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BRIEF REPORT

REVISED Weak and strong ties and its connection to experts' problem-solving styles in scaffolding students' PBL activities on social media [version 2; peer review: 2 approved, 2 approved with reservations]

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Abstract

Background: Studies have acknowledged that social media enables students to connect with and learn from experts from different ties available in the students' personal learning environment (PLE). Incorporating experts into formal learning activities such as scaffolding problem-solving tasks through social media, allows students to understand how experts solve real-world problems. However, studies that evaluate experts' problem-solving styles on social media in relation to the tie strength of the experts with the students are scarce in the extant literature. This study aimed to explore the problem-solving styles that the experts portrayed based on their ties with the students in problem-based learning (PBL) on Facebook.

Methods: This study employed a simultaneous within-subject experimental design which was conducted in three closed Facebook groups with 12 final year management students, six business experts, and one instructor as the participants. The experts were invited by the students from the weak and strong ties in their PLE. Hinging on the Strength of Weak Ties Theory (Granovetter, 1973) and problem-solving styles (Selby et al., 2004), this study employed thematic analysis using the ATLAS.ti qualitative data analysis software to map the experts' comments on Facebook.

Results: The experts from strong and weak ties who had a prior relationship with the students showed people preference style by being more sensitive to the students' learning needs and demonstrating firmer scaffolding compared to the weak ties' experts who had no prior relationship with the students. Regardless of the types of ties, all experts applied all manner of processing information and orientation to change but the degree of its applications are

Open Peer Review

Reviewer Status ✓ ✓ ? ?

	Invited Reviewers			
	1	**2**	**3**	**4**
version 2 (revision) 16 Dec 2021	✓ report	✓ report		
version 1 25 Oct 2021	? report	? report	? report	? report

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correlated with the working experience of the experts.
Conclusion: The use of weak or strong ties benefited the students as it expedited their problem-solving tasks since the experts have unique expertise to offer depending on the problem-solving styles that they exhibited.

Keywords
Problem-based learning, Facebook, business experts, problem-solving styles

This article is included in the Research Synergy Foundation gateway.

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Author roles: Abdullah AH: Data Curation, Formal Analysis, Investigation, Methodology, Writing – Original Draft Preparation; **Neo TK**: Supervision, Validation; **Low JH**: Supervision

REVISED   **Amendments from Version 1**

This revised manuscript incorporated comments from four reviewers.

Reviewer 1 commented on the fundamental of theory and concepts used in this study. The reviewer suggested removing the theory of fluid and crystallised intelligence to avoid connotations that might not be intended. The new revision removed all elaborations related to the theory and elaborated more on past studies that used the Strength of Weak Ties Theory (Granovetter, 1973) in multiple contexts including problem-solving with the experts. The inclusion of these extant studies showed experts favoured certain problem-solving styles when engaging themselves in strong and weak ties, which supported the rationale of the study to explore the patterns of experts' problem-solving styles when reasoning with students in problem-solving activities. Accordingly, additional arguments were included extensively in the discussion section particularly on the problem-solving styles of the experts and knowledge representations they exhibited. The network analysis (Figure 1) was also revised incorporated with the above changes. The authors agreed with the reviewer that available expertise was the decisive factor particularly on the experts' manners of processing information and orientation to change, however the experts' tie strength with the students affected ways of deciding, whereby experts that established a prior relationship with the students showed more accommodating to the students' learning needs (people preference).

Reviewers 2, 3 and 4 commented mostly on methodological issues. In enhancing the clarity of the methodological section, the revised version included elaborations supported by some literature and the problem-solving protocols used. Elaborations on the ethical considerations were included as well. The fourth reviewer suggested improving the structure of the manuscript. Attention was given on the flow of discussions and placement of figures to help improving the readability the manuscript. These changes affected the numbering orders of the references, but the necessary changes were made accordingly.

Any further responses from the reviewers can be found at the end of the article

Introduction
Background

The use of experts to facilitate students' learning in online settings has gained substantial attention among problem-based learning (PBL) scholars, mainly because expert thinking differs vastly from novice thinking.[1] Novices tend to lose direction when dealing with complex problem-solving, especially when confronting information that is presented simultaneously in an online context. Consequently, when placed in online platforms to solve complex problems, students often need a more experienced individual to guide their thinking to approximate the experts' reasoning[2] and to reconcile the misunderstanding. The use of PBL in technology-rich environments such as social media allows students to receive online scaffolding, a form of assistance from more experienced people who could guide them in performing unfamiliar tasks they are incapable of performing on their own in online mediated platforms.[3] Students may integrate their personal learning environment with unlimited arrays of scaffolders who are socially connected in social media including instructors, peers, and experts to assist in the problem-solving tasks.

Personal learning environment (PLE) is a self-driven learning space that allows individuals to collaborate, connect and participate using one or more technological artifacts, platforms, or online tools available in the personal learning space.[4] Siemens,[5] the founder of social connectivism theory, asserted that the inclusion of PLE is vital in online learning as students could form connections with external sources of more experienced people from dispersed geographical locations that could contribute knowledge and experiences that essentially aid students' educational experience.

