 100%agreed).ThehighestFuzzyscaleselectedwillshowthehighestlevel ofaccuracyofthe experts' agreement (Mohd Ridhuan Mohd Jamil, 2016; Muhammad Nidzam, 2016; Sukor Beram et al., 2021).

**RESEARCHFINDING**

The threshold value from the expert consensus is one of requirement for FDM analysis. The threshold value must lower or equal to 0.2 ($d \leq 0.2$). Table 4 show the threshold value (d) for the types of hardware application elements' instrument involve of 13 experts.

**Table**Error! Notext of specified style in document.**:The types of hard ware application elements**

| Experts | TYPESOFHARDWAREAPPLICATION ELEMENTS | | | | | | |
|---|---|---|---|---|---|---|---|
| | **E1** | **E2** | **E3** | **E4** | **E5** | **E6** | **E7** |
| 1 | 0.024 | 0.024 | 0.853 | 0.035 | 0.279 | 0.095 | 0.279 |
| 2 | 0.024 | 0.129 | 0.125 | 0.118 | 0.135 | 0.079 | 0.052 |
| 3 | 0.024 | 0.024 | 0.125 | 0.035 | 0.863 | 0.095 | 0.279 |
| 4 | 0.024 | 0.024 | 0.125 | 0.035 | 0.135 | 0.095 | 0.113 |
| 5 | 0.024 | 0.024 | 0.125 | 0.035 | 0.135 | 0.095 | 0.113 |
| **Experts** | **TYPESOFHARDWAREAPPLICATION ELEMENTS** | | | | | | |
| 6 | 0.024 | 0.024 | 0.125 | 0.035 | 0.135 | 0.095 | 0.113 |
| 7 | 0.024 | 0.024 | 0.125 | 0.035 | 0.135 | 0.095 | 0.113 |
| 8 | 0.024 | 0.024 | 0.125 | 0.035 | 0.135 | 0.095 | 0.113 |
| 9 | 0.129 | 0.024 | 0.268 | 0.118 | 0.079 | 0.079 | 0.052 |
| 10 | 0.024 | 0.024 | 0.125 | 0.035 | 0.135 | 0.095 | 0.113 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 11 | 0.024 | 0.024 | 0.125 | 0.035 | 0.135 | 0.095 | 0.113 |
| 12 | 0.024 | 0.024 | 0.065 | 0.035 | 0.135 | 0.095 | 0.113 |
| 13 | 0.129 | 0.129 | 0.065 | 0.118 | 0.135 | 0.882 | 0.279 |
| **Threshold Value(d) for each** | **0.040** | **0.040** | **0.183** | **0.054** | **0.182** | **0.153** | **0.142** |
| **Value(d) Construct** | | | | **0.113** | | | |

Refer to Table 4. show the value (d) construct is 0.118 and lower than (d ≤ 0.2). The value of the(d)construct indicates theacceptable construct based on FuzzyDelphi process. In spiteof thevalue(d)constructis0.113.Therefore,7elementsinE1(d)=0.040,E2(d)=0.040,E3(d)=0.183,E4(d)=0.054,E5(d)=0.182,E6(d)=0.153andE7(d)=0.142areaccepted in hardware application construct as required by the Fuzzy qualification requirement, the valued ≤ 0.2.Thus, Fuzzy qualification requirement also required to the expert consensus percentage, which is the percentage value must have more than 75 % expert consensus for each element.

**Table5: Summary of the Defuzzification table for the selection of types of hardware application elements**

| | ***TriangularFuzzy Numbers*** | | ***DefuzzificationProcess*** | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Elements** | ***Threshold*,d, value** | **% Expert Consensus** | **m1** | **m2** | **m3** | **Fuzzy Score (A)** | **Expert Consensus** | **Acceptable elements** | **Ranking** |
| 1 | 0.040 | 100% | 0.869 | 0.985 | 1.000 | 0.951 | Accepted | 0.951 | 1 |
| 2 | 0.040 | 100% | 0.869 | 0.985 | 1.000 | 0.951 | Accepted | 0.951 | 1 |
| 3 | 0.183 | 85% | 0.777 | 0.908 | 0.954 | 0.879 | Accepted | 0.879 | 7 |
| 4 | 0.054 | 100% | 0.854 | 0.977 | 1.000 | 0.944 | Accepted | 0.944 | 3 |

| **Ele** | ***TriangularFuzzy Numbers*** | | ***DefuzzificationProcess*** | | | | **Expert** | **Acceptabl** | **Ranki** |
|---|---|---|---|---|---|---|---|---|---|
| 5 | 0.182 | 85% | 0.792 | 0.915 | 0.954 | 0.887 | Accepted | 0.887 | 6 |
| 6 | 0.153 | 92% | 0.808 | 0.931 | 0.962 | 0.900 | Accepted | 0.900 | 4 |
| 7 | 0.142 | 77% | 0.77 | 0.91 | 0.97 | 0.89 | Accept | 0.890 | 5 |

