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Using Digital Crowdsourcing in the Development of Innovative Thinking Skills in Generating Research Ideas for Postgraduate Students

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Abstract:

The central focus of this study is exploring the impact of digital crowdsourcing on the development of innovative thinking skills among postgraduate students in the context of generating research ideas. The study employed a descriptive survey approach, utilising a questionnaire as the data collection tool. The questionnaire was designed to address two main aspects. Firstly, it aimed to identify a comprehensive set of innovative thinking skills required for generating research ideas suitable for postgraduate students. Secondly, it focused on assessing the significance of crowdsourcing and its role in cultivating innovative thinking skills during the research idea-generating process. The study involved a sample of 82 educational technology students. The findings of the study revealed a noteworthy trend among the respondents, with the majority expressing agreement or strong agreement with the thesis statement. In addition, the results emphasised the students' clear need for innovative thinking skills to effectively generate research ideas through the technology of digital crowdsourcing.

Keywords: Digital transformation, Technological methods, Research sources, Collaborative approach, Cognitive load, Knowledge production.

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حشد المصادر الرقمية في تطوير مهارات التفكير الابتكاري في توليد الأفكار البحثية لطلاب الدراسات العليا

د. منى بنت صالح الوزان[1]

المستخلص:

هدفت هذه الدراسة على استكشاف تأثير حشد المصادر الرقمية على تنمية مهارات التفكير الابتكاري بين طلاب الدراسات العليا في سياق توليد الأفكار البحثية. اتبعت الدراسة المنهج الوصفي المسحي باستخدام الاستبانة كأداة لجمع البيانات. تم تصميم الاستبانة لمعالجة جانبين رئيسيين ، أولًا ، تحديد مجموعة شاملة من مهارات التفكير الابتكاري المطلوبة لتوليد الأفكار البحثية لطلاب الدراسات العليا. ثانيًا ، ركزت على تقييم أهمية حشد المصادر الرقمية الجماعية ودوره في تنمية مهارات التفكير الابتكاري أثناء عملية توليد الأفكار البحثية. اشتملت الدراسة على عينة من 82 طالبًا من طلاب تكنولوجيا التعليم. كشفت نتائج الدراسة عن اتجاه جدير بالملاحظة بين المبحوثين ، حيث عبرت الأغلبية عن موافقتها بأهمية استخدام حشد المصادر الرقمية. بالإضافة إلى ذلك ، أكدت النتائج على حاجة الطلاب الواضحة لمهارات التفكير الابتكاري لتوليد الأفكار البحثية بصورة فعالة من خلال استخدام حشد المصادر الرقمي.

الكلمات المفتاحية: حشد المصادر الرقمية ، مهارات التفكير الإبداعي ، توليد الأفكار البحثية.

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1. Introduction

In the realm of education, innovation and development are inherently intertwined. Innovation brings forth novelty and originality, propelling the advancement of education. It harnesses the minds of learners and their experiences to foster innovative and shared ideas among students, resulting in improved learning outcomes. By adopting a collaborative approach to innovation in education, and leveraging the input of learners, new ideas that align closely with their specific needs can be identified.

The digital transformation in education has necessitated the use of technological methods to ensure the quality of learning outcomes. One notable outcome of this transformation is the emergence of digital crowdsourcing as an educational tool for developing effective practices in scientific research. The term 'crowdsourcing,' coined by Howe (2006), refers to the process of leveraging external sources to generate content and solve problems. According to Howe, it entails delegating tasks that were traditionally handled internally to an open and undefined network, where active participation and collaboration, as well as individual contributions, can take place.

Likewise, Kronk (2017) highlighted crowdsourcing as an approach that harnesses collective intelligence, drawing on the data and information available from a large number of individuals online to facilitate collaborative problem-solving. Both Howe and Kronk concur on the importance of incorporating a collaborative approach in education to foster expansion and innovation. Digital mediums play a crucial role in facilitating this process by providing the necessary tools and platforms for collaboration and knowledge sharing. Crowdsourcing is revolutionizing the way groups of individuals collaborate to produce knowledge, generate ideas, and translate these ideas into actionable outcomes (Surowiecki 2004). Buecheler et al. (2010) asserted that academic research groups have achieved greater success by incorporating crowdsourcing techniques into their practices.