The use of social media embedded in students' PLE enables students to gain access to experts who could support their formal and informal learning.[2,6] Social media allows students to tap into the connections of the weak ties from which they might draw resources.[7] In his famous strength of weak ties experiment, Granovetter[8] reported that people secure jobs mostly through weak ties by getting job information from acquaintances rather than close friends or family. Weak ties are defined by relationships that involve infrequent contacts such as distant relatives, acquaintances, or people unknown to us. Meanwhile, strong ties refer to relationships of people who are closely in touch such as family members and close friends. Granovetter argued that although weak ties display low intimacy and emotional intensity than strong ties, it offers vital benefits such as providing more social support and networking strength.[9] Past studies also espoused weak ties provide better connection and support than strong ties.[10,11] The main reason is strong ties usually offer redundant and homogenous resources, which reduces the need to communicate.[11] Therefore, experts devise solutions faster than novices because they use necessary knowledge based on their life experiences that are stored in long-term memory which makes up their crystallised intelligence. Additionally, experts also demonstrate fluid intelligence, namely the ability to reason and adapt without the need for substantial levels of prior learning when confronted with new problems or situations. This enables business experts, for instance, to accustom themselves to an ever-changing contemporary business environment characterised by volatility, uncertainty, fuzziness, and complexity.[13]

In contrast, novices tend to lose direction when dealing with complex problem-solving, especially when confronting information that is presented simultaneously in an online context. Consequently, when placed in online platforms to solve complex problems, students often need a more experienced individual to guide their thinking to approximate the experts' reasoning[14] and to reconcile the misunderstanding. The use of PBL in technology-rich environments such as social media allows students to receive online scaffolding, a form of assistance from more experienced people who could guide them in performing unfamiliar tasks they are incapable of performing on their own in online mediated platforms.[4] Students may integrate their PLE with unlimited arrays of scaffolders who are socially connected in social media including instructors, peers and experts to assist in the problem-solving tasks.

Several studies have investigated how experts deal with novices in problem-solving activities,[1,16–18] very few have explored the patterns of experts' problem-solving styles that are drawn via the use of strong and weak ties to support problem-solving activities with the students. Since problem-solving styles resemble an attitudinal dimension of individual personality[15] and are relatively stable over time,[14] understanding the styles of the experts in different learning settings is vital in developing meaningful learning opportunities with the students.

Objectives and rationales

This study explored the patterns of experts' problem-solving styles when reasoning with students in problem-solving activities, whereby the patterns were mapped against the ties that the students established in their PLE. Since experts think differently from novices, understanding these patterns would help novices and educators gain insight into the scaffolding provided by experts from different ties.

Methods

The sampling techniques and the instruments used were reported according to STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) reporting guideline,[19] a popular guideline in social science research.

Ethical approval and consent

This study was approved by the Research Ethical Committee of Multimedia University (EA2012021). Initially, all participants were briefed on the assignment deadlines and expected roles in the problem-solving protocols. Subsequently, written informed consent for participation and publication of the research has been obtained from the participants. All communications on Facebook were transcribed and their identities were concealed for maintaining the participants' anonymity following STROBE guideline and Subirats *et al.*[20] Before conducting the study, all the participants were informed to set their Facebook accounts to a private setting and were assigned to a private and closed group Facebook to communicate, clarify issues, and share resources.

Study design, setting and participants

The researchers made a call for volunteers who were undertaking a global management course at a Malaysian private university to participate in solving a decision-making business problem. The volunteers were required to invite along two business experts from their PLE to scaffold them for eight weeks. In line with the objective of the study to evaluate the problem-solving styles of the experts that the students have in their PLE, allowing students to select experts from their own PLE is deemed appropriate. This coincides with Dabbagh and Castaneda[4] recommendation to encourage students to use their PLE in formal courses as a means to enrich students' learning experience through interactions among the students, instructors and experts.

The requirements of the business experts were set as follows: having substantial working experience of 10 years or more, holding a managerial position and the experts have one of the following ties with the students; both experts are from strong, weak or both ties. Finally, 12 final-year baccalaureate students (aged 21 to 22 years old) from the Bachelor of Business Administration programme in a global management course that met the research criteria volunteered to participate in a simultaneous within-subject experimental design. Three groups, comprising four students each (two from Cohort 2017 and one from Cohort 2018) was assigned in a closed group Facebook to communicate, clarify issues, and share resources. Furthermore, this group arrangement is common in PBL studies.[21] Facebook was selected because of its effectiveness in supporting various degrees of ties and capability to accommodate small PBL groups.[22]

Meanwhile, Table 1 depicts the business experts' profiles. Groups 1 and 2 used weak ties. A student in Group 1 invited two experts from her former internship company during her diploma studies. Group 2 invited two experts whom the students searched from an organisation's website; none of the students knew the experts before inviting them to participate in this study. Group 3 used a combination of weak and strong ties. The strong tie was one of the students' close relatives while the weak tie was one of the student's internship acquaintances. The business experts from Groups

Table 1. The business experts' profile.

Group	Ties	The industry that the business experts were engaged in and the assigned case.
1	Weak	Shipping industry https://www.nst.com.my/news/2016/03/132323/revival-hope-floats-shipping-master-plan
2	Weak	E-commerce industry https://www.digitalnewsasia.com/digital-economy/slow-internet-speeds-damping-malaysias-digital-economy-aspirations-mdec-ceo
3	Strong + Weak	Airport management https://www.thenational.ae/business/aviation/mattala-rajapaksa-airport-fails-to-take-off-as-sri-lankas-newest-destination

1 and 3 have 20 to 30 years of work experience in the shipping and airport management industry, respectively. Meanwhile, the experts in Group 2 have 10-15 years of work experience in the e-commerce industry.