7 5 7 0 ed

Table 5, show the summaryof the defuzzification process for the selection types of hardware application elements. The defuzzification score illustrated the ranking for each element based on the expert consensus. Fuzzy score (A) analysis is range between 0.879 to 0.951 for all elements. In spite of the defuzzification process value also show all the 7 elements have the value of α-cut ≥ 0.5. Thus, all the 7 acceptable elements bythe expert panels and the value of α-cutareE1 andE2 =0.951,E3=0.879,E4=0.944,E5=0.887,E6=0.900andE7=0.890and all the elements have reached the qualify as required by the Fuzzy Delphi requirement. Therefore, the defuzzification process will shift to the ranking process. This process is to determine the ranking of the acceptable elements based on the defuzzification process. The result show that E1 and E2 is at the first ranking number (1) followed by E4 at ranking number(3)and E6 at rankingnumber(4), E7 at rankingnumber(5) and E5 as the ranking (6) and E3 as the last ranking for the element types of hardware application.

**FindingfortheTypesof technologyapplicationtoolsforOnlinetutorial**

The threshold value from the expert consensus is one of requirement for FDM analysis. The threshold value must lower or equal to 0.2 (d ≤ 0.2). Table 4.39 show the threshold value (d) for the types of technology tools for online tutorial elements involve of 13 experts.

**Table6: Types of technology applicationtoolsforOnlineTutorial**

| **Experts** | **TypesoftechnologyapplicationtoolsforOnlineTutorial** | | | |
|---|---|---|---|---|
| | **E1** | **E2** | **E3** | **E4** |
| 1 | 0.000 | 0.053 | 0.309 | 0.000 |
| 2 | 0.000 | 0.053 | 0.083 | 0.000 |
| 3 | 0.000 | 0.053 | 0.083 | 0.000 |
| 4 | 0.000 | 0.053 | 0.083 | 0.000 |
| 5 | 0.000 | 0.053 | 0.083 | 0.000 |
| 6 | 0.000 | 0.053 | 0.083 | 0.000 |
| 7 | 0.000 | 0.101 | 0.075 | 0.000 |
| 8 | 0.000 | 0.053 | 0.083 | 0.000 |
| 9 | 0.000 | 0.101 | 0.075 | 0.000 |
| 10 | 0.000 | 0.053 | 0.083 | 0.000 |
| 11 | 0.000 | 0.053 | 0.083 | 0.000 |
| 12 | 0.000 | 0.053 | 0.083 | 0.000 |

| **Experts** | **TypesoftechnologyapplicationtoolsforOnlineTutorial** | | | |
|---|---|---|---|---|
| 13 | 0.000 | 0.339 | 0.309 | 0.000 |
| **Threshold Value(d)for each item** | 0.000 | 0.082 | 0.116 | 0.000 |
| **Value(d) Construct** | | 0.050 | | |

Refer to Table 6, show the value (d) construct is 0.050 and lower than ($d \leq 0.2$). The value of the (d) construct indicates the acceptable construct based on Fuzzy Delphi process. The threshold (d) value is indicated that all the elements in E1 (d) and E4 (d) =0.000, E2 (d)=0.082 and E3=0.116 are accepted in application tools for online tutorial construct as required bythe Fuzzyqualification requirement, the value $d \leq 0.2$.Thus, Fuzzyqualification requirement also required to the expert consensus percentage, which is the percentage value must have more than 75 % expert consensus for each element.

**Table7: Summary oft heDefuzzification table for the selection types of technology application tools for online tutorial**

| | ***TriangularFuzzy Numbers*** | | ***DefuzzificationProcess*** | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Elements** | ***Threshold,* d , value** | **% Expert Consensus** | **m1** | **m2** | **m3** | **Fuzzy Score (A)** | **Expert Consensus** | **Acceptable elements** | **Ranking** |
| 1 | 0.000 | 100% | 0.900 | 1.000 | 1.000 | 0.967 | Accepted | 0.967 | 1 |
| 2 | 0.082 | 92% | 0.838 | 0.962 | 0.992 | 0.931 | Accepted | 0.931 | 3 |
| 3 | 0.116 | 85% | 0.808 | 0.938 | 0.985 | 0.910 | Accepted | 0.910 | 4 |
| 4 | 0.000 | 100% | 0.900 | 1.000 | 1.000 | 0.967 | Accepted | 0.967 | 1 |