Crowdsourcing is intricately linked to various theories, including the theory of Cognitive load. This theory describes the limitations regarding the amount of information that can be effectively processed by the human brain's short-term memory. The accumulation of diverse elements creates an insurmountable cognitive burden for the learner (Sweller et al., 2011). Therefore, the theory underscores the importance of cognitive organisation and information storage (Sweller et al., 2011). Crowdsourcing serves as a means to alleviate the cognitive load by engaging learners in collaborative tasks with peers during training activities.

Additionally, crowdsourcing aligns with Hutchins' (1995) Distributed Cognition Theory, which posits that cognition is not solely an individual process but is shaped through social interactions as well as interactions with various tools and the environment. According to Hutchins, knowledge exists outside of individuals and is acquired through the interaction between individuals and resources in the educational environment, particularly when engaged in specific tasks, such as crowdsourcing. As Schreibman et al. (2016) mentioned the utilisation of crowdsourcing is on the rise and provides valuable opportunities for participation in digital humanities research. This is especially evident when addressing challenges that arise during the construction of projects for online collections.

In their study, Tyrrell and Shalavin (2022) emphasized the utilisation of digital crowdsourcing in educational fields to assess the collective thinking abilities of a group of learners. Furthermore, Aacharya (2021) explained the current necessity of crowdsourcing, particularly within the context of open education and the rising popularity of online learning. Notably, crowdsourcing offers significant advantages to education in various ways: enhancing feedback, creating educational content, providing scholarly expertise, and facilitating knowledge sharing (Jiang & Schlagwein, 2018). In addition, crowdsourcing is supported by and benefits from the collective intelligence of the participants (Salminen, 2013).

Moreover, Hassan (2021) affirmed that crowdsourcing provides an environment conducive to the exchange of sources and scientific research skills among students. This collaborative exchange not only facilitates the sharing of experiences but also enables individual collective skill development. Skaržauskaitė (2012) examined the development of crowdsourcing models specifically designed for educational purposes, implemented through a dedicated crowdsourcing platform. This approach involves the engagement of both public and private individuals to contribute towards problem-solving or task execution (Prester et al., 2019).

Chootongchai and Songkram (2018) conducted a study demonstrating the positive impact of online learning systems on the thinking and innovative thinking skills of higher education learners in team settings. The research highlighted how online technology facilitated unrestricted learning and supported the development of innovative thinking skills. The study identified several benefits of online learning, including the acquisition of values, knowledge exchange, and the creation of an environment conducive to critical thinking and innovative problem-solving. This environment promotes collaborative creativity and is not constrained by time or location. Ultimately, the study concludes that innovative thinking, supported by crowdsourcing methods, is an effective approach for addressing challenges, exploring new areas, and generating research ideas.

Aldoreni (1982), defined innovation as the ability to discard the conventional and embrace a new pattern. As such, it is essential to nurture and identify innovative researchers, particularly those who demonstrate a propensity for exploration, synthesis, composing, and discovering. This aligns with one of the interpretations of innovation proposed by Torrance (1965). Additionally, Guilford (1959) asserted that innovation encompasses various cognitive attributes, with fluency, flexibility, and originality being the most significant among them. Building upon this, Rogers (1954) subsequently outlined innovation as the emergence of a new and unique production that stems from the interplay between individuals and their experiential encounters.

Furthermore, Dintoe (2019) highlights the presence of another theory associated with innovation known as The Diffusion of Innovation Theory, originally proposed by Everett Rogers (1963). The Diffusion of Innovation Theory provides a framework for understanding the spread of new technological advancements within educational systems, tracing their journey from initial introduction to widespread adoption. In essence, the theory seeks to explain the process and motivations behind the adoption of new ideas and practices (Dearing & Cox, 2018).