In order to monitor the progress, the students documented their work on a Google document and the link was pinned on Facebook that could be assessed only by the instructor, experts and students for each respective group. To optimally guide Facebook problem-solving discussions, this study followed Optima 7 Jump (e-learning) protocol of Rienties *et al.*[23] that is commonly used in business education, in the following sequential orders - (1) identifying difficult terms or concepts, (2) identifying the problem and its requirements (the goal of the problem), (3) gathering relevant information such as personal experiences, literature, a news report that is aligned with the learning goal, (4) presenting on the findings in the previous step, (5) discussing the answers to reach an agreement, (6) assessing learning goals if they are answered and (7) summarizing the key points of the entire discussion. We redesigned the Optima model by incorporating, Ge and Land's[24] problem-solving protocol which involved problem identification, developing and evaluating solutions, and assessing alternative solutions to make the discussions and progression more structured. These protocols were briefed to all participants before they began the problem-solving.

Methods of analysis

Friese *et al.*[25] recommended the use of deductive thematic analysis when a pre-existing framework is available. Therefore, the discussions between the business experts and the students were thematically mapped using Selby's *et al.*[15] three problem-solving styles or known as VIEW: An Assessment of Problem-Solving Style.

Orientation to change identifies individuals' preferences when dealing with new problems. This preference covers the cognitive dimension of problem-solving styles that are divided into explorer or a developer. Explorers enjoy initiating a broad range of tasks in a non-directional manner and thriving to see new possibilities and patterns emerge from the new information. Meanwhile, developers prefer the structuredness of the tasks and plans. They usually begin with the basic elements of a problem, then organise and build more complete, functional, and useful outcomes. Whereas, manners in processing information refers to the way individuals arrange information and its flow that can be identified as internal and external processing style. Individuals that prefer internal processing styles need more time to decipher all relevant information before sharing it with others. In contrast, individuals with an external processing style appear to be full of energy when engaging with others while seeking the inputs and expect others to do the same. They also revise ideas along the way.

Finally, ways of deciding are related to individuals' preferences when deciding about options. They can be categorised as people preference or task preference. Individuals with people preference are more concerned with people's feelings and emotions. They also show effort in maintaining harmony and positive relationship with other team members. Oppositely, individuals who are task preference are concerned with task accomplishment, seeking logical arguments to arrive at the most practical solutions, tend to be natural and act free from emotion.

The Facebook communications were transcribed and available in a dataset[26] ATLAS.ti software (Version 8.4.25.0) was used to analyse the identified themes to reflect the business experts' responses. Acknowledging that there is available open-source software as alternatives to ATLAS.ti such as QualCoder and Tagguete, many qualitative scholarly papers adopted ATLAS.ti for its user-friendliness for coding and displaying network analysis results. Besides that, ATLAS.ti has a variety of tools to analyse unstructured data.[27] Moreover, one of the researchers in this study is well-versed in using ATLAS.ti. For those reasons, ATLAS.ti was chosen. Subsequently, the problem-solving preferences (explorer vs.

developer) were coded as follows: orientation to change (OC) (OC: Explorer and PS: Developer), manners in processing information (MP) (MP: Internal and MP: External); and ways of deciding (WOD) (WOD: People and WOD: Task).

Results

Figure 1 displays the network analysis based on the themes extracted from Facebook discussions.

A closer examination of each group disclosed some differences in the problem-solving styles that the experts used. The weak tie experts in Group 1 (Figure 2) displayed a few combinations of problem-solving styles. The experts applied a more accommodating approach and showed a sense of belongingness by using phrases such as "dear team" and "keep moving team". Selby et al.[15] described this as the people preference style where this approach is seen as an effort to maintain harmony in the group. The experts also respected the students' own pace of processing information. Besides that, they required time to digest and internalise the meaning of the information presented to them by the students before responding. This resembles internal style. However, the experts also tended to use the explorer style and expected students to contribute some ideas after the experts presented their points or when the experts would like to comprehend an issue.

In contrast, the business experts from Group 2 (weak ties 2) (Figure 3) adjusted their reasoning based on the information the students presented to them first. The experts preferred the students to explore all possible options and present the latest information before guiding the students based on the materials presented. This sort of arrangement falls under the explorer style. However, the experts mostly engaged with external style or explorer style only after the students probed them questions. Eventually, once they were able to decipher the information, they gradually exhibited a more task preference style, where the tone of the discussion was more towards task accomplishment and tended to be free from emotion.

Lastly, Group 3 which used a combination of both weak and strong ties (Figure 4) showed mixed findings. The strong tie expert (Expert 1 from strong tie) was sensitive to the participants' feelings and ended her comments with remarks such as "Otherwise, good job all". This style is categorised as the people preference. The strong tie expert also demonstrated more persistence and patience in scaffolding the students by presenting the developer style. She directed the students beginning with a basic idea and gradually developed the ideas as the students were progressing by making statements such as "I think it would be a good idea if … .". This characteristic is similar to the style of experts in Group 1. In contrast, the weak tie expert (Industry Expert 2) mostly displayed a task preference style and the explorer style after receiving
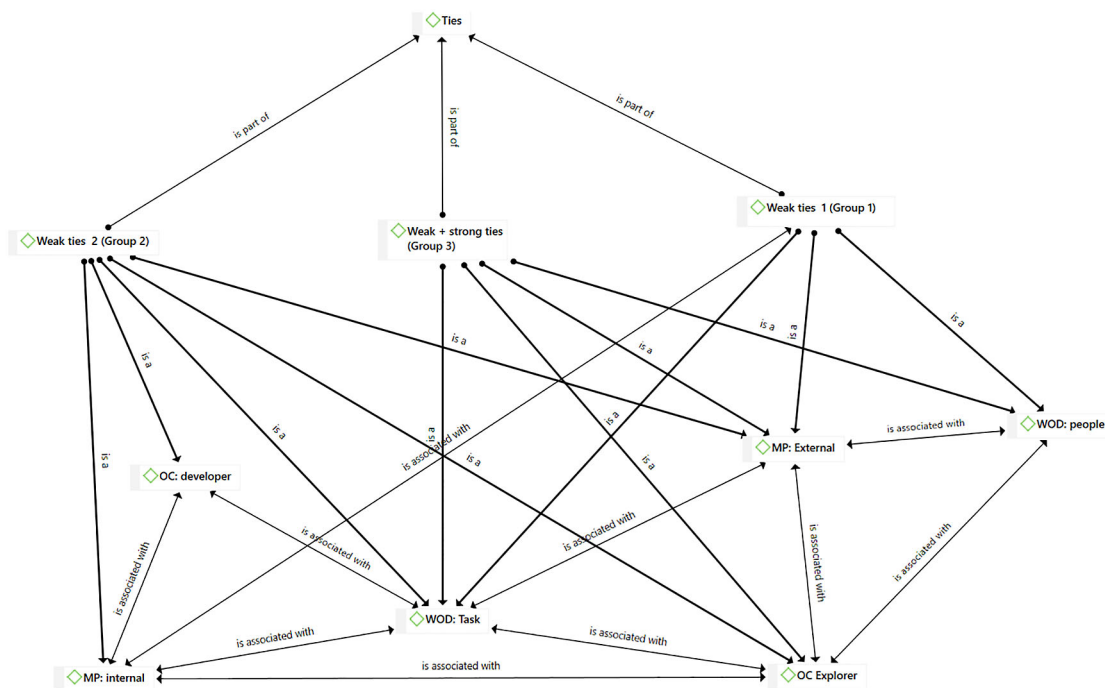