Table 7 show the summary of the defuzzification process for the selection types oftechnologyapplication tools for online tutorial elements. The defuzzification score illustrated therankingforeach elementbased ontheexpertconsensus. Fuzzyscore(A)analysis isrange between 0.910 to 1.000 for all elements. In spite of the defuzzification process value also show all the 5 elements have the value of $\alpha$-cut $\geq 0.5$. Thus, all the 4 acceptable elements by the expert panels and the value of $\alpha$-cut are E1 and E4 =1.000 E2=0.931and E3=0.910 which indicatesalltheelementshavereachedthequalifyasrequiredbytheFuzzyDelphi requirement. Therefore, the defuzzification process will shift to the ranking process. This process is to determine the ranking of the acceptable elements based on the defuzzification process. The result show that E1 and E4 is at the first ranking number (1) followed by E2 at ranking number (3) and E3 is at the last ranking (4) for the element types of technology application tools for online tutorial.

**Finding fort heTypes of technology application tools for Online Learning**

The threshold value from the expert consensus is one of requirement for FDM analysis. The threshold value must lower or equal to 0.2 ($d \leq 0.2$). Table 8 show the threshold value (d) for the types of technology tools for online learning elements involve of 13 experts.

**Table8: Types of technology applicationtoolsforOnlineLearning**

| Experts | TypesoftechnologyapplicationtoolsforOnlineLearning | | | | |
|---|---|---|---|---|---|
| | **E1** | **E2** | **E3** | **E4** | **E5** |
| 1 | 0.115 | 0.094 | 0.125 | 0.133 | 0.106 |
| 2 | 0.279 | 0.094 | 0.268 | 0.148 | 0.070 |
| 3 | 0.863 | 0.094 | 0.853 | 0.729 | 0.872 |
| 4 | 0.115 | 0.059 | 0.125 | 0.251 | 0.106 |
| 5 | 0.115 | 0.059 | 0.125 | 0.251 | 0.106 |
| 6 | 0.115 | 0.059 | 0.125 | 0.251 | 0.106 |
| 7 | 0.115 | 0.059 | 0.125 | 0.251 | 0.106 |
| 8 | 0.115 | 0.059 | 0.125 | 0.251 | 0.106 |
| 9 | 0.072 | 0.094 | 0.065 | 0.133 | 0.070 |
| 10 | 0.115 | 0.094 | 0.125 | 1.009 | 0.106 |
| 11 | 0.115 | 0.059 | 0.065 | 0.133 | 0.070 |
| 12 | 0.115 | 0.059 | 0.125 | 0.133 | 0.106 |
| 13 | 0.115 | 0.059 | 0.125 | 0.133 | 0.106 |
| **Threshold Value(d)for each item** | **0.182** | **0.072** | **0.183** | **0.293** | **0.157** |
| **Value(d) Construct** | | | **0.177** | | |

Refer to Table 8, show the value (d) construct is 0.177 and lower than ($d \leq 0.2$). The value of the (d) construct indicates the acceptable construct based on Fuzzy Delphi process. The threshold (d) value is indicated that the elements of E1 (d) =0.182, E2 (d)=0.072, E3=0.183 and E5=0.157 are accepted in application tools for online learning construct as required bytheFuzzyqualificationrequirement,thevalued≤0.2.However,elementE4isrejectedwith(d)value =0.293, higher than 0.2.Thus, Fuzzyqualification requirement also required to the expertconsensus percentage, which is the percentagevaluemust have morethan 75 % expert consensus for each element.

**Table9: Summary of the Defuzzification table for the selection types of technology application tools for online learning.**

| | ***TriangularFuzzy Numbers*** | | ***DefuzzificationProcess*** | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Elements** | ***Threshold, d*, d value** | **% Expert Consensus** | **m1** | **m2** | **m3** | **Fuzzy Score (A)** | **Expert Consensus** | **Acceptable elements** | **Ranking** |
| 1 | 0.182 | 85% | 0.792 | 0.915 | 0.954 | 0.887 | Accepted | 0.887 | 3 |
| 2 | 0.072 | 100% | 0.823 | 0.962 | 1.000 | 0.928 | Accepted | 0.928 | 1 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 3 | 0.183 | 85% | 0.777 | 0.908 | 0.954 | 0.879 | Accepted | 0.879 | 4 |
| 4 | 0.293 | 46% | 0.662 | 0.815 | 0.900 | 0.792 | Rejected | | |
| 5 | 0.157 | 92% | 0.792 | 0.923 | 0.962 | 0.892 | Accepted | 0.892 | 2 |

Table 9, show the summary of the defuzzification process for the selection types of technology application tools for online learning elements. The defuzzification scoreillustrated the ranking for each element based on the expert consensus. Fuzzy score (A) analysis is range between 0.792 to 0.928 for all elements. In spite of the defuzzification process value also show all the 5 elements have the value of α-cut ≥ 0.5. Thus, all the 4 acceptable elements by the expert panels and the value of α-cut are E1 =0.887, E2=0.928, E3=0.879andE5=0.892whichindicatesalltheelementshavereachedthequalifyasrequired by the Fuzzy Delphi requirement. However, the element of E4=0.792 is not acceptable because not reach the qualify for all the Fuzzy Delphi requirement in the threshold value (d)=0.293 and expert consensus percentage=46%. Therefore, the defuzzification process will shift to the ranking process. This process is to determine the ranking of the acceptable elements based on the defuzzification process. The result show that E2 is at the first ranking number (1) followed by E5 at ranking number (2), E1 is at ranking number (3) and E3 is at the last ranking (4) for the element types of technology application tools for online learning.