In addition, Tyrrell and Shalavin (2022) mentioned the need for innovative learning spaces in higher education educational contexts. They propose that online platforms can facilitate dialogue and communication among students by involving them in crowdsourcing activities. In addition, Balabel (2011) cited the importance of developing scientific research skills among postgraduate students and highlighted the need for tools to measure these skills and identify students' training requirements.

Moreover, Salminen (2013) reported that crowdsourcing helps higher education institutions remain at the forefront of teaching and research innovation. In addition to this, it prepares learners and researchers to meet the challenges of the online world (Salminen, 2013). Consequently, the Organization for Economic Co-operation and Development (OECD, 2015) asserted that innovation is imperative for driving qualitative changes and expanding education systems. Thus, education policies should facilitate learners' ability to innovate and adapt to innovations, leading to increased efficiency, improved outcomes, and enhanced learning opportunities overall.

Nakano and Wechsler (2018) highlight how, from primary education to higher education, there is a critical need for education that is innovative and prioritises learner motivation, particularly in terms of learning and discovering new topics. Hence it is of great importance that teaching strategies are reevaluated and reshaped in a way that fosters the development of innovative skills relevant to the twenty-first century.

Kairisto-Mertanen et al. (2010) argued that educational innovation should be grounded in a fresh perspective on learning, one that harnesses the potential of modern technology within a modern-day context. Such technologies should facilitate increased engagement and participation both from teachers and students, rendering them more applicable and practical. These points resonate with the objectives of socio-cultural theory (Vygotsky, 1982), which advocates for the integration of theory and practice to effectively address real-world challenges.

Fields, (2014) indicated that the adoption of new methodologies aimed at generating innovative ideas in scientific research enriches knowledge creation and advancement. Embracing such an approach aligns with the recognition of the immense value of utilising crowdsourcing in scientific research.

It has been suggested that future studies incorporating crowdsourcing should explore additional variables, such as critical thinking or innovative thinking (Hassan, 2021). Dow et al. (2013) acknowledged the challenges associated with implementing digital crowdsourcing in education but recognized its potential to foster innovation, emphasizing the importance of well-informed and consistent participation from involved groups. Crowdsourcing is part of the innovation process, especially in involving learners in the creative formulation of innovations (Doan et al., 2011).

The problem addressed in this study stems from the body of existing research, which consistently affirms that Digital crowdsourcing serves as a valuable educational tool for cultivating effective practices within the field of scientific research. Nontable, Hassan (2021). Underscored this point, asserting that Digital crowdsourcing supports resource exchange and enhances the scientific research skills of students (Jiang & Schlagwein 2018; Prester et al., 2019). Furthermore, Schreibman et al. (2016) corroborated that crowdsourcing creates conducive opportunities for active participation in digital humanities research.

Tyrrell and Shalavin (2022) stressed the need to involve students in crowdsourcing activities to establish an innovative educational environment within higher education. Chootongchai and Songkram (2018) complemented this perspective by emphasising how online learning can stimulate innovative thinking skills.

Building upon this foundation, Hassan (2021) proposed that research should explore additional dimensions of crowdsourcing, such as innovative and critical thinking. Dow et al. (2013) affirmed the capacity of crowdsourcing to amplify innovation, positioning it as an integral element of the innovation process, especially when learners engage in creative tasks (Doan et al., 2011).

In light of the above, digital crowdsourcing emerges as an optimal platform for fostering peer-to-peer communication and the adoption of original ideas—a concept aligned with the theory of the spread of innovation (Kaminski, 2011). Therefore, this study seeks to address the research problem, which revolves around assessing the influence of digital crowdsourcing on the development of innovative thinking skills among postgraduate students, within the context of generating research ideas aligning with the digital transformation in education. It is essential to note that the research problem is guided by the following questions:

2. Research Questions

1. What are the innovative thinking skills needed to generate research ideas?
2. How can digital crowdsourcing contribute to the development of innovative thinking skills among postgraduate students in the context of generating research ideas?