Figure 1. The network analysis from ATLAS.ti.

Excerption from Group 1 (Weak ties)

[Post 3 initiated by Expert 1]:
Dear team, here are my comments and hints:

1. Problem analysis using 5W1H must be consistent with the problem-solving goal....based on your lecturer's comment dated 17 Jan., your team needs to create a new gap. Subsequently, the problem solving goal needs to be amended.
2. Information for problem analysis must be supported with facts and figures i.e. statistics for performance, comparisons, business model, actual costs, indices, for example LSCI etc. Show graphs or figures.
3. Streamline the discussion in problem analysis. The issues on foreign vessels are redundant.
4. The six thinking hats used in this case study is incomplete. Please do not force thru the possible solutions.

Comments for the post:
Expert 1 : Can I look at your finalised versions of stage 1 and 2 again. Just to make sure I don't miss anything important....but Does google docs being updated with the latest/finalised versions?

Student 3: Yes , they were updated

Expert2: before i put forward my comments, just need a little enlightenment on your problem and whose problem that you are going to solve......

Expert 1: since there is a lack of clarity on the "problem", the discussion at the analysis stage indicates lack of continuity and focus. Do not just cut and paste from the article....put your analysis and formulate the information to be consistent with the 5Ws 1H questions.

Student 1: Means we should use Student 3's versions of problem-definition and create the questions from that?

Expert 2 : we can look at her version 1 and 2

Expert 2: Hints: LSCI has 5 major components i.e TEU capacity, shipping companies, services, maximum ship sizes and a number of ships.....Student 3's Version 1 and 2 refer to the attainment of global competitiveness....dear team, my recommendation is to look into these areas and support your facts and figures with LSCI ranking.
Hints: Attainment of global competitiveness but LSCI is showing otherwise....

Expert 1: pertinent question: whose problem do you intend to solve. Which players are we referring to? Shipbuilders, MRO? Ports and Logistics? or any specific trade, such as a commodity, passengers etc.

Expert 2: Ask a simple question, who is the customer/s and player/s of this industry?

Figure 2. The weak tie from Group 1.

information from the students. However, the expert from the weak tie in Group 3 deliberated more insights compared to weak ties' experts in Group 2.

These sorts of problem-solving styles of the experts are correlated with their working experiences. Experts from Group 2 (with 10-15 years of work experience) were flexible in dealing with new information in thinking and reasoning with the students mostly after more information was supplemented by the students. Nevertheless, they provided information lacking in detail to be applied in the context of the problem. In contrast, the business experts in Groups 1 and 3 (with more than 30 years of work experience) demonstrated and shared validated business solutions by occasionally sharing how the presented information was linked to their past experiences. The explanations given by the experts in Groups 1 and 3 were also seen as more insightful compared to the guidance provided by experts in Group 2, for instance, they guided the students to the correct discussion paths by ensuring the students supply up to date information and present information in a logical manner.

Discussion and conclusion
According to Bilalić, McLeod, and Gobet,[18] the greater the degree of expertise, the more flexible the experts are in responding to new information. Experts from Group 1 and 3 were seen flexible in switching between developer and

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Excerption from Group 2 (Weak ties)

Student 1: Among all the new ERG (expectation, reality & gap) stated above, I quote from the text , "Given the target for SMEs to contribute to 41 per cent of GDP by 2020" . That 41% is SME contribution as a whole or SOLELY from online platform. That has to be given more consideration. I would like to gain some insights from our experts Expert 2 and Expert 1 on the suggestions given in the text and the comments by my teammates in the comments above. As of my understanding, the gap between expectation and reality is like what Expert 2 post last time (the 3 points in the final part of the text)

Expert 1: 41% is the whole SME contribution to GDP by 2020

Expert 1: Please download and read National eCommerce Strategic Roadmap here https://mdec.my/about-malaysia/government-policies/national-ecommerce-strategic-roadmap/

Expert 1: Both roadmaps are aligned.

Expert 1: Use both roadmaps as your main reference

Student 1: So yes. To the team, we are focusing on e-Commerce contribution or what is expected. 41% may not be fit to use in our ERG as that figure is about SME business GDP contribution overall. Our EXPECTATION is already as simple and concise as it has been. Expectation: Malaysia government expect to see SMEs/Retailers to extend their business to digital platform.