**DISCUSSION AND CONCLUSION**

This study obtains the 13 experts' consensus analysis using Fuzzy Delphi technique. Mostly the experts have the agreements toward the technology elements in the NGLS conceptualize framework. The findings shown the threshold value for hardware, online tutorial and online learning elements is between 0.000 to 0.183 which is indicates the acceptable elements in termoftechnologytools.Asforhardwareapplicationelements,7elements are acceptable based on thevalueof (d) lowerthan≤ 0.2. Smartphonein ranking6 ofthe hardwareelements also define as suitable device in online and tutorial learning as smartphone has become ubiquitous fortoday'steachers andstudents.However,smartphonecaninfluencethestudents focus in the teaching and learning process, especially when students are less aware of smartphone information security threats and the suggestion of new ways of learning as supported by(Deni Sutisna et al., 2020; Sage et al., 2020; Taha & Dahabiyeh, 2021) . Extra care must be taken to utilized smartphone in educational settingssince data in smartphonecan be easilybreached and stolen (Taha &Dahabiyeh, 2021). In spite of (Bala, 2020) explain that smartphone is one of the best technology tools in classroom.

Hardware tools also illustrate the experts' agreement to the use of laptop, tablet, interactive audio, desktop, video production and digital cameras. All the elements shown the percentage of 77% to 100% with the value of Fuzzy score (A) range 0.874 to 0.95. The laptop and interactive audio were in the first ranking of the elements as supported from the findings by (Galway et al., 2020; Khaydarova & Uz; Sundar, 2020) who explain that the interactiveaudio, tablet and laptop are suitable technologytools as the pedagogical shift platform among teachers or educators. Therefore, for the next generation, portable computers, laptops, tablet are as personal digital assistants' device for technology tools in learning spaces significantly increased (Nurbanati et al., 2021).

The findings also illustrate that technology tools for online tutorial and online learning are very suitable elements for the NGLS conceptualize framework. As in line with the finding from (Edwards et al., 2021) explain the important of emerging technologies in nextgeneration learning spaces as significant roles in changing learning spaces practices. These findings also supported by (Hensley, 2020; Şentürk, 2020) who stated that, teachers need to enable and enhance their skill in multiple modes of online tutorial and online learning to encourage and motivate active learning (M.Yaqoob Koondhar et al., 2021; Nurbanati et al., 2021).

Online tutorial and online learning are the innovative in a world that increasingly dependent on digital technology, connectivity and access to knowledge and learning. The nextgeneration learning spaces is parallel to the traditional environment, despite that fully supported by technological features. Due to this, with the new learning space, teachers can access teaching and learning material at any time and at any place (Azlan et al., 2020;Galway et al., 2020; Imms & Mahat, 2021; M.Yaqoob Koondhar et al., 2021). The findings also tackled the important use of online tutorial and online learning such as Google Meet, Zoom, Screen Casting, YouTube, Telegram in dealing with the recent phenomena of next generation formal and informal learning (Abidin & Saputro, 2020; Ahmad Alif Kamal et al., 2020; Hidayat & Shafie, 2020; Ishak & Jamil, 2020). This implies that the interactionbetween teachers and students in online tutorial and online learning not only as new teaching strategies, but also the use of technology tools towards improving future generation' intellectual capital.

This study has revealed various implication on teaching practice. From the research findings, theknowledgeandskillrelatedtothepracticeanduseoftechnologytoolscanimprove teachers' confidence as new dimension in teaching strategies. All the technological elements are based on experts' consensus and teachers should create a real functioning learning spaces in line with the technology tools and have to adopt useful technology which is ease of use in their pedagogy strategies is a significant factor. In conclusion, the findings were used to develop the NGLS conceptualize framework and to inform stakeholder about possible the usability of the next generation learning spaces (NGLS) conceptualize framework inteachers' pedagogy as needed by next generation leaners. The implications of this imminent change for next generation education especially as guidelines of the framework are highlighted.The framework also played as important role of education by the Ministry of Education (MOE) to develop technology competency among teachers. The need for new instructional package and teachers' preparation and development programs to capture thenew roles in NGLS.

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