3. Methodology

3.1 Study Design

The study employed a descriptive survey methodology, focusing on the examination and evaluation of available events and incidents, while ensuring minimal disruption to normal procedures. A questionnaire was selected as the data collection to survey the responses of 82 postgraduate students. Subsequently, the collected data were subjected to thorough, precise, and meticulous analysis and interpretation. This provided the researcher with specific results regarding the problem that is the subject of the research. The results were then benefited to contribute to developing and improving teaching and learning outcomes in scientific research.

The study sample consisted of all graduate students in the Department of Educational Technology at the College of Education, Qassim University, Saudi Arabia. The researcher opted for a simple random sampling technique and selected 82 students, who willingly participated in the study by responding to the invitation to participate in the questionnaire. Prior to their participation in the questionnaire, graduate students were provided with verbal and written information about the research's purpose and objectives, and their consent was obtained aligning with BERA guidelines. Participants' data remained confidential and was not disclosed throughout the research period.

To ensure the design's efficacy and reliability in handling the potential errors, a preliminary survey was administered to 20 students prior to commencing the main study. This pilot study, assisted in refining subsequent versions of the research design. a pilot study is the first step in the entire research protocol, and is often a small study that helps to plan and adjust the main study (Vemulakonda & Jones, 2016).

3.2 Validity and Reliability of the Data Collection:

This study employed exploratory factor analysis and principal components analysis to examine the structure and validity of the scale. The

Promax diagonal rotation was used, and a loading value cut-off of 0.45 was chosen to determine the acceptance of item loadings. Two items were excluded from each dimension. Confirmatory factor analysis was then conducted using the items obtained from the exploratory factor analysis, employing the maximum likelihood method. Due to the violation of multivariate normality caused by the small sample size, the option RO = .1 RC was utilised. The results demonstrated that the item factor loadings ranged from .38 to .71 for the first dimension and from .57 to .83 for the second dimension. Items were deemed significant if their t-values exceeded 1.96 at a .05 significance level.

The analysis showed satisfactory fit indices, and the factor loadings indicated that the items aligned with their respective dimensions. The results revealed significant item t-values, confirming the acceptance of the items.

Furthermore, to ensure reliability, internal consistency was computed using Cronbach's alpha. This was equal to .90 for overall items on the scale. The Alpha coefficient equaled .86 for the first subscale, and then the alpha coefficient equaled .89f.

4. Results

This section analyses the findings and draws conclusions based on the data obtained through a questionnaire completed by 82 postgraduate students in instructional technology. The results of the data analysis are presented below:

4.1 Responses Tendency According to the Subscale

To answer the first question: What are the innovative thinking skills needed to generate research ideas? The frequencies and percentages were used to identify the sample's tendency on the vocabulary in the sub-scales of the study, and the results were shown in Tables 4 and 5.

Table(4)

. The Frequencies and Percentages of the First Subscale Items

Items	Strongly disagree	disagree	neutral	Agree	Strongly Agree
Factor 1: Innovation thinking skills in generating research ideas					
Flexibility in presenting ideas through educational platforms	-	2 2.5%	-	59 73.8%	19 23.8%
Openness of knowledge in the selection of references and sources	-	3 3.8%	-	50 62.5%	27 33.8%
Distributed knowledge skill	-	3 3.8%	-	55 68.8%	22 27.5%
Generating unfamiliar ideas to solve problems	1 1.3%	2 2.5%	-	48 60%	29 36.3%
Producing ideas creatively	-	2 2.5%	-	48 60%	30 37.5%
Critical thinking as asking questions about the characteristics of the research idea	-	3 3.8%	-	51 63.7%	26 32.5%
The brainstorming skill to produce ideas in an effective manner	-	1 1.3%	-	48 60%	31 38.8%
Examine the research problem in different ways	-	4 5%	-	46 57.5%	30 37.5%
Arranging ideas using visual representations	-	8 10%	-	42 52.5%	30 37.5%
Incorporating other research into one innovative and new idea	-	4 5%	-	36 45%	40 50%
Exploration skill in research area	-	3 3.8%	-	43 53.8%	34 42.5%
Scientific curiosity to embrace change	-	5 6.3%	-	42 52.5%	33 41.3%

Upon reviewing the findings, it is notable that a neutral response option was not available. This indicates that the respondents' opinions generally lean towards supporting the use of digital crowdsourcing to enhace innovative thinking skills when generating research ideas. In addition, the rejection responses do not exceed three out of the total sample size.