Instructor : You may also focus on SWOT ..esp SMEs readiness, the issue is more towards the attitude of the SMEs or the facilities readiness (broadband level etc) --Internet speed in Malaysia is also slow , behind Indonesia. dig out more information https://www.malaysianwireless.com/.../akamai-malaysia.../

Expert 1 : Benchmarking with other countries

Student 2: Is it better for us to compare with ASEAN country or globally?

Student 3: We will do the benchmarking on a table and post it here

Expert 1: Compare with developing countries similar to the Malaysian environment eg Taiwan

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Figure 3. The weak ties from Group 2.

explorer style, possibly due to vast experiential knowledge, rendering them capable of deciphering information from different perspectives. The experts mostly used developer style in a combination of internal style when they wanted to check their understanding. For instance, the experts requested, "Can I look at your finalised versions of stage 1 and 2 again. Just to make sure I don't miss anything important" or "I have vetted the case study", which could be inferred that the experts needed some time to appraise the information that the students gave and tried to put the "pieces of the information together" in a way students could understand and use it. Additionally, it was observed that the experts from both groups sometimes expressed experience-based statements such as "I am very familiar with the local shipping industry. I hope this information can provide some clues" and "In aviation, we called it the bird strike hazards". Selby *et al.*,[15] described, this as one of the characteristics of developer styles whereby the problem-solvers framed the discussions based on their present work experience and formulate practical working solutions that can be assimilated into the current reality.

However, they switched to explorer styles when they noticed students started to deviate from the discussion goals. Holton and Clarke[28] noted, experts with complete conceptual knowledge can guide students greatly such as providing forewarning against lacked in progression or mistakes because they know this knowledge exists. In this study, the experts alerted the students by urging cautions such as "your lecturer has mentioned Liner Shipping Connectivity Index. Get hold of it and understand it carefully. Use it in the Malaysian context" or asked probing questions like "Whose problem do you intend to solve? Which players are we referring to? Shipbuilders, maintenance, repair, and operations (MRO) operators? Ports and Logistics? or any specific trade, such as a commodity, passengers, etc". By virtue of having subject-knowledge expertise allowing them to guide students more flexibly and better at posing questions to accommodate critical learning points.[28] Nevertheless, the experts used more technical terms and jargon which necessitated the students to ask a second party to provide the meaning-making for them. Occasionally, the students were observed needing to rely on the other expert or instructor for the meaning-making process (to put the meaning in a context understandable to the students). This

Excerption from Group 3 - Strong ties (Expert 1) and Weak ties (Expert 2)

Expert 1 : Good job team. So.. let's look in-depth at the above matter.

1. Try to find out who owns the airport either an independent company @ the government
2. If the government itself, there shall be less bureaucracy in applying the ICAO Regulations & Standards. Follow all annexes of the ICAO
3. HRI should practise one of the annexes, i.e. Annex on Bird Hazard Management, to avoid the accident.
4. Then only we look at commercial/sort of urban development in the airport itself & at the airport border.
5. Sufficient infrastructure & facilities to attract & make ease the people to link to the airport.

Will get back to you once i've found more details about the info that you've given above (smiley icon)

Expert 2:
Ok Student 2... when the above matter could be solved, more aircraft will accommodate & utilize HRI as their connecting link, the passenger movement will be improved, hence HRI's revenue will be proportionately improved too..

Expert 2: Thanks Expert 1 for the input. I can see 2 main problems with MRIA.
1. The bird strikes
2. Low passenger load
Bird strikes are a common problem at airports in America & Europe. There are solutions such as pyrotechnics, lasers & lights, loud speakers, drones etc with varying degrees of success. Look up bird control on Google.

The low passenger traffic is part of a bigger issue. I think the infrastructure is now in place but there is not enough economic activity to justify the airport in the first place. I think the Sri Lankan govt already has a solution & is going ahead with it. It remains to be seen if that is the right solution.

Students may want to look up the article in Forbes. Also look China's Belt and Road Initiative to understand China's interest & the importance of Sri Lanka in its plans. Just a thought..

Figure 4. The strong and weak ties from Group 3.

is supported by Ryberg[22] who claimed that placing students in different degrees of ties sometimes require different participants like the instructor to provide the interpretation of meaning.

In contrast, experts from Group 2 had different problem-solving styles with the students. Instead of offering the information asked by the students straightaway, the experts from Group 2 often asked the students to search for the materials first, and later worked on the materials together with the students. This reflects the internal style of processing information. This was possibly done to avoid offering inaccurate advice and to verify the information before formulating relevant strategies to scaffold the students. However, Boshuizen, Grubber, and Strasser[29] asserted, intermediate experts usually lacked cognitive capacity when solving problems and may acquire more concepts to better connect existing knowledge networks. In other words, they may have basic concept knowledge but may still require assistance to make the basic knowledge more complete before it could be transcendent into a specific application context.[30] Possibly, the experts lacked situated knowledge, knowledge within the context of an individual environment or where one is currently located,[31] that allowing them to quickly adjust the relevant information embedded in the current context of the problem.

This might explain why experts in Group 2 mostly provided policy papers rather than offering specific real-life business evidence that the students could use as a reference. As a result, the experts tended to share information in a broader sense, for example, the experts recommended, "Benchmarking with other countries", "Do the SWOT analysis on each component of digitization/e-commerce e.g., platform, payment, logistics and fulfillment, small-medium enterprises readiness and others". Whereby, Group 1 and 3, the experts usually shared information by detailing the sources and the connections of the sources with the specific needs of the problem, for instance, "Try to find out who owns the airport either an independent company or the government. If the government itself, there shall be less bureaucracy in applying the International Civil Aviation Organization (ICAO) Regulations & Standards. Follow all annexes of the ICAO".

One common similarity that all of these experts demonstrated was they needed initial information from students before they could fine-tune their scaffolding strategy. This could be implied as initiating a pre-scaffolding strategy. Although experts have more experiential knowledge than novices, experts sometimes need to rely on students and instructor to scaffold their initial understanding. This is consistent with social constructivism viewpoints on the need for knowledge to be co-constructed with others in a dialectical process through problem-solving experiences, to guide thinking and meaning-making towards a more complete understanding.[32] Business problems are usually more intricate to be understood as the problems contain multidisciplinary data sources and sometimes lacked business evidence-based practices.[29]

Since each business problem is unique, experts may not be able to find complete answers and may rely on their current expertise or other people's assistance that could be seen as an effort to obtain reciprocal scaffolding from other team members. Each member in the group at different points may have different expertise, hence, they may reciprocate their scaffolding to help others.[28] The students in this study may have more knowledge about the initial background of the problem, which prompted the experts to exhibit explorer style in combination with external style to gauge the initial information from the students. Once the relevant information was accumulated, they needed time to comprehend the issues by displaying developer and internal styles before channeling to task preference style and eventually exchanging with the students on task-related information. Occasionally, the students and the experts interchangeably played the experts' roles, but the business experts displayed firmer scaffolding roles due to the wider conceptual and experiential knowledge than the students.

In this study, we concluded, all experts displayed orientation to change (explorer vs. developer) and the manner in processing information (external vs. internal) but the degree of its usages depends on the working experiences or situated knowledge that the experts had. However, one noticeable finding was the use of task and people preference style correlates with the past relationship that the students and the experts had. Experts from Group 1 and 3 had a past working relationship with one of the students in each group during internship placement led the business experts to display a more empathic attitude towards the students' learning needs. In contrast, the business experts from Group 2 had no prior relationship with the students, thus their preference for using more task-oriented problem-solving styles that seemed lacking in granting supports such as providing encouragement and showing efforts to maintain group harmony. Although weak ties lack emotional closeness and reciprocal actions,[33] the finding of this study showed the ties with prior relationships help students alleviate available hurdles, which are in line with Castañeda and Selwyn[34] connotation of humanising the technology adoption and learning process itself. This study also verified that scholars should not equate all weak tie experts share similar problem-solving styles. It is postulated that how the students knew the business experts matters. Nonetheless, despite their different styles, the inclusion of the experts in the problem-solving discussions still accelerated the students' learning, in tandem with previous studies that acknowledged business experts' inclusion in PBL enhances students' learning experience.[35,36]

Conclusion

This study contributes towards our understanding of the roles of problem-solving styles and the strength of ties in problem-solving activities on Facebook. The use of networked learning in PBL depends on individualised networking and social collaboration that encourage content generation in problem-solving.[22] It can be concluded from the findings that not all experts from the weak ties have similar problem-solving styles. Factors such as the experts' work experience and how the weak ties were developed played a major role in determining the experts' problem-solving styles, which indirectly influenced their thinking and reasoning strategies with the students.

The experts, regardless of whether they were from weak or strong ties, still benefited the students in expediting their problem-solving tasks. Thus, inviting business experts to participate in formal learning on social media by utilising the strong and weak ties the students have should be encouraged as each expert has unique expertise to offer, especially in helping the students see the different sides of complex information that are essential to prepare for their future career.

Limitations

The use of non-probability sampling involving two experts in each of the three groups in one degree-level management course limits the generalisability of the findings to other courses. Hence, the study's findings should be evaluated with caution and may only be applied to similar studies, for example, those that examine Facebook use for PBL in management courses.

Data availability
Underlying data
Figshare: Facebook Discussion with Business Experts (transcribed), https://doi.org/10.6084/m9.figshare.16811542.v2.[26]

This project contains the following underlying data:

- Full transcribed data:

  - Datafile 1: Transcribed conversation of Group 1

  - Datafile 2: Transcribed conversation of Group 2

  - Datafile 3: Transcribed conversation of Group 3

- Data coding:

  - Datafile 4: Orientation to change (OC) developer style

  - Datafile 5: Orientation to change (OC) explorer style

  - Datafile 6: Manner of processing (MP) external style

  - Datafile 7: Manner of processing (MP) internal style

  - Datafile 8: Way of deciding (WOD) task preference style

  - Datafile 9: Way of deciding (WOD) people preference style

Data are available under the terms of the Creative Commons Attribution 4.0 International license (CC-BY 4.0).

Acknowledgments

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Open Peer Review

Current Peer Review Status: ✓ ✓ ? ?

Version 2

Reviewer Report 24 December 2021

✓ **Els Boshuizen** (iD)

Faculty of Educational Sciences, Open University, Heerlen, The Netherlands

I am very pleased about the way the author revised the article. It is very well readable now, and makes an interesting contribution to what we know about how ways of expert scaffolding of student learning processes.

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Expertise development; expert vs novice knowledge and knowledge structure; expert vs novice reasoning.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Reviewer Report 23 December 2021

✓ **Fauziah Sulaiman** (iD)

Faculty of Science and Natural Resources, Universiti Malaysia Sabah, Kota Kinabalu, Malaysia

I have read the revised article and it seems all corrections were done accordingly. Thus, from my side, I don't have any issue in accepting the article for further process.