To answer the section question: How can digital crowdsourcing contribute to the development of innovative thinking skills among postgraduate students in the context of generating research ideas? Frequencies and percentage distribution were used to identify the sample's inclination towards the vocabulary in the role of crowdsourcing in developing innovation skills sub-scales of the study, and the results were as shown:

Table(5)

The Frequencies and Percentages of the Second Subscale Items

Items	Strongly disagree	disagree	neutral	Agree	Strongly Agree
Factor 2: The role of crowdsourcing in developing innovation skills					
Helps to complete difficult tasks	-	6 7.5%	-	53 66.3%	21 26.3
Contributes to benefiting from different experiences	-	-	-	48 60%	32 40%
Encourages collaborative work among peers	1 1.3%	10 12.5%	-	39 48.8%	30 37.5%
Gather information from various sources	-	2 2.5%	-	45 56.3%	33 41.3%
Reducing effort and time in tasks achievement	-	6 7.5%	-	44 55%	30 37.5%
Helps to develop digital research groups	1 1.3%	3 3.8%	-	49 61.3%	27 33.8%
Doing the search method more attractive	1 1.3%	2 2.5%	-	45 56.3%	32 40%

Items	Strongly disagree	disagree	neutral	Agree	Strongly Agree
Helps competitiveness among learners by mutual experiences	-	12 15%	-	41 51.2%	27 33.8%
Engage learners' research potential on the Internet.	-	1 1.3%	-	49 61.3%	30 37.5%
It reduces the challenges and obstacles facing learners in generating ideas	-	7 8.8%	-	46 57.5%	27 33.8%
Contributes to generate more and better ideas	-	2 2.5%	-	42 52.5%	36 45%
Helps creative reading and thinking	-	5 6.3%	-	44 55%	31 38.8%
Control and check of multiple sources	-	10 12.5%		40 50%	30 37.5%

The first statement within the second dimension reflects higher degrees of rejection across all items in the scale. This suggests that 7.3% of the total sample possess either a low level of technological self-efficacy or a decline in digital skills, particularly related to searching for and providing digital content to navigate generating research ideas. In addition, in the item "Encourages collaborative work among peers," the use of digital crowdsourcing by postgraduate researchers tends to exhibit subjectivity. It is evident that the inclination of 12.5% of the sample towards cooperative work should be highlighted and included. The phrase "Reducing effort and time in tasks achievement" indicates a degree of rejection, with 7.5% of the sample expressing concerns about the time and effort spent. This suggests that the researcher may require more time to search for knowledge and cognitive integration, subsequently leading to the generation of more original research ideas. Therefore, innovative thinking skills assist learners in enhancing several cognitive attributes, with originality being the most

significant (Guilford, 1959). This assertion is supported by Rogers (1954), who argued that innovative thinking skills facilitate the generation of new and novel ideas through interactions between the learners and their experiences.

1.1 Descriptive Statistics

Descriptive statistics indicators were used to estimate scale dimension parameters, such as mean, weighted mean, variance, skewness, and kurtosis (Table 6).

Table(6)

Descriptive Indicators of Subscales

	Min	Max	Mean	Weighted mean	Variance	Skewness		Kurtosis	
						Statistic	Std. Error	Statistic	Std. Error
Innovation thinking skills in generating research ideas	21	50	42.86	4.29	19.43	-1.32	0.27	6.33	0.53
role of crowdsourcing in developing innovation skills	24	55	46.47	4.22	34.86	-0.73	0.27	1.42	0.53

The weighted average values of the two dimensions ranged from 4.22 and 4.29, indicating agreement and strong agreement between participants. However, the variance for the second dimension was inflated, reaching 34.86. This suggests a greater dispersion of individual differences in terms of generating research ideas.

On the other hand, the 19.43 variance of the first dimension is considered acceptable compared to the second dimension. Figure 2 presents the variance length in the two factors in boxplots.

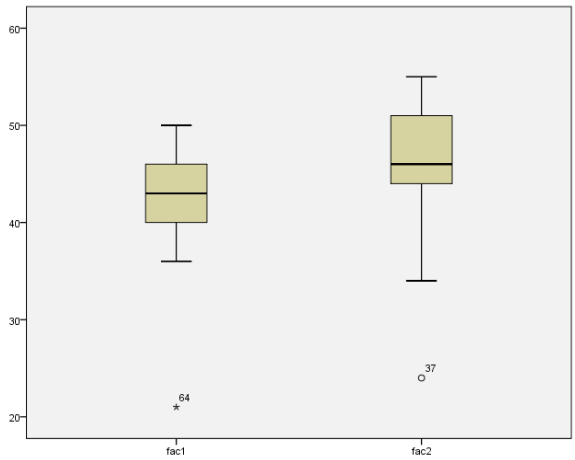

Figure 2. The Boxplot of the Subscales

Notes: Fac1 refers to innovative thinking skills in generating research ideas , and Fac2 refers to The role of crowdsourcing in developing innovative thinking skills.

Table(7)

The Means and std Deviation of the First Subscale Items

Items	Mean	Std deviation
Factor 1: Innovation thinking skills in generating research ideas		
Flexibility in presenting ideas through educational platforms	4.16	0.66
Openness of knowledge in the selection of references and sources	4.26	0.65
Distributed knowledge skill	4.20	0.62
Generating unfamiliar ideas to solve problems	4.27	0.71
Producing ideas creatively	4.33	0.61
Critical thinking as asking questions about the characteristics of the research idea	4.25	0.65
The brainstorming skill to produce ideas in an effective manner	4.26	0.56
Examine the research problem in different ways	4.28	0.71
Arranging ideas using visual representations	4.18	0.87
Incorporating other research into one innovative and new idea	4.40	0.74

Items	Mean	Std deviation
Exploration skill in his research area	4.35	0.68
Scientific curiosity to embrace change	4.29	0.77

The average values for the items in the first dimension ranged from 4.16 to 4.40, indicating a strong agreement among the respondents. Values suggest that the sample recognizes the importance of innovative thinking skills supported by digital crowdsourcing in generating research ideas, demonstrating a consensus among participants.

Table(8)

The Means and std Subscale Items

Items	Mean	Std deviation
Factor 2: The role of crowdsourcing in developing innovation thinking skills		
Helps to complete difficult tasks	4.11	0.75
Contributes to benefiting from different experiences	4.40	0.49
Encourages collaborative work among peers	4.09	1
Gather information from various sources	4.36	0.62
Reducing effort and time in tasks achievement	4.23	0.80
Helps to develop digital research groups	4.23	0.75
Doing the search method more attractive	4.32	0.73
Helps competitiveness among learners by mutual experiences	4.04	0.97
Engage learners' research potential on the Internet.	4.35	0.55
Reduces the challenges and obstacles facing learners in generating ideas	4.16	0.82
Contributes to generate more and better ideas	4.40	0.63
Helps creative reading and creative thinking	4.26	0.76
Control and check of multiple sources	4.13	0.93

The average values of the items in the second dimension ranged from 4.04 and 4.40; indicating a strong level of agreement among the respondents. These values suggest that the sample recognises the importance of generating research ideas supported by digital crowdsourcing, further supporting the results of the study.