Competing Interests: No competing interests were disclosed.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

- -

Version 1

Reviewer Report 23 November 2021

https://doi.org/10.5256/f1000research.76848.r97802

?   **Lillian Buus** (iD)

VIA University College, Aarhus, Denmark

The article works with weak and strong ties in relation to PBL group-work inviting in experts to scaffold students learning.

This is an interesting and relevant research, although I miss a clear theoretical approach, as it seems the theory is not following through the article. The authors present in the introduction 'connectivism' but do not refer to this or their arguments in the introduction or the discussion. I also wish to stress that the first two references are placed wrong and that Siemens is missing an s (just to have some formats in place).

What I would suggest to the authors, is to work a little more with the structure of the article as well. I miss a clear theoretical part, that also can be part of the argumentation in the discussion. So, choose only some of the theoretical approaches brought in, and go more in depth with these arguments.

Another part I would like the authors to consider is the figures. It might be good to structure the 'Excerption from the groups' after each other, as it becomes confusing to read the analysis 'in between' figures. I also miss the arguments for the statement: "The explanations given by the experts in group 1 and 3 were also seen as more insightful compared to the guidance provided by experts in Group 2" - I miss the "Why" and "How" arguments on this.

I also would like the authors to elaborate more on the analysis and how they have conducted that e.g. with examples of parts that identified the expert's roles. Also, for other being able to in details to replicate the research. Transparency is important, and there is a minor lack in this part.

A part I also think is missing in the methods is the ethical consideration on using SoMe like Facebook for this. Not that it is wrong but I believe that there is some issue combined with this. What if an expert didn't have Facebook or would use this media for professional work issues? What about the right for information on Facebook? Other ethical issues could also be stressed. Just a notion on this could be expected as well when talking ethical issues.

It was positive to read that the authors took into consideration the sampling for the research, which is good. I think the research is interesting and I would like the authors to go more into this to gain more insights for this.

Good work so far and just work on the combination of theoretical arguments and analysis/conclusion will give your article more strength.

Is the work clearly and accurately presented and does it cite the current literature?
Partly

Is the study design appropriate and is the work technically sound?
Partly

Are sufficient details of methods and analysis provided to allow replication by others?
Partly

If applicable, is the statistical analysis and its interpretation appropriate?
Not applicable

Are all the source data underlying the results available to ensure full reproducibility?
Yes

Are the conclusions drawn adequately supported by the results?
Partly

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Expertice in Problem-Based learning and education, knowledge about strong and week ties, from novice to expert (Dreyfuss and Dreyfuss), Teaching with digital technologies and social media use,

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Reviewer Report 09 November 2021

https://doi.org/10.5256/f1000research.76848.r97803

? **Mohd Nazir Md Zabit** (iD)

Department of Educational Studies, Universiti Pendidikan Sultan Idris, Tanjong Malim, Malaysia

This paper aims to explore the problem-solving styles that the experts portrayed on Facebook based on their ties with the students.

Overall, the methodology suits the research requirements. It has been clearly explained and easily understood by readers. The only concern is how the authors arrange and monitored the three closed Facebook groups with 12 final year management students, six business experts, and one instructor as the participants. Need a little bit of explanation.

Overall, the manuscript has been written and prepared in a moderate writing style. The work is acceptable based on the suggestions given and should also be based on other assessors' comments.

Is the work clearly and accurately presented and does it cite the current literature?
Yes

Is the study design appropriate and is the work technically sound?
Partly

Are sufficient details of methods and analysis provided to allow replication by others?
Partly

If applicable, is the statistical analysis and its interpretation appropriate?
Not applicable

Are all the source data underlying the results available to ensure full reproducibility?
Yes

Are the conclusions drawn adequately supported by the results?
Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Business education; teacher pedagogy; thinking skills

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Reviewer Report 08 November 2021

https://doi.org/10.5256/f1000research.76848.r97807

? **Fauziah Sulaiman** (iD)

Faculty of Science and Natural Resources, Universiti Malaysia Sabah, Kota Kinabalu, Malaysia

Overall the article is well written and easy to follow. It is about the use of PBL in the Facebook platform to students' engagement in real-life activities by involving the business expert as the booster for them to really immersed in the issue they are facing. However, the weak and strong ties in this research are lacking with basic info, for example, why does the student need to choose by themself the business expert? Why not the researcher choose the business expert? Therefore the weak, strong, and weak+strong group setting maybe can be arranged. Having these totally different group settings can lead maybe different impactful outputs. Just a thought anyway.

So these are my comments on the statement that I commented as partly:)

Other than that, all looks adequate.

A few additional comments on the manuscript can be found here.

Is the work clearly and accurately presented and does it cite the current literature?
Yes

Is the study design appropriate and is the work technically sound?
Yes

Are sufficient details of methods and analysis provided to allow replication by others?
Partly

If applicable, is the statistical analysis and its interpretation appropriate?
Partly

Are all the source data underlying the results available to ensure full reproducibility?
Yes

Are the conclusions drawn adequately supported by the results?
Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Education: Physics/Science Education, Educational Technology, Higher Education, in-depth in Problem Based Learning Model. Physics: Non-Destructive Testing (Eddy-Current Testing Technique)

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Reviewer Report 02 November 2021

https://doi.org/10.5256/f1000research.76848.r97804

❓ **Els Boshuizen** [ID]

Faculty of Educational Sciences, Open University, Heerlen, The Netherlands

This article investigates how external experts (that is, not connected to the university) with weak or strong ties to the students can support them through social media in their problem-based learning activities.

It is investigated in three PBL groups of four students each, who worked on divergent topics, and who invited two domain experts per group. The Facebook platform was used for communication and cooperation as it provides ample opportunities for data collection.