1. Discussion

The findings discussed above suggest that the participants' responses to the questions regarding innovative thinking skills and the role of crowdsourcing in developing innovation skills for postgraduate students have significant implications.. This study concludes that the participants have limited technological competence in the context of to digital crowdsourcing, and would therefore benefit from improving innovative skills in generating research ideas. This aligns with Aacharya's (2021) assertion that digital crowdsourcing is needed in education today, especially in open online learning, given the widespread availability of online resources and the prevalence of online learning. Additionally, the subjective nature of postgraduate researchers' use of digital crowdsourcing highlights the significance of cooperative work among peers. This finding is further supported by Tyrrell and Shalavin (2022), who found that digital crowdsourcing enhances collective thinking abilities among learners, especially in educational settings. Kaminski (2011) also emphasized the importance of peer communication in the generation of original research ideas, as highlighted by the Diffusion of Innovation Theory. Therefore, fostering original research ideas is of utmost importance.

The rejection observed in the phrase "Reducing effort and time in tasks achievement" may suggest that the researcher requires more time for knowledge search and cognitive integration, ultimately leading to the generation of more original research ideas. Therefore, innovative thinking skills assist learners in various cognitive attributes, particularly in fostering originality (Guilford, 1959). This viewpoint is supported by Rogers

(1954), who argued that innovative thinking skills facilitate the production of novel ideas through learners' interactions with their experiences.

The widening of individual differences observed in the study can be attributed to several factors. Some learners exhibited low technological self-efficacy, lacked guidance and perceived support, and had limited familiarity with the relevant knowledge. Additionally, their conversational and debating abilities were compromised, and they experienced reduced work efficiency. These findings align with Dow et al. (2013), who highlighted that the challenges faced by digital crowdsourcing in promoting its use in education, especially in fostering innovation. Chootongchai and Songkram (2018) further emphasised that digital learning assists in enhancing innovative thinking skills and enables learners to gain knowledge and exchange experiences.

As a result, there is a convergence in the individual differences associated with innovative thinking skills, indicating the transmission of the training impact among the sample members in tasks related to generating research ideas. Nakano and Wechsler (2018) asserted the need for innovative education that motivates learners from across various educational levels to explore and discover new subjects and ideas. In summary, the results indicate a strong agreement on the use of crowdsourcing to develog innovation thinking skills generating research ideas. This finding supports Hassan's (2021) affirmation that digital crowdsourcing enables students to exchange research skills, share experiences, and enhance their competencies. This may be attributed to its ability to empower learners in navigating knowledge and linking ideas, and gaining access to published papers, ultimately saving them time and fostering openness to new experiences.

2. Conclusion

The study investigated the feasibility of digital crowdsourcing in developing innovative thinking skills for generating original research ideas among graduate students in the Educational Technology Department. The resuls indicated a rang eof responses. There was some variance in response,

whereby the sample's answers ranged between agreeing and agreeing strongly. The results demonstrated that digital crowdsourcing has a significant role in developing innovative thinking skills to generate research ideas. In addition, the results were illustrative of how all innovative thinking skills had been achieved to a large extent through the support of generating research ideas. Not only this, but they demonstrated the extent to which postgraduate students need to develop their innovative skills in research through the technology of digital crowdsourcing.

3. Recommendations

In light of these results, the researcher recommends conducting more studies related to the effectiveness of using digital crowdsourcing with other variables that may enhance other aspects of education, such as critical thinking and scientific research skills in general, or academic achievement and others, including their application to other stages of education. In addition, it would be feasible to conduct the study with a larger variety of methodologies, such as conducting future experimental studies on activating digital crowdsourcing in developing innovative thinking skills to generate research ideas to ensure their direct realisation. Finally, it will be necessary to work on designing learning platforms based on digital crowdsourcing; this may benefit those responsibe for designing social e-learning environments.

4. Limitations

It is crucial at this point to mention the circumstances that influenced this research and, consequently, its findings. The most important of these circumstances were focus on education technology students, in which to conduct my research as it is the researchers specialty, so in possible that future research focus in different fieds. In addition, the research was limited to postgraduate students, so it is possible that future research will address these variables in the context of university education students. It is possible that the results may differ due to the different level of experience. The

descriptive approach was used and not the experimental one, as postgraduate students are not from one region, but rather from different regions, which makes it difficult to apply the experimental method to them. Also, the current research was limited to generating ideas for the research plan, so it is great to use crowdsourcing can be used in the entire scientific thesis.

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