A couple of theoretical foci were applied: strong vs weak ties; PLE as a means to receive on-line scaffolding; expertise seen as fluid vs crystallised intelligence; aspects of expert-novice interaction; Selby's problem solving styles; system1 vs system2 thinking. One could say that this is an innovative combination of theoretical approaches, however - in my view - it blurs the real innovation in this study, that is, the participation of outsider-experts in student support through many different expert actions: providing information and information sources, pointing out gaps, asking questions, etc. combined (or not) with motivating actions. Also the role of the instructor as a go-between students and experts is an interesting addition. And I agree with the authors that the participation of these experts was successful.

Having said that I list a couple of issues that need clarification:
1. The authors should make clear why they introduced the theory of fluid and crystallised intelligence to describe expert reasoning and knowledge use in combination with interaction with novices. Using this theory introduces connotations that might not be intended. Especially in a short article like the present one, it is better to be sparsimonious with concepts used. Very much research has been done on the issue expert-novice communication in PBL including the question whether intermediates might fulfil a better role (for instance by Schmidt and Moust) that does not use these concepts.

2. Furthermore, the authors should better document how the use of fluid vs crystallise intelligence was coded. And in the Results section it is good practice to provide proof using quotes. The excerpts given provide interesting reading material but they do not show how the researchers coded this.

3. The issue of strong vs weak ties is very interesting. I wonder whether the way expert invitation was carried out was sensitive to tie strength. I assume that available expertise was the decisive factor, not kind of tie. It is, of course, interesting whether kind of tie affects communication.

4. The issues raised by Bilalic et al. and by Kahneman resonate in different ways with fluid and crystallised intelligence. They are very interesting but by introducing these authors it is

more difficult to bring the message across.

5. Small issue p7: According to Bilalic, <u>McLeod</u>, and Gobet .. McLeod is missing.

6. As the journal's focus is on fast publication, I would prioritise the comments on Method and Results.

Is the work clearly and accurately presented and does it cite the current literature?
Partly

Is the study design appropriate and is the work technically sound?
Partly

Are sufficient details of methods and analysis provided to allow replication by others?
No

If applicable, is the statistical analysis and its interpretation appropriate?
Not applicable

Are all the source data underlying the results available to ensure full reproducibility?
Yes

Are the conclusions drawn adequately supported by the results?
Partly

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Expertise development; expert vs novice knowledge and knowledge structure; expert vs novice reasoning.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Author Response 02 Nov 2021
Aznur Hajar Abdullah, Multimedia University, Cyberjaya, Malaysia

Dear Prof Els Boshuizen,

We are greatly appreciative of the insightful comments and helpful suggestions that you have provided.

Some of the issues are somewhat similar in term of the responses, so we encapsulated issue 1 and 3, in the last comments (comment no# 5).

The following are our response on the five issues that you have highlighted:

1. Thank you for proposing Schmidt and Moust's paper, we had read the paper with great interest. Schmidt and Moust studied about what makes a tutor effective and we found some similarities in the line of argument, that also emphasizes the personal qualities of the tutor . In essence this study proposed, do not presume experts from similar ties would offer similar degree of scaffolding as their degree of scaffolding corresponds with the level of crystallised intelligence that they have .
We have commented more detailed in comment #5 below).

2. * In the revised version later, we will incorporate more clearly on why t the theory of fluid and crystallised intelligence was used.

3. In the original submission the codes were attached, but they were coded directly from Facebook communication (all Facebook communications were the snapshots from Facebook and coded in ATLAS.ti). Despite the identities of all participants were cancelled and made anonymous , for copyright purposes, the F1000 reviewer recommended to transcribe the conversations as they cannot be published with any element associated to Facebook.

   *In the revised version, we will incorporate again the coding.

4. To some extent we believe the ties matter as strong tie and weak tie with more working experiences who showed differing in levels of intelligence (fluid vs strong intelligence) - they were more accommodative to students' learning needs. Explaining about the tie per se seems incomplete to explain why not all weak tie experts behave in similar manner when scaffolding the students. Experts from Group 2 showed different scaffolding approach from experts from Group 1 and Group 3 . We have commented more detailed in comment #5 below).

5. Rather than looking at Bilalic and Gobet resonate differently from Kahneman's, we opine that the arguments from these authors complement the findings of this study. Bilalic and Gobet resonate the flexibility of the experts is in accordance with the degree of fluid and crystallised intelligence that the experts have. This study showed that, experts with lesser working experiences tended to seek "help" or to rely on information provided by the students before they could fully utilised System 2 thinking to scaffold the students to deal with ill-structured problems. Although novices have to go through certain stages before they could pick up and put pieces of information into a meaningful context, your comments made us realised, the experts with less crystalised intelligence need to put pieces of information too. Interestingly, we view this as a pre-scaffolding preparation that experts from Group 2 in this study exhibited before they could devise an appropriate assistance to students. Your comment has enlightened us to propose future research to investigate the reciprocal role that students could play in scaffolding the experts' thinking.

In the revised version we will improve the clarity of the sentence to capture the above comments in the revised version. If you agree with the above comments, please let us know.

Thank you again for your time in reviewing this manuscript.

Competing Interests: No competing interests were disclosed.

Comments on this article

Version 1

Author Response 21 Nov 2021

Aznur Hajar Abdullah, Multimedia University, Cyberjaya, Malaysia

Dear respected reviewers,

Thank you for your time in reviewing the manuscript and providing insightful comments.

We just would like to let you know that we are in the midst of incorporating all the changes that you had proposed.

Regards,
Aznur, Neo (Ken), Low (Jimmy)

Competing Interests: No competing interests were disclosed.